LITHUANIAN ACADEMY OF PHYSICAL EDUCATION

Arūnas Emeljanovas

EFFECT OF REGULAR LONG TERM SPORTS GAMES AND CYCLICAL SPORTS EVENTS EXERCISES AT THE AGE OF 11–14 YEAR OLD FOR BOYS DEVELOPMENT IN MOTOR AND SENSOMOTOR ABILITIES AND CARDIOVASCULAR SYSTEM

Summary of doctoral dissertation
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LIETUVOS KŪNO KULTŪROS AKADEMIJA

Arūnas Emeljanovas

SPORTINIŲ ŽAIDIMŲ IR CIKLINIŲ SPORTO ŠAKŲ POVEIKIS 11–14 METŲ BERNIUKŲ ŠIRDIES IR KRAUJAGYSLIŲ SISTEMAI, MOTORINIŲ IR SENSOMOTORINIŲ GEBĖJIMŲ RAIDAI

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INTRODUCTION

Biological maturation is one of the critical factors that determine physiological response to physical load (Rowland, 1996). Body responses to exercising asserts as changes of functional and morphological systems (Stergiou, 2004; Karoblis, 2005). Children develop very individually and irregularly (Martin,1993). Individual development depends not only on inherent qualities but also on effective environment influence. At first children who matures earlier also are physically superior, they show relatively very high results, often they gain on and overtake those who mature subsequently. During sportsmen selection coaches have to take notice of those who potentially strong, but mature later (Olson, 1996; Платонов, 1997; Karoblis, 1999; Kozlowski et al., 2001; Busso et al., 2002; Docherty, 2002; Armstrong, Welsman, 2005).

Children and adolescents' exercising closely linked to sportsmen selection process improvement, the discovery of talents and education by scientifically reasonable research methods during their exercising type predisposition considering their individual features (Кочергина, Ахметов, 2006).

The obtained results of long term repetitive workouts indicated essential adaptive changes in cardiovascular system (Pober et al., 2004) and skeletal muscle. Regular physical load determines increase in functional capability of cardiovascular system. Functional potential of the heart often appears as a conditional factor, which restricts organism adaptive abilities therefore heart adaptation to intensive physical loads is one of the most important conditions that limits general organism adaptation of ambient environment. While body growth the first 10 – 15 years until the mechanism of blood flow is not developed, the main importance goes to heart rate (HR) under the influence of increase in heart capacity during physical load, whereas in adults, after changes in blood-vessels appear, dominant alternation are determined by changes in arterial blood pressure (ABP). Changes in cardiovascular system determine that in different ranges of age physical load activates different physiological adaptive mechanisms, i.e., their different parameters (Hainsworth, 1995; Fletcher et al., 1996; Ivaniura, 1999; Winsley et al., 2003; Poderys, 2004).

Thus, young sportsman body is different than grown-up body. Adolescent is very good at adaptation of grown-up sportsmen' training regime however training programs for children and adolescents have to be prepared for every range of age individually considering all the factors of physical development (Malina, Bouchard, 1995; Rowland, 1996; Wilmore, Costill, 2001; Philippaerts et al., 2006). Lately given rather high worldwide sports achievements, due to this selection of talented children plays a significant role. The results showed that competitive sports have no negative influence on growth before sexual maturation and factors of body constitution are essential for children during selection of exercising type. All the young sportsmen comparisons with non-athletes indicate better maturation of young sportsmen. These comparisons show both unquestioned positive effect of exercising (Seibutienė, 2004; Strong et al., 2005) and selection process. Adolescents of a better maturation sooner achieve higher results therefore it is a great possibility that they are going to become high skilled athletes (Wilmore, Costill, 1999; Damsgaard, 2000; Armstrong, Welsman, 2005).

Hypothesis: The age phase from 11 to 14 is very sensitive to external impacts. Furthermore, in conformity with principle of adaptation specificity it is probable that sports games and cyclical sports events for their exercise type particularity *(variable intensity, partially regulated is appropriate for sports games performances and for cyclical sports events are appropriate cyclic nature and strictly regulated physical loads)* have different effect on cardiovascular system adaptation peculiarities, motor and sensomotor abilities development in growing and expeditiously developing body functions. Therefore the results of this age phase in exercising children can reveal complicated interaction between inherent and acquired (*endogenous and exogenous*) factors.

The aim of this study is to determine the effect of regular and long term sports games and cyclical sports events exercises at the age of 11–14 year old for boys development in motor and sensomotor abilities and cardiovascular system adaptation peculiarities.

Tasks of the work:

1. To assess the development of non-athletes' cardiovascular system, motor and sensomotor abilities in the age phase of 11–14.
2. To identify the effect of cyclic sports events on development of cardiovascular system, motor and sensomotor abilities for the boys of 11–14 years old.
3. To identify the effect of sports games on development of cardiovascular system, motor and sensomotor abilities for the boys of 11–14 years old.
4. To compare the effect of variable intensity, partially regulated physical load which is appropriate for sports games performances and cyclic nature, strictly regulated physical load which is appropriate for cyclical sports events on the changes of boys functional preparedness indices.

Work originality:

The originality of this work can be generalized with these assertions:

There were deepened knowledge about children's irregularity of growth and development. It was established irregular improvement in muscular power and capability parameters as much as in indices of central nervous system (CNS): in the age phase of 13–14 the rate of improvement decreases. Functional state indices of cardiovascular system and its changes increase during physical load with the age, whereas at the age of 13–14 the rate of improvement in functional indices of cardiovascular system increases.

There was revealed that in the age phase of 13–14 variable intensity type physical load as a appropriate feature of sports games performances is more essential external factor than cyclic exercises which have influenced on faster dynamics in functional indices of muscles, cardiovascular system and CNS.

While the comparison of functional parameters changes of athletes and non-athlete children peculiarities were evaluated by the change of the effect of interaction of endogenous and exogenous factors on children body maturation. We showed that endogenous factors' influence increased in the age phase of 13–14, therefore by the change of functional indices of cardiovascular system and CNS increased significantly and non-athlete children getting almost equal to the athletes contemporaries considering these parameters.

1. RESEARCH ORGANIZATION AND METHODOLOGY

1.1. Subjects

The results of two studies are presented in this research work:
The first – evaluation of changes in cardiovascular system, motor and sensomotor abilities at the age of 11–14 non-athlete, sports games and cyclic sports events sportsmen (groups' comparison).

The contingent of this study was 257 boys of 11–14 years of age: all participants were distinguished into three groups: non-athlete $NA_{11\text{-}14}$ (n=85), engaged in cyclic sports events – track and field athletes $C_{11\text{-}14}$ (n=89) and sports games athletes – basketball, volleyball, football players $SG_{11\text{-}14}$ (n=83) (1 – 4 investigations).

The second – cyclic sports events and sports games athletes were tested for four years (every year on September – October): C_{11} (n=35), C_{12} (n=21), C_{13} (n=18), C_{14} (n=15), SG_{11} (n=35), SG_{12} (n=19), SG_{13} (n=17), SG_{14} (n=16) (5 investigation).

1.2 Methods

The subjects had no any hard training session two days before the investigation. All tests were performed at the same time of the day. The next methods were used:

1) Tapping test,
2) Roufier exercise test,
3) Vertical jump test,
4) 30 s maximal jumping test,
5) Measurements of ABP,
6) Electrocardiography,
7) Dynamometry,
8) Stabilography,
9) Measurements of body mass components,
10) Nonlinear ECG data analysis methods.

1.3. Protocol of the studies

Due to answer our study tasks we will present the data of five investigations:
The first – changes of non-athletes' cardiovascular system, motor and sensomotor abilities in the age phase of 11–14.
The second – changes of cyclic sports events athletes' cardiovascular system, motor and sensomotor abilities in the age phase of 11–14.
The third – changes of sports games athletes' cardiovascular system, motor and sensomotor abilities in the age phase of 11–14.
The fourth – the effect of long-term adaptation to sports games and cyclic sports events physical loads (groups' comparison).
The fifth – the effect of long-term impact of sports games and cyclic sports events on cardiovascular system, motor and sensomotor abilities.

We divided all investigations into two days: The first day – all participants were measured by body mass components, stabilography and dynamometry methods and the second – all subjects underwent Tapping test and vertical jump tests, Roufier exercise test and 30 s maximal jumping test. The period between two investigation days were 24 hours.

The first day, before measurment of body mass components indices, boys 10 minutes were sitting in the laboratory and were instructed to investigation process. After measuring body mass components, subjects performed 10 minutes warm-up and then were evaluated balance abilities by

stabilography method. While boys had 10 minutes rest was evaluated muscular power with manual dynamometer.

The second day. Tapping test were performed before vertical jump test, Roufier exercise test and 30 s maximal jumping test. Before tapping test there was not any warm-up, but subjects were instructed to investigation process and they were allowed to try it. Afterwards boys performed 15 minutes warm-up and then underwent vertical jump test. They accomplished 3 onetime maximal efforts, vertical jumps selecting the best one. Later all participants had 15 minutes rest while they were standing and were prepared for ECG registration, ABP assessement. While participant was sitting were registered ECG and ABP at rest. After were performed Roufier test and then subject had been sitting for 2 minutes. Next cohorts underwent 30 s maximal jumping test and at the oneset of the rest they performed 10 knee-bends (knee-bend at a 90^{o} angle of knee-joint) and then again had been sitting for 2 minutes. During all investigation were registered standard 12-lead ECG and estimated ABP before workouts, straight afterwards and each minute during recovery.

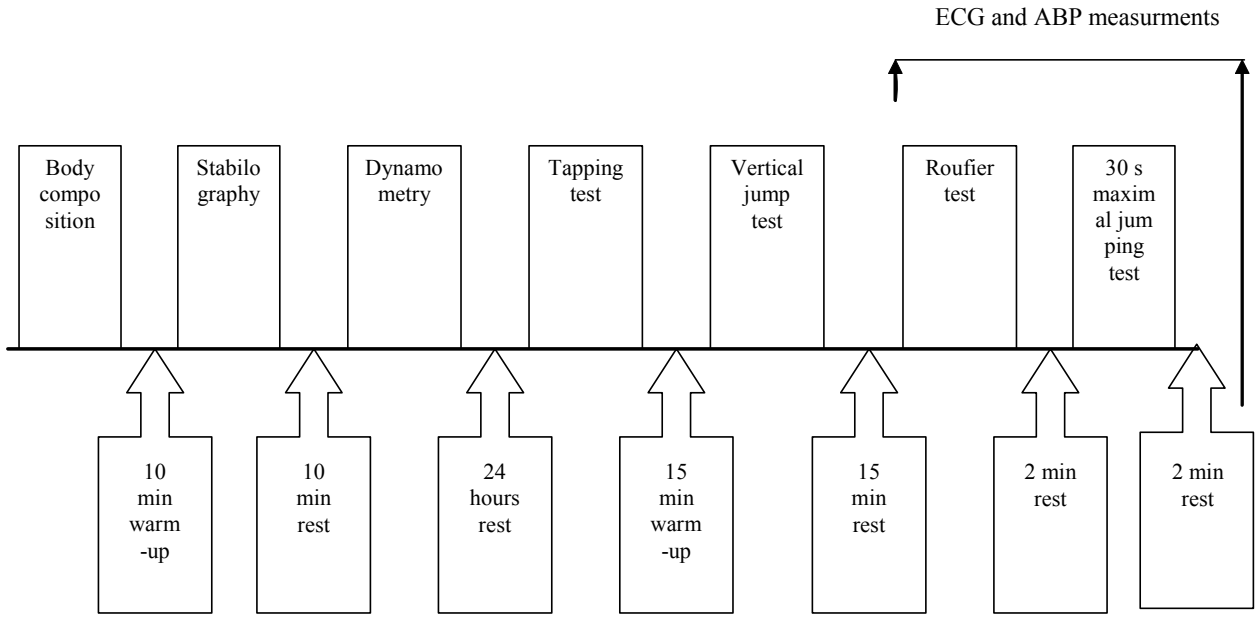


Fig. 1. **1–4th investigations organization scheme (*the first study*).**

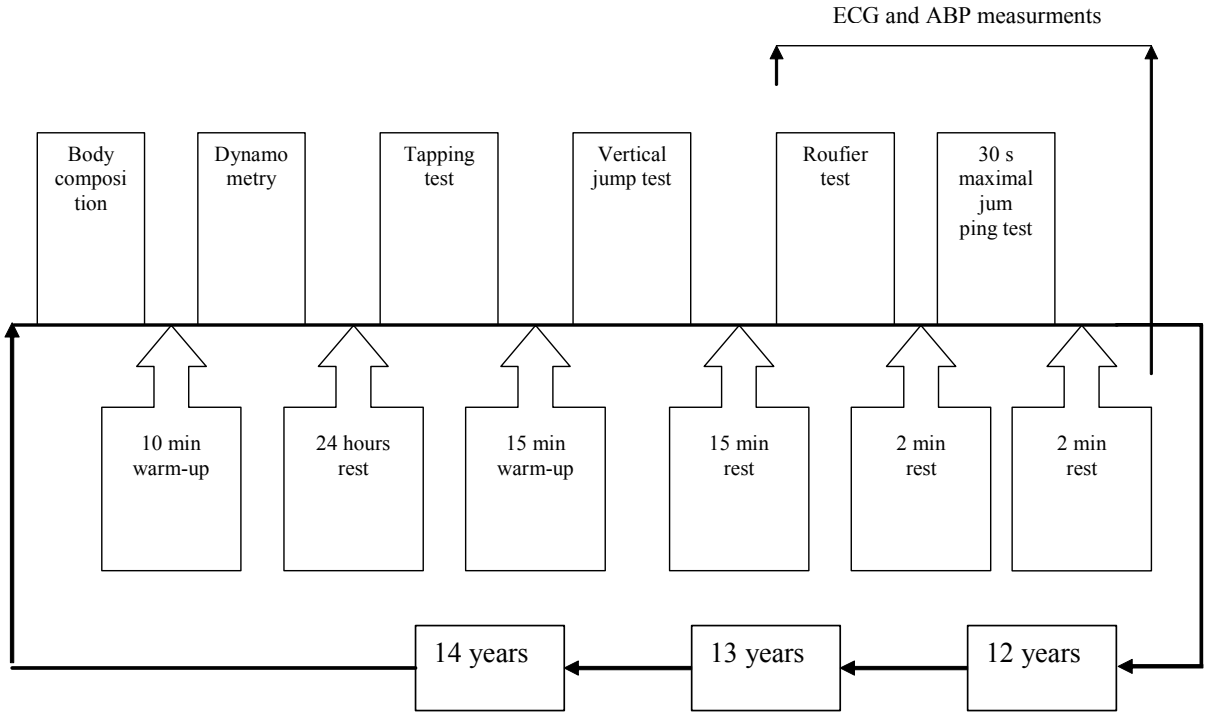


Fig. 2. **5th investigation organization scheme (*the second study*).**

2. RESULTS

2.1. Changes of non-athletes' cardiovascular system, motor and sensomotor abilities in the age phase of 11–14.

During evaluation of changes in non-athlete' sensomotor abilities in the age phase of 11–14 it was indicated that over years changes of indices of CNS in non-athletes children improve considering tapping test results in our study.

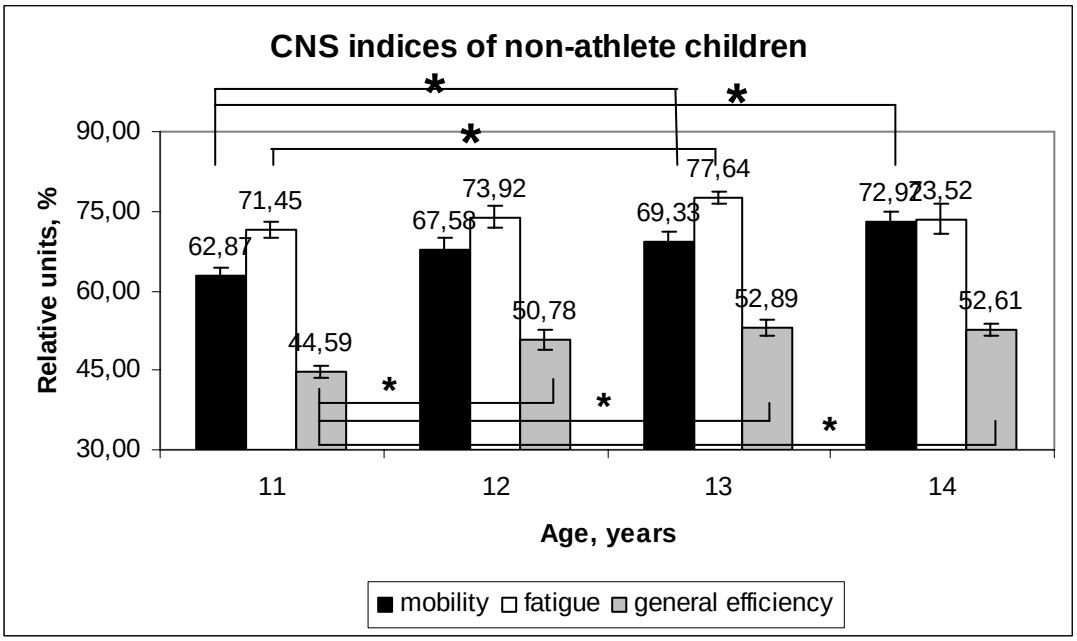
Statistically significant differences were observed comparing the results of CNS general efficiency and anaerobic work capacity of 11 years of age children with other three age groups (Fig. 3).

In the age phase of 11–14 non-athlete boys' muscular efficiency indices increased statistically significantly. This was shown by the 30 s maximal jumping test (Fig. 4) and dynamometry, measuring the power of hand levators, hips flexors, calf flexors (Fig. 5) and extensors, forearm levators and extensors.

Research results revealed that the balance evaluation stabilography indices with the open eyes of the 11–14 years of age children were lower compared to closed eyes (Fig. 6 and 7), what is related to better balance sustention, i.e. significant visual control role in balance tasks performance.

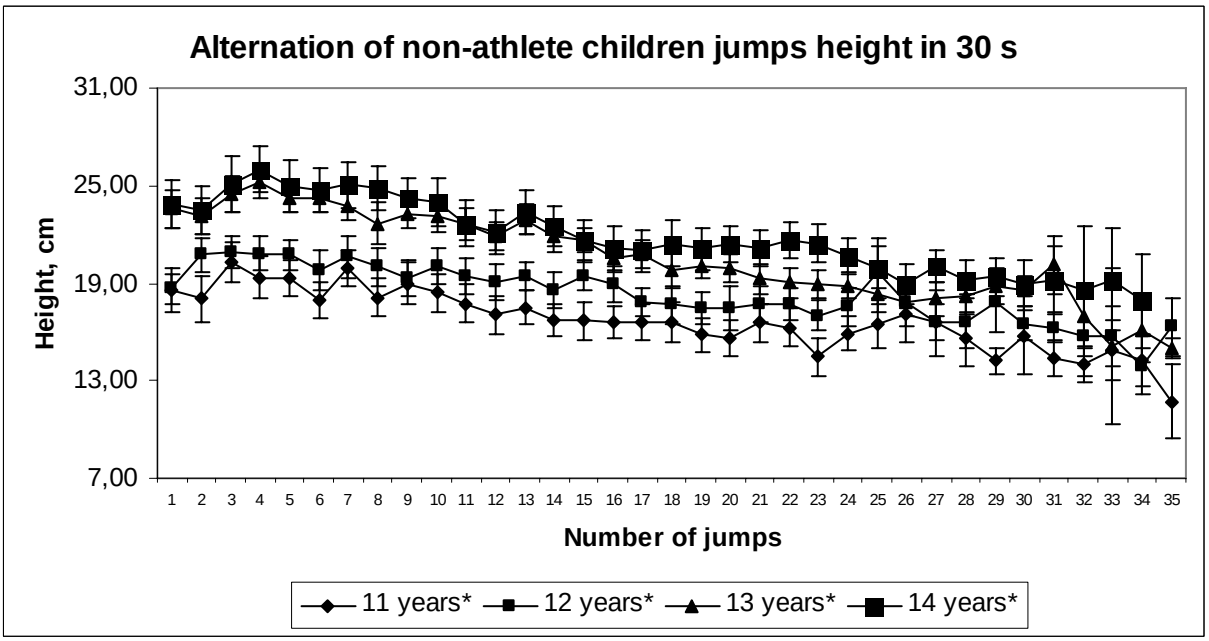
The results of non-athletes ABP measurements indicated that diastolic ABP did not vary much with age, and, observing systolic ABP alternation, statistically significant differences were determined comparing 11–14 years of age groups and in most cases 13–14 years of age groups.

When participants were performing physical load tests, most of the registered ECG indices alternations statistically significantly differed just after 30 s maximal jumping test. HR values significantly differed among 12–13 years of age non-athletes boys and, in most cases, in 11–13 years of age period as well. Accordingly ECG JT interval values varied during investigations.



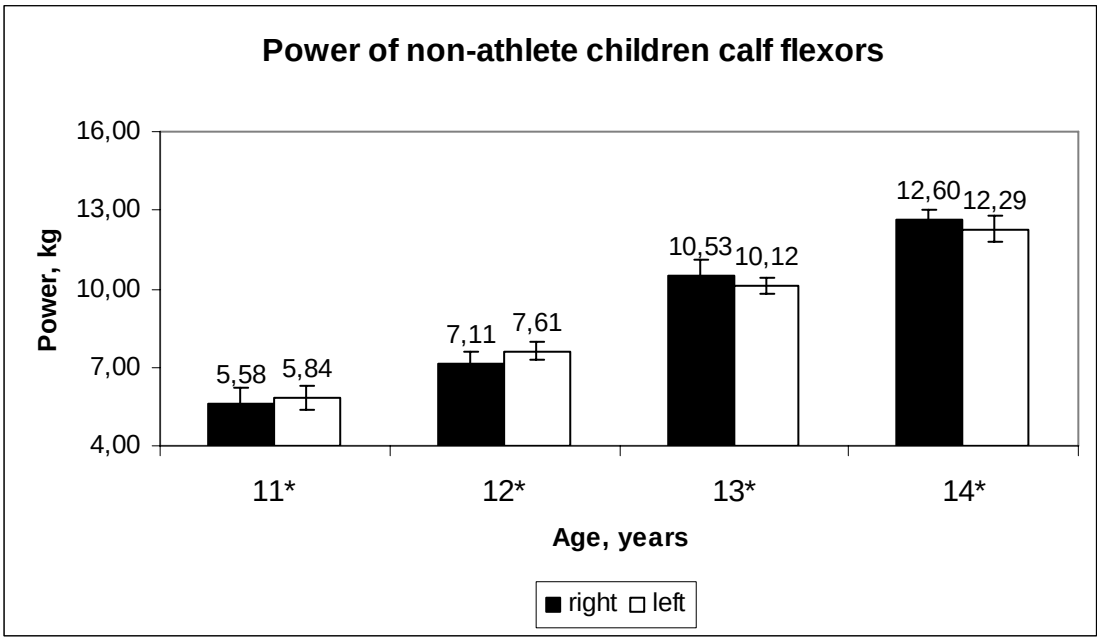
Note. * – statistically significant difference, p<0.05.

Fig. 3. **CNS mobility, fatigue and general efficiency indices of non-athlete boys**



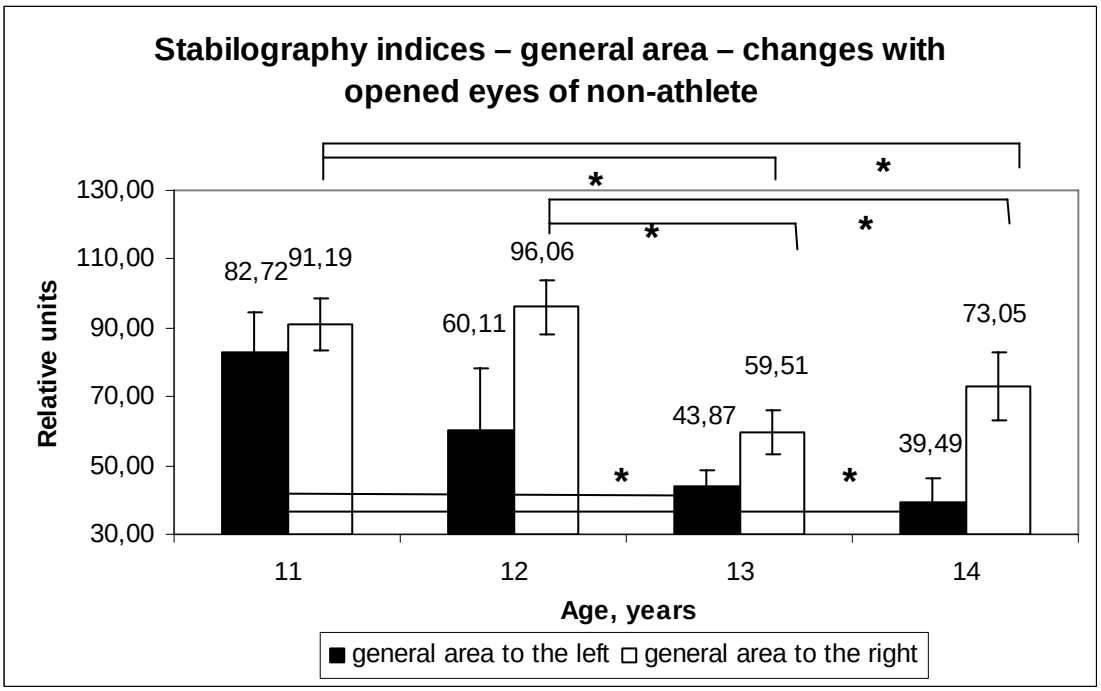
Note. * – statistically significant difference, p<0.05.

Fig. 4. **30 s maximal jumping test height results of non-athlete boys**



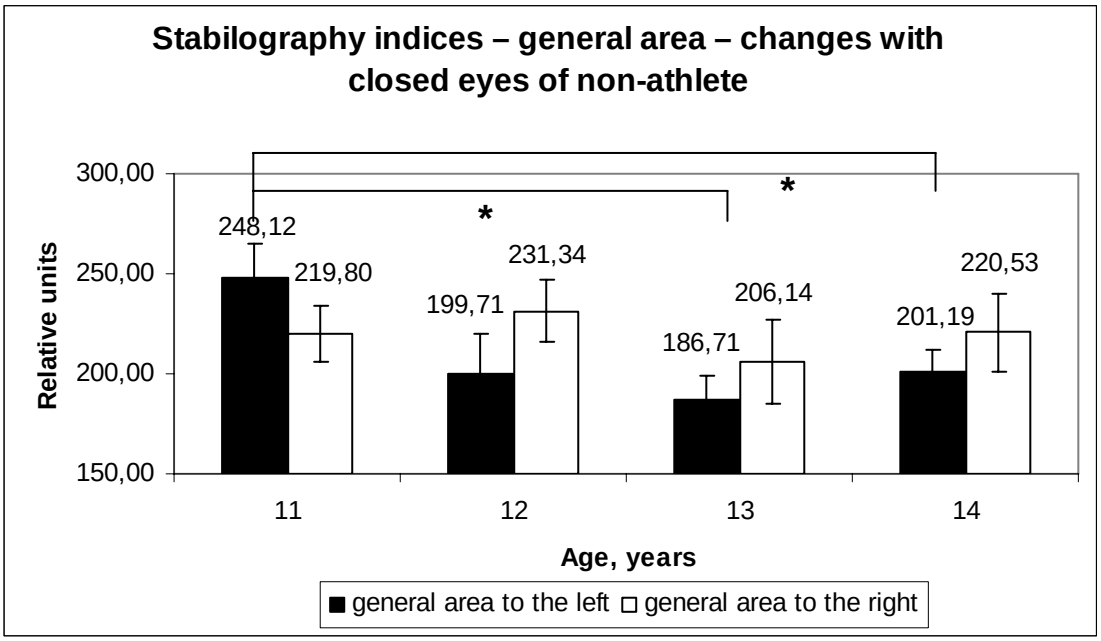
Note. * – statistically significant difference, p<0.05.

Fig. 5. **Non-athlete boys calf flexors power results**



Note. * – statistically significant difference, p<0.05.

Fig. 6. **1 min with opened eyes stabilography indices – general area to the left and to the right –results**



Note. * – statistically significant difference, $p<0.05$.

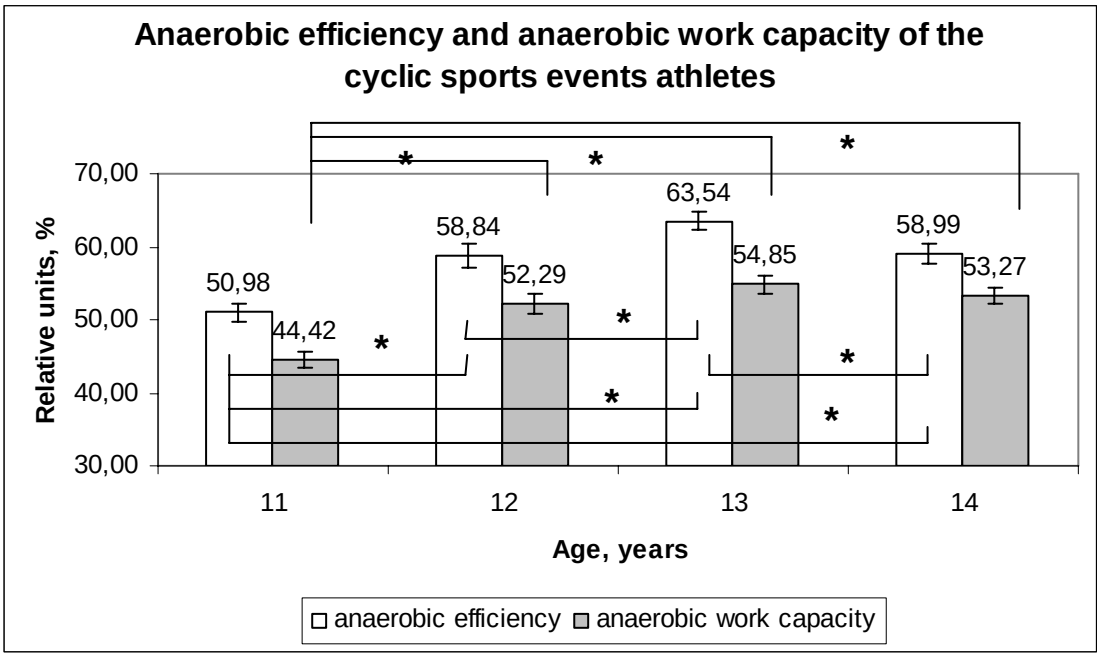
Fig. 7. **1 min with closed eyes stabilography indices – general area to the left and to the right – results**

2.2. Changes of cyclic sports events athletes' cardiovascular system, motor and sensomotor abilities in the age phase of 11–14

As in case of non-athletes boys, cyclic sports events athletes'CNS efficiency and functional state indices, which were registered in the second research stage by Tapping test, improve with age because a statistically significant difference was determined between 11 years of age and 12, 13 and 14 years of age groups, assessing both CNS mobility and anaerobic and general efficiency (Fig. 8). However, when the boys reach the age of 13, the rates of CNS indices improvement decelerate, 14 years of age cyclic sports events athletes'CNS indices slightly decreased.

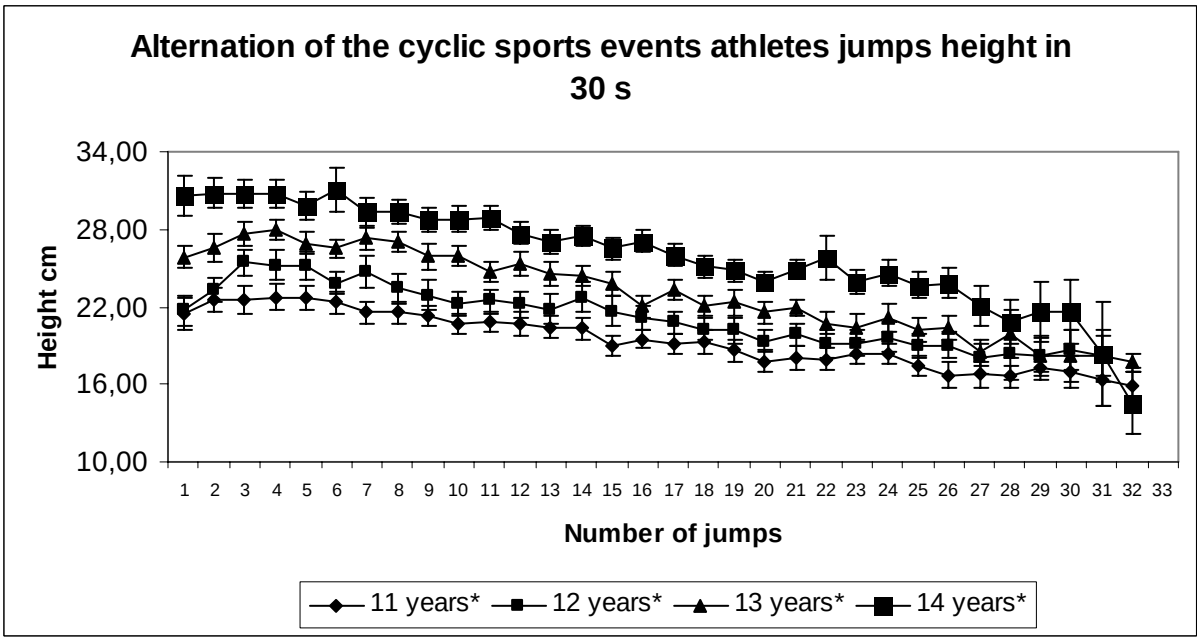
Vertical test and 30 s maximal jumping test indicated that cyclic sports events athletes their best results achieved at the age of 14, statistically significant differences were observed among all age groups (Fig. 9). Investigating the power of muscles it could be seen that it also increases with age and the highest power increase was determined at the boys'age of 13 (Fig. 10).

The minimal HR indices were found of 11 years of age boys, maximal – of 13 years of age boys. After both loads HR most rapidly restored of 11 years of age cyclic sports events athletes, slowliestly – 13 years of age boys. By this research, statistically significant difference was determined among 11-13 years of age boys'groups (Fig. 11).



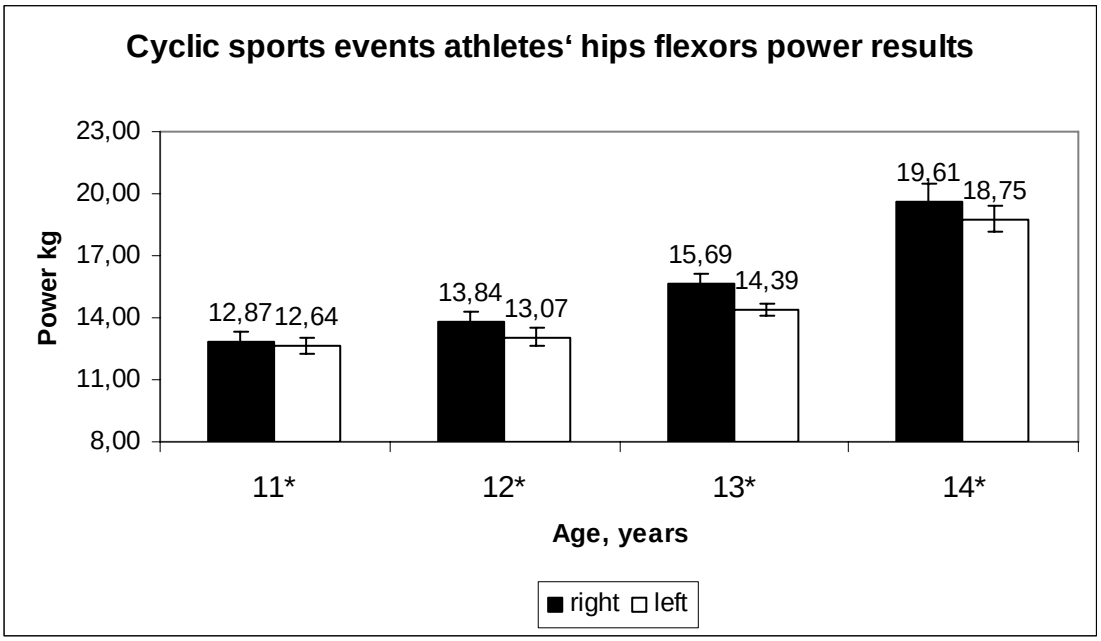
Note. * – statistically significant difference, p<0.05.

Fig. 8. **Anaerobic efficiency and anaerobic work capacity indices of the cyclic sports events athletes**



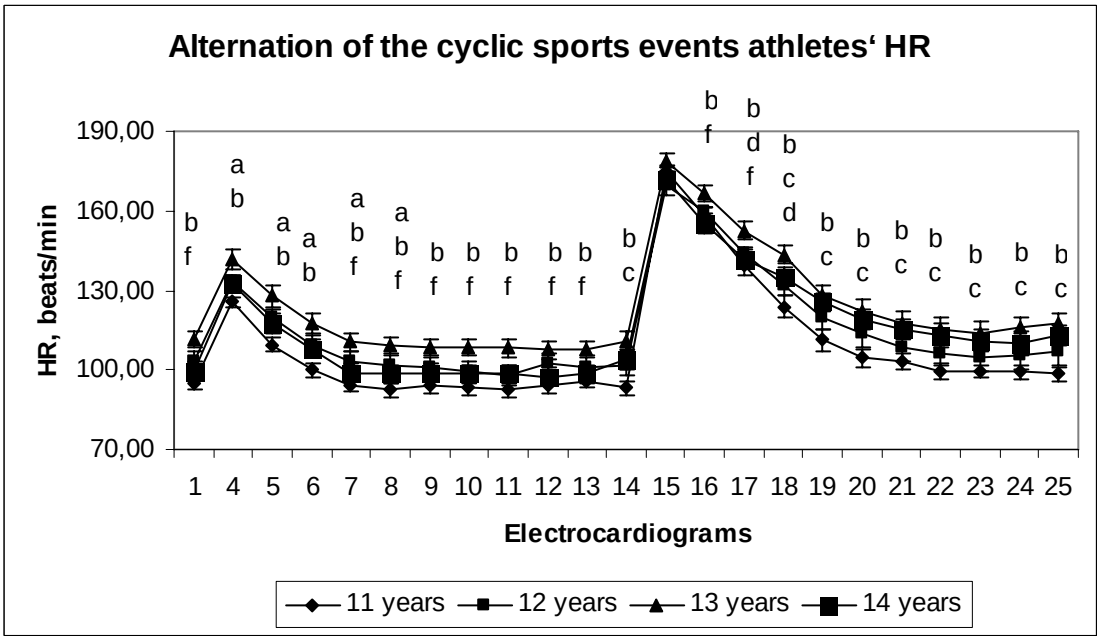
Note. * – statistically significant difference, p<0.05.

Fig. 9. **30 s maximal jumping test height results of the cyclic sports events athletes**



Note. * – statistically significant difference, p<0.05.

Fig. 10. **Cyclic sports events athletes‘ hips flexors power results**



Note. Difference between 11-12 years – a, 11-13 years – b, 11-14 years – c, 12-13 years – d, 12-14 years – e, 13-14 years – f – statistically significant difference, p<0,05.

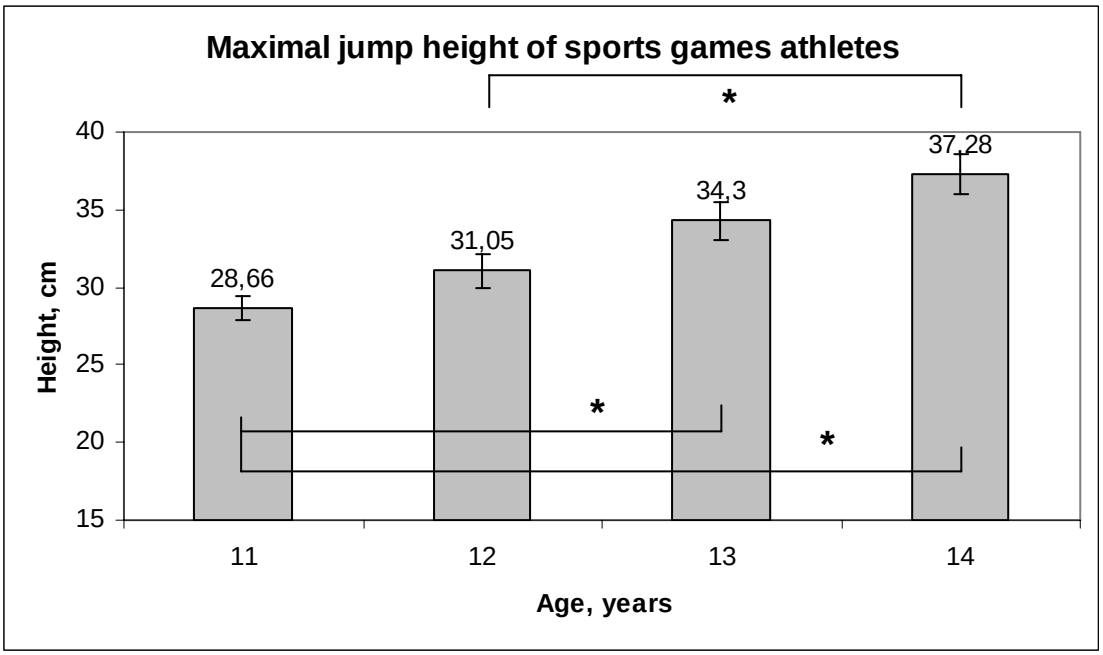
1 ECG – before load; 4-14 ECG – recovery afterRoufier test; 15-25 ECG – recovery after 30 s maximal jumping test.

Fig. 11. **Alternation of the cyclic sports events athletes‘ HR performing Roufier test and 30 s maximal jumping test**

2.3. Alternation of the cardiovascular system, motor sensomotor abilities of sports games athletes in the age phase of 11–14

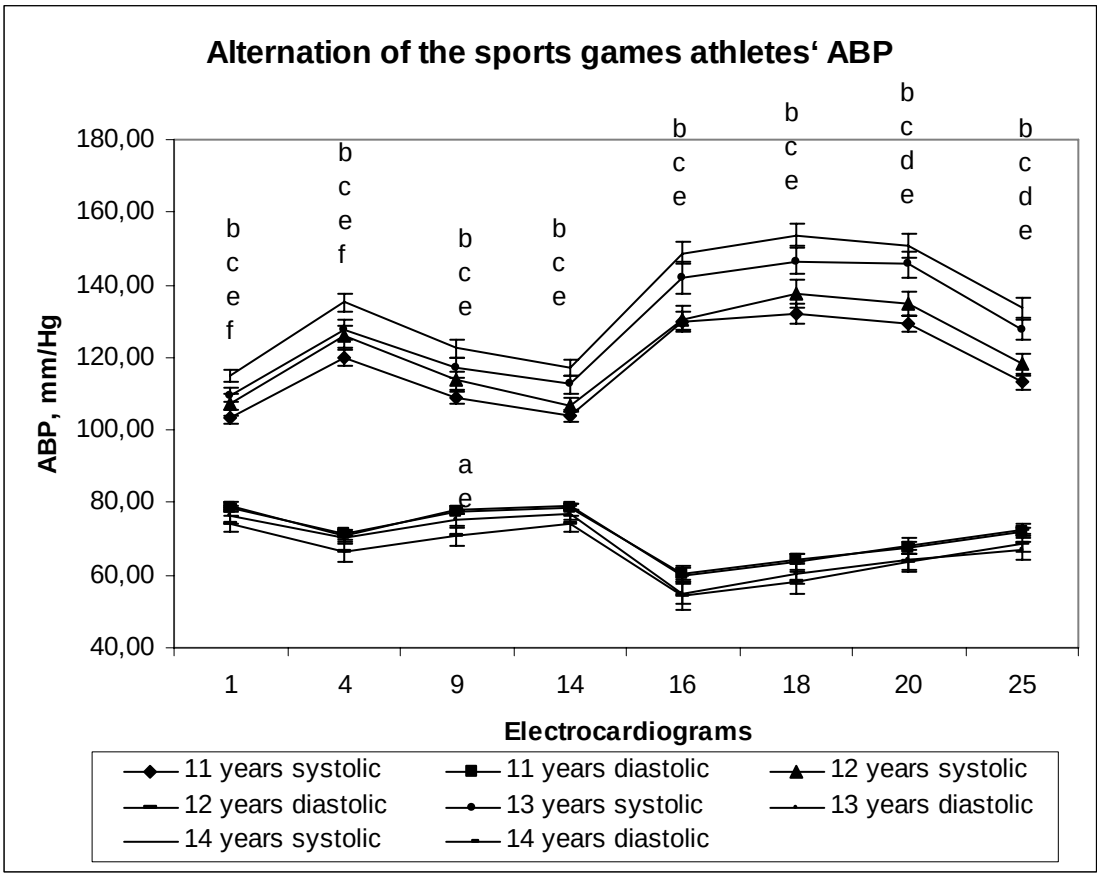
Considering the results of third investigation, it could be maintained that the improvement of sports games athletes CNS indices is not steady in the range of 11-14 years of old.

Vertical jump test, 30 s maximal jumping test and dynamometry measurements were performed on purpose to figure out the possibilities of sports games athletes‘ motor abilities. Vertical jump height increased in the range of 11-14 years of age (Fig. 12). Statistically significant difference was between 11 and 13, 14 years of age and 12 and 14 years of age groups. 11-14 years of age sports games athletes' jump height in 30 s statistically significantly increased. After the dynamometry test with the sports games athletes it was found that the power of muscles grew with age and the highest increment was found in the range of 13-14 years of age, where statistically significant differences were determined. The age had not considerable influence on a diastolic ABP in the range of 11-14 years of age and systolic ABP was affected conversely (Fig. 13). During all research work, 14 years of age athletes had the highest systolic blood pressure, 11 years of age – the lowest. During all research work, statistically significant difference was observed among 11-13 years of age, 11-14 years of age and 12-14 years of age groups. It was determined that in the range of 11-14 years of old sports games athletes HR after Roufier test did not vary significantly, and significant differences were observed among 11-14 years of age after 30 s maximal jumping test.



Note. * – statistically significant difference, p<0.05.

Fig. 12. **Maximal jump height of sports games athletes**



Note. Difference between 11-12 years – a, 11-13 years – b, 11-14 years – c, 12-13 years – d, 12-14 years – e, 13-14 years – f – statistically significant difference, $p<0,05$.

1 ECG – before Roufier test; 4ECG –beginning of a recovery; 9 ECG – I recovery minute; 14 ECG – II recovery minute; 16 ECG – beginning of a recovery after 30 s maximal jumping test; 20 ECG – I recovery minute; 25 ECG – II recovery minute.

Fig. 13. **Alternation of the sports games athletes‘ ABP performing Roufier test and 30 s maximal jumping test**

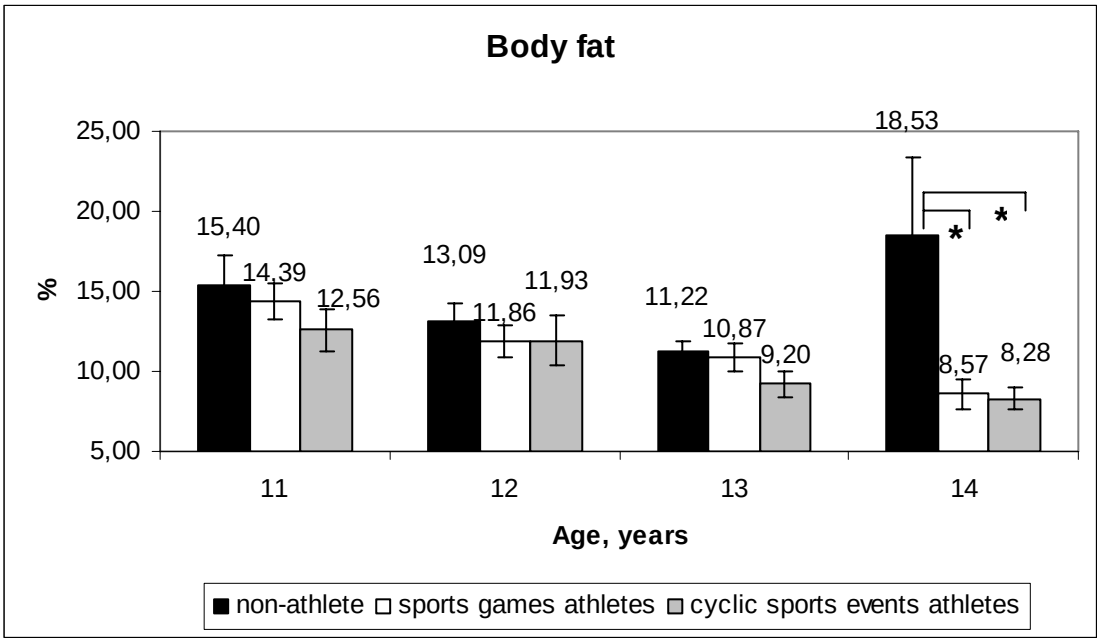
2.4. The comparison (intersectional evaluation) of sports games and cyclic sports events' long-time adaptation to physical loads

In the fourth stage of the investigation, the influence of sports games and cyclic sports events load character particularities' differences on boys' cardiovascular system, motor and sensomotor abilities development. Intersectional evaluations were carried out to fulfil this task.

Studying the results of the intersectional evaluation of the 11-14 years of age boys motor system, it was detected that a jump height and 30 s maximal jumping test results were higher for those boys, who were going in for sports, compared to non-athlete. Dynamometry measurements were performed to assess the results of 11-14 years of age boys' muscles power. Intersectional investigations revealed that cyclic sports events athletes' muscles power was higher than non-athletes and sports games athletes. Statistically significant differences were observed among all age groups estimating both right and left sides.

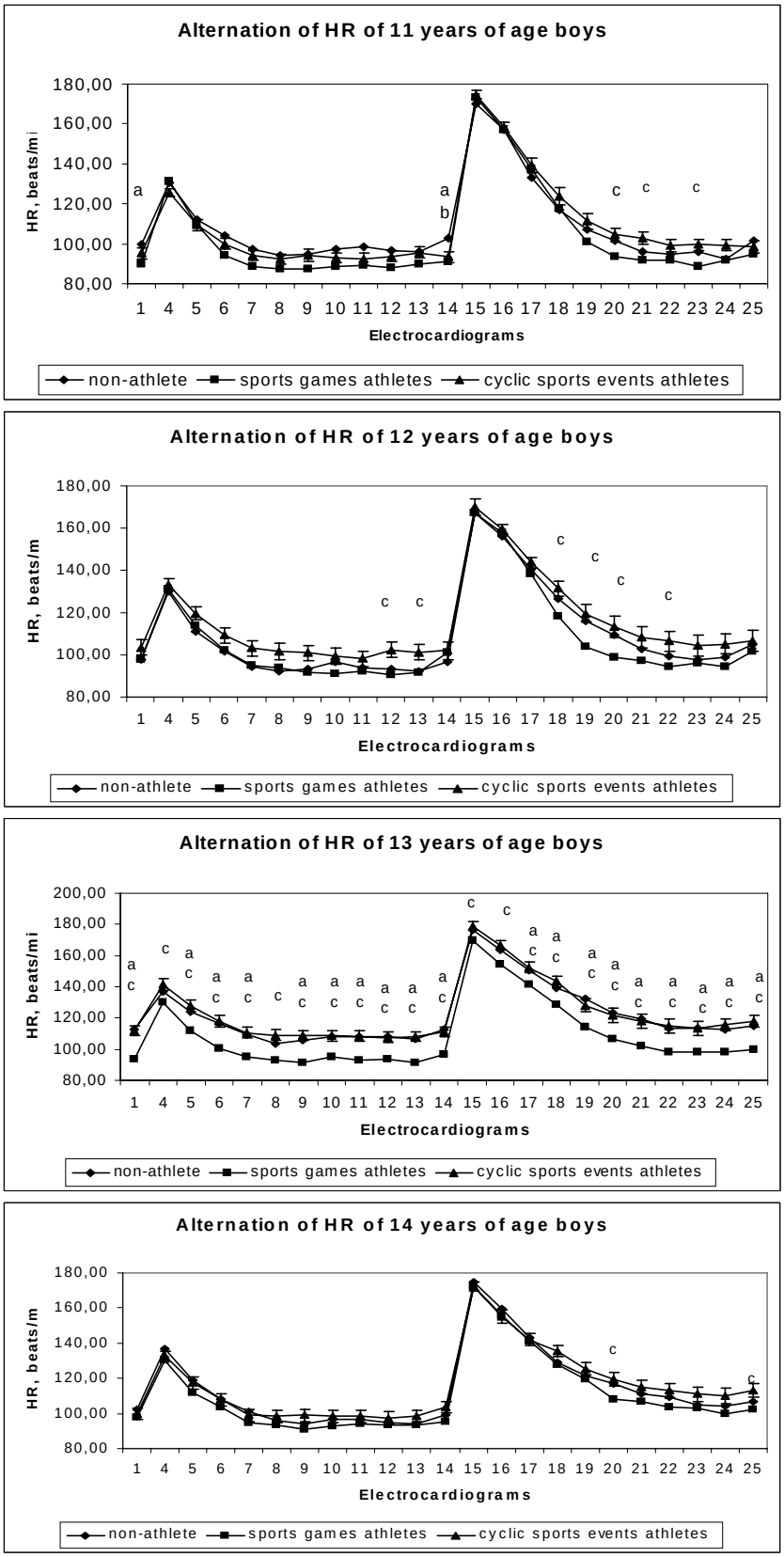
The investigation of the body mass components showed that 14 years of age non-athlete boys had higher BMI and it was significantly different from boys who were going in for sports. Furthermore, intersectional evaluation established strong physical exercises impact on a body fat in a range of 14 years of age (Fig. 14) and statistically significant differences were determined between non-athlete and boys who were going in for sports.

Evaluating HR values registered in the fourth investigation, it was found that the lowest HR values were in a group of 13 years of age sports games athletes and significantly differed from the non-athletes and cyclic sports events athletes' values (Fig. 15). Evaluating the electrocardiogram JT interval, it was found, that various sports events had no influence in the range of 11, 12 and 14 years of old groups, but JT interval of 13 years of age sports games athletes was statistically significantly higher compared to non-athletes and cyclic sports events athletes.



Note. * – statistically significant difference, $p<0.05$.

Fig. 14. **Body fat of non-athletes, sports games athletes and cyclic sports events athletes**



Note. Difference between non-athletes and sports games athletes – a, non-athletes and cyclic sports games athletes – b, sports games athletes and cyclic sports games athletes – c – statistically significant difference, $p < 0.05$.

1 ECG – before loads; 4-14 ECG – recovery afterRoufier test; 15-25 ECG – recovery after 30 s maximal jumping test.

Fig. 15. **Alternation of HR of non-athletes, sports games athletes and cyclic sports events athletes performing Roufier test and 30 s maximal jumping test**

2.5. The sports games and cyclic sports events long-time effect impact on cardiovascular system, motor and sensomotor abilities

On purpose to estimate if the intersectional evaluations reflected a real physical exercises influence on growth and development processes, the fifth investigation was carried out, i.e. the same boys were examined four years consecutively, and HR, motor and sensomotor abilities of 11-14 years of age cyclic sports events athletes' and sports games athletes were compared.

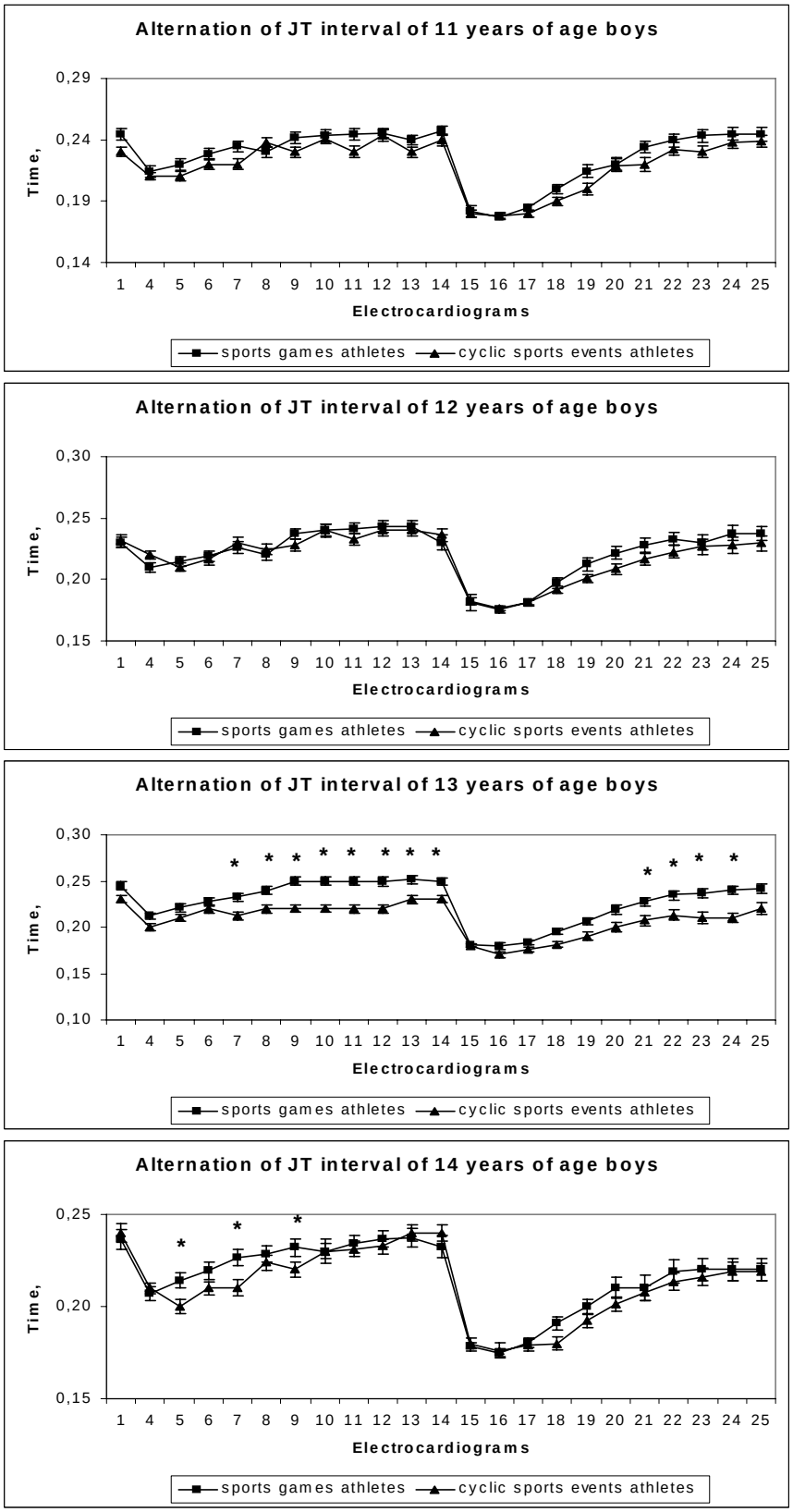
Considering the results of CNS functional state and efficiency, it was determined that sports games, i.e. partially regulated physical load, had greater impact on these indices. Sports games athletes were superior to cyclic sports events athletes taking into account CNS mobility, anaerobic efficiency and anaerobic work capacity. Evaluating boys' motor abilities (performing vertical jump and 30 s maximal jumping test), it was observed that these indices were improving with age in both sports games athletes and cyclic sports events athletes groups, but did not vary statistically significantly among each other. Evaluating the indices of muscles power by dynamometry measurements, it was determined that cyclic sports events had greater influence. These findings correspond to the results of the fourth investigation.

Long-time research of body components revealed similar results as intesectional evaluation of the fourth investigation. In this case the body fat decreased with age and active body mass and total body water mass increased with age, but in case of sports games athletes and cyclic sports events athletes, they did not vary.

Results of the HR function investigations showed that ABP did not differ among sports games athletes and cyclic sports events athletes. Sports games athletes were characterized as having lower HR values than cyclic sports events athletes, though during all investigation statistically significant differences were observed in 13 years of age group. Statistically significant differences were found evaluating JT interval data (Fig. 16).

According to the evaluation of fractal dimensions of the electrocardiogram indices change, it could be maintained that HR complexity increased with age and this could be seen in many ECG indices (HR, JT interval, and JT/RR) (Fig. 17). The data of this analysis showed that the calculated dimensions' values of most o9f the indices increased with age, but there were any changes comparing 13 and 14 years of old groups.

Summarising the results of the research work, i.e. while examining the same boys four year consecutively, it could be maintained that basically this research only confirmed the results of the fourth investigation, due to what it would be right to be of the opinion that the stated conclusions were correct.



Note. * – statistically significant difference, $p<0.05$.

1 ECG – before load; 4-14 ECG – recovery afterRoufier test; 15-25 ECG – recovery after 30 s maximal jumping test.

Fig. 16. **Alternation of JT interval of 11-14 years of age sports games athletes and cyclic sports events athletes performing Roufier test and 30 s maximal jumping test**

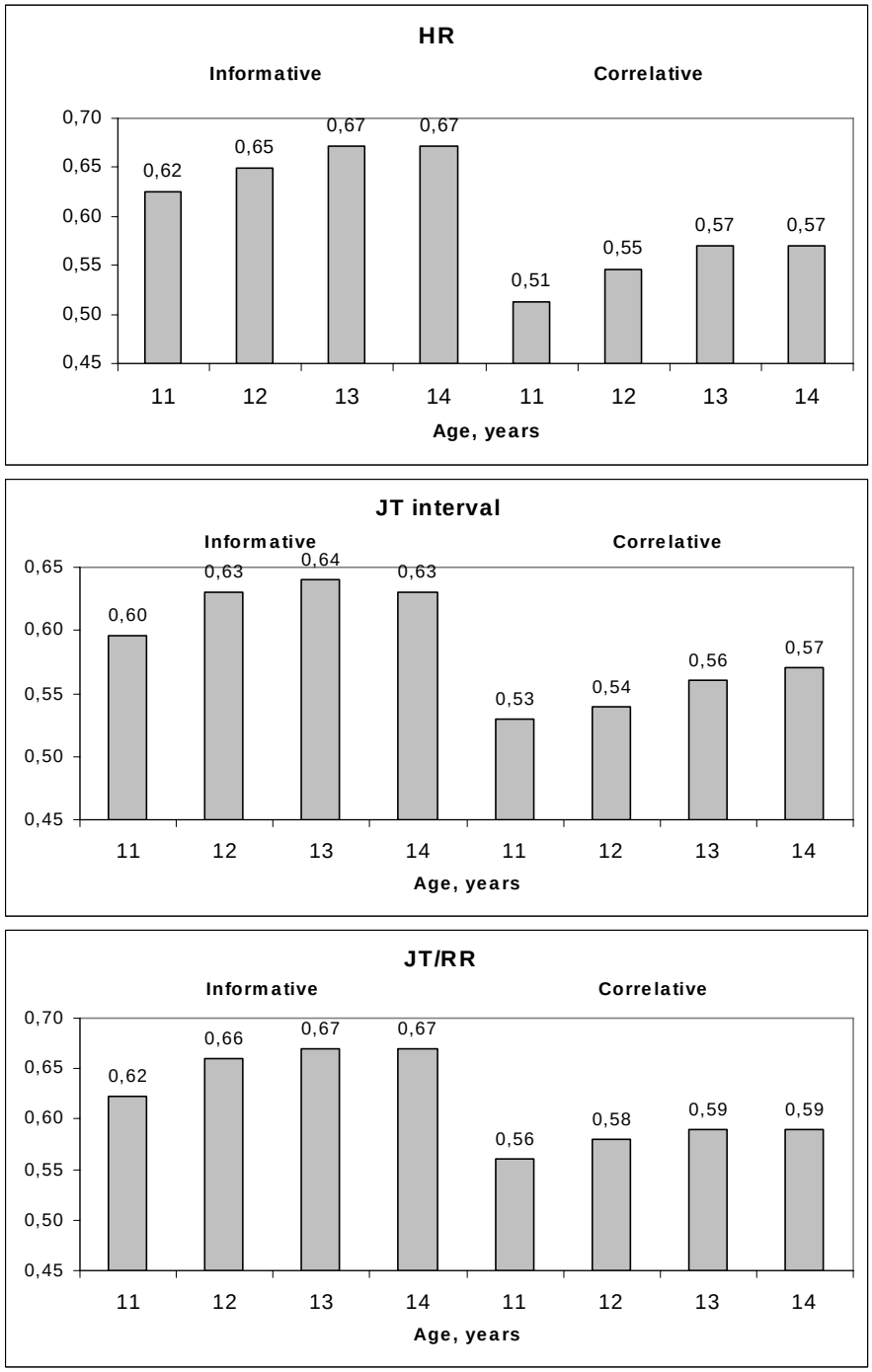


Fig. 17. **Fractal dimensions‘ values of cardiovascular indices (HR, JT interval and JT/RR) in the period of 11-14 years of age**

3. GENERALIZATION OF RESULTS

Completeness and interaction of endogenous and exogenous factors determine physical efficiency and health of man (Szopa, Żychowska, 2001). When children choose particular sport (event), regularly and long-term attend training, dominant exercising type becomes an essential factor in training (Платонов, 2004). The range of 11–14 years of age is an essential to external effect because of several significant factors. Firstly, growing child is not reduced copy of a grown-up therefore interaction of endogenous and exogenous factors is difficult to predict precisely (Szopa, Żychowska, 2001). Secondly, because of irregular organism growth and development

during sexual maturation, type of exercising is an essential factor which determines organs and its systems structural and functional changeovers (Кочергина, Ахметов, 2006).

In this study were investigated and evaluated the effect of sports games and cyclical sports events on 11 – 14 years of age children' functional preparedness changes. It was showed that type of exercising *(variable intensity, partially regulated is appropriate for sports games performances and for cyclical sports events are appropriate cyclic nature and strictly regulated physical loads)* have different effect on cardiovascular system adaptation peculiarities, motor and sensomotor abilities development in growing and expeditiously developing organism.

The results obtained during research indicated that cardiovascular system, motor and sensomotor abilities in non-athletes children develop in the range of 11–14 years of age: indices of muscles power and capability, indices of CNS capability. Increase of indices is irregular: in the range of 13–14 years of age the rate of improvement slows down. Functional state indices of cardiovascular system and its changes increase during physical load with age, whereas 13–14 years of age the rate of improvement in functional indices of cardiovascular system increases. Likewise other researches (Poderytė et al., 2002; Платонов, 2004) maintain that endogenous factors, particularly in the range of 13–14 years of age, have considerable influence on cardiovascular system thus even functional indices of cardiovascular system in non-athletes children increase expeditiously.

While subjects underwent physical load tests, registered changes of ECG indices statistically significantly differed only after 30 s maximal jumping test. Significantly HR values differed between non-athletes boys in the range of 12–13 years of age and in many cases – in the range of 11–13 years of age as well. Such research results can be explained by appropriate greater HR alternation in particular range of age under the influence of sympatic and parasympatic systems (Rowell, 1993; Hainsworth, 1995; Žemaitytė, 1997; Mokrane, Nadeau, 1998; Winsley et al., 2003). Respectively during investigation altered values of ECG JT interval which is related with metabolic rate in myocardium (Vainoras 1996; 2000; Hlaing et al., 2005). While evaluation of ratio ECG JT/RR intervals revealing peculiarities of cardiovascular mobilization (Poderys et al., 2006) and statistically significant difference after Roufier test was indicated between 13–14 years of age groups, whereas after 30 s maximal jumping test – between 11–13 years of age groups. Unlike others ECG indices, ST-segment depression of non-athletes boys group almost did not change according to age and this showed that during investigation applied physical loads had not significant influence on this index.

While evaluating motor and sensomotor abilities of 11–14 years of age non-athletes children was revealed that in conformity with Tapping test results alteration of CNS indices of non-athletes children improved with age. Statistically significant difference was comparing 11 years of age children CNS general efficiency, anaerobic efficiency and anaerobic work capacity results with other three groups. Only children' CNS asymmetry peculiarities were not under influence of age. These results show that 11–14 years of age boys are still developing and are not mature (Olson, 1996; Платонов, 1997; Kozlowski et al., 2001; Munchmeier, 2001). However CNS directed commands determine the extent of muscle efforts and other intramuscular coordination characteristics (Skurvydas, 1991; Taylor et al., 1996). This authors' statement is confirmed by established increasing cohorts' muscle power and capability indices since increases relative muscle power and maximal jump height values. During the second investigation cyclic sports events same as non-athletes children' CNS efficiency and functional state indices, registered by tapping test, improve with age since statistically significant difference were assessed between 11 years and 12, 13, 14 years of age groups evaluating CNS mobility, anaerobic and general efficiency. In addition, the alteration of CNS efficiency and functional state always is observable by muscles work indices (Busso, et al., 2002; McCarthy, et al., 2002; Shephard, 2001). Statistically significant values of relative muscles power and maximal jump height were between 11 years and 13, 14 years as well as 12 and 14 years of age groups assessing maximal jump height. While evaluating cardiovascular

system and most of CNS indices in the range of 13–14 years of age were not statistically significant differences, still it was established essentially better sportsmen' muscles functional efficiency indices than non-athletes. In conformity with these results we can maintain that this advantage asserted under physical loads influence, which is appropriate for the boys of this range of age, on muscles peculiarities development and slightly less – on cardiovascular system. Cyclic sports events children' motor, sensomotor and cardiovascular systems indices higher improvement is observed in the range of 11–13 years of age. Equally, 11–13 years of age groups children' same indices significantly differed than non-athletes contemporaries.

CNS and cardiovascular systems preparedness indices of sports games children were evaluated in the third investigation. The results of sports games players showed that most of functional indices an essential improvement is in the range of 11–13 years of age. This improvement is significantly higher than non-athletes or cyclic sports events athletes. These results can be pointed out by other authors (Olson, 1996; Платонов, 1997; Buliuolis, 2006) conclusions that different type physical loads determine different adaptation peculiarities by generating distinct relations between external and internal stimulus. Similarly, the age of 13–14 years is exceptional wherein the rate of indices changes reduces and only muscles preparedness indices significantly improve. Consequently, under the influence of applied regular physical loads during sports games trainings expeditiously were improved functional preparedness indices of cardiovascular system and CNS: muscles efficiency indices' improvement depends on applied physical load type – muscles power indices more increased of athletes groups who attend cyclic sports events, whereas capability indices – of sports games groups. There is a tendency that HR reduces at rest while performing dosed and all-out workloads HR significantly decreases, but recovery rate of most ECG and ABP indices increases.

Most of studies were accomplished due to evaluate the consistent patterns of growth and development (McCarthy et al., 2002; Munchmeier, 2001), searching for purposeful physical loads (Olson, 1996; Платонов, 1997; Kozlowski et al., 2001; Busso et al., 2002; Docherty, 2002; Wolpert et al., 2003). To sum up, we may say that the above cited studies of others scientists and results obtained during this research manifested that interaction of external and internal factors determine 11–14 years both boys' muscles and cardiovascular systems functional potential development and its manifestation peculiarities during physical loads. The alternation rate of cardiovascular system indices increases under the influence of variable intensity physical load which is appropriate for sports games trainings and is an essential external factor. Still the functional indices of cardiovascular system of non-athletes children improve rapidly under the influence of endogenous factors, especially at the age of 13–14, and non-athletes children getting almost equal to the athletes contemporaries considering these parameters. Differences between functional indices of different sports type athletes were assessed as a result of their distinct preparedness and physical load type.

While evaluating study results it is necessary to consider that sportsmen' physical mature and functional preparedness indices are as a result of both selection and adaptive changes (Malina, Bouchard, 1995; Rowland, 1996; Wilmore, Costill, 2001; Philippaerts et al., 2006). Due to this reason it was planed two studies on purpose answering problem questions: the first – evaluation of 11–14 years of age non-athletes, sports games and cyclic sports events athletes' cardiovascular system, motor and sensomotor abilities changes (*groups' comparison*) and the second – investigating two sportsmen' groups for four years. The statements which were received after generalisation of long-term investigations of two sportsmen' groups considering the first study accomplished investigations' results were confirmed.

The lowest HR values were obtained at rest and during workouts in sports games group at the age of 13 years and significantly differed from non-athletes and cyclic sports events athletes, whereas in the age of 14 these differences were considerably lower. The same results were received

after evaluation of ECG JT interval alternation peculiarities: were registered the greatest values of JT interval. However sports games players' slower recovery of these functions after physical loads than cyclic sports events athletes proclaim that cardiovascular system adaptation peculiarities is under the influence of physical loads specificity. Thus, variable intensity physical load type as appropriate feature of sports games trainings is an essential external factor which has influence on faster changes of muscles and cardiovascular indices in the age of 11–13. Apparently, endogenous factors influence on child's growth and development increases in the age of 13–14 that is why an essential changes of cardiovascular indices proceed and non-athletes children getting almost equal to the athletes contemporaries considering these parameters. While considering changes of functional indices proceeded at the age of 13–14 it is necessary to mark that muscles' functional preparedness indices increased more steadily. It can be explained as follows: optimal physical loads are those which have more influence on muscles peculiarities development and to a lower extent – on cardiovascular system. That would be indirect confirmation of optimal training strategy selected by coach, but we have no precise evidences in proof of it. To sum up, the data of changes of muscles preparedness indices confirmed other authors' opinion that exercises have influence on growth and development processes (Rowell, 1996; Wilmore, Costill, 1999).

CONCLUSIONS

1. Motor and sensomotor abilities of non-athlete children develop in the age phase of 11–14: muscles' power and capability, CNS efficiency indices increase. The improvement of results is irregular: the rate of improvement decreases at the age of 13–14. Equally, cardiovascular system functional state indices and its alteration during physical loads improve with the age. The improvement of the rate of cardiovascular functional indices increases at the age of 13–14.

2. The increase in motor, sensomotor and cardiovascular system indices of cyclic sports events for children were indicated higher than in non-athlete contemporaries at the age of 11–13. Statistically significant differences of cardiovascular and most of CNS indices were not noticed at the age of 13–14 and muscles' functional preparedness indices were significantly better than non-athletes.

3. The improvement of children, attending sports games trainings, functional preparedness indices are significantly greater than in non-athletes and cyclic sports events athletes at the age of 11–13. At the age of 13–14 the rate of indices reduce and except muscles preparedness indices, differences were not statistically significant between groups.

4. Muscles, cardiovascular system and functional indices of CNS improved under the influence of regular exercising:

    a) The improvement of muscles capability indices depends on physical load type: muscles power indices increased in cyclic sports events groups mostly.
    b) There is a strong tendency that HR reduces at the rest while performing dosed and all-out workloads HR significantly decreases and recovery rate of most ECG and ABP indices increases.
    c) CNS functional mobility and functional stability indices, evaluated by finger tapping test, significantly improved, and there is a tendency that the indices of general efficiency and anaerobic efficiency improves.

5. The alternation rate of muscles, cardiovascular system and CNS indices increases under the influence of variable intensity of physical load which is appropriate for sports games trainings and is an essential external factor at the age of 11–13. Decisive influence of endogenous factors on child' growth and development significantly increases at the age of 13–14 due to the changes of important cardiovascular system and CNS indices accelerate and non-athletes children getting almost equal to the athletes contemporaries considering these parameters.

PRACTICAL RECOMMENDATIONS

1. The development of cardiovascular system and CNS indices is more induced by variable intensity physical loads at the age of 11–13, consequently agile and sports games are recommended to be implemented during lessons and in the various sports events training' content.
2. Increase of functional muscles indices is under the influence of cyclic (*dynamic*) exercise more than sports games trainings at the age of 11–14, therefore solving child's muscles functional preparedness' improvement problems is recommended to apply to name as "functional training" principles.
3. Physical educators and coaches are recommended that one of the most important strategic physical training tendencies at the age of 11–13 would be the development of functional muscles abilities and slightly less – on cardiovascular system.

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SANTRAUKA

Vaiko fizinis išsivystymas – endogeninių ir egzogeninių veiksnių sąveikos rezultatas. Kūno matmenys, somatoskopiniai duomenys, jų chronologija yra jautrūs tiek pavienio individo, tiek visos vaikų populiacijos augimo ir vystymosi indikatoriai ir, be individualių augimo galių, rodo aplinkos sąlygų poveikį. Vaikų ir jaunuolių amžiui būdinga tai, kad šiuo metu vyksta intensyvus augimo procesas. Taigi vaiko brendimas yra įgimtų, paveldėtų ir įgytų asmenybės savybių kitimas (Armstrong, Welsman, 2005). Vaikui bręstant, sparčiai didėja ūgis, keičiasi funkcinių sistemų organai, formuojasi asmenybės bruožai, kinta judesiai (Armstrong, Welsman, 2005; Karoblis, 2005). Taip pat susidaro tam tikri pavienių organizmo sistemų ir centrinės nervų sistemos (CNS) ryšiai (Rowell, 1993; Mokrane, Nadeau, 1998; Naužemys ir kt., 2000; Winsley et al., 2003).

Individuali raida priklauso ne tik nuo įgimtų ypatybių, bet ir nuo veiksmingos aplinkos poveikio. Treneriai, atrinkdami sportininkus, turi kreipti dėmesį į potencialiai stiprius, bet vėliau bręstančius berniukus (Olson, 1996; Платонов, 1997; Kozlowski et al., 2001; Busso, Benoit, 2002; Docherty, 2002; Armstrong, Welsman, 2005). Vaikų ir paauglių sportinė veikla glaudžiai siejasi su sportininkų atrankos proceso tobulinimu, talentų atradimu ir ugdymu moksliškai pagrįstais tyrimų metodais, nustatant vaikų sportinę predispoziciją ir atsižvelgiant į individualius jų duomenis (Кочергина, Ахметов, 2006).

Esant ilgalaikiam kartotiniam fiziniam krūviui labai pakinta širdies ir kraujagyslių sistemos (ŠKS) (Pober et al., 2004), griaučių raumenų adaptacija. Reguliarus fizinis krūvis lemia ŠKS funkcinio pajėgumo didėjimą. Širdies funkcinės galimybės dažnai tampa organizmo adaptacinių galimybių ribojamuoju veiksniu, dėl to širdies adaptacija dideliems fiziniams krūviams yra viena iš svarbiausių sąlygų, lemiančių bendrą organizmo adaptaciją aplinkoje.

Taigi jaunojo sportininko organizmas skiriasi nuo suaugusiojo organizmo. Paauglys gerai adaptuojasi suaugusiųjų sportininkų treniruotės režimui, tačiau parengiamosios programos vaikams ir paaugliams turi būti sudaromos kiekvienai amžiaus grupei individualiai, atsižvelgiant į visus fizinės brandos veiksnius (Malina, Bouchard, 1991; Rowland, 1996; Wilmore, Costill, 2001; Philippaerts et al., 2006). Pastaruoju metu, kai pasaulinio lygio sporto rezultatai tokie aukšti, talentingų vaikų atranka atlieka ypač svarbų vaidmenį. Rezultatai rodo, kad prieš lytinę brandą varžybinis sportas augimui nekenkia, o kūno konstitucijos veiksniai yra svarbūs vaikams renkantis sporto šaką. Visi jaunųjų sportininkų palyginimai su nesportuojančiaisiais rodo geresnį pirmųjų subrendimą. Šie palyginimai rodo ne tik neginčijamai teigiamą treniruotės (Seibutienė, 2004; Strong et al., 2005), bet ir atrankos proceso poveikį. Geriau fiziškai subrendę paaugliai greičiau pasiekia geresnių rezultatų, todėl yra didesnė tikimybė, kad jie taps didelio meistriškumo sportininkais (Wilmore, Costill, 1999; Damsgaard et al., 2000; Armstrong, Welsman, 2005).

Darbo hipotezė: 11–14 metų amžiaus tarpsnis yra labai jautrus išorės veiksniams. Be to, vadovaujantis adaptacijos specifiškumo principu tikėtina, kad sportiniai žaidimai ir ciklinės sporto šakos dėl krūvio pobūdžio specifikos (*kintamo intensyvumo iš dalies reglamentuotas, būdingas sportinių žaidimų veiklai ir ciklinio pobūdžio griežtai reglamentuotas fizinis krūvis, būdingas ciklinių sporto šakų treniruotėse*) skirtingai veikia augančio ir sparčiai bręstančio organizmo širdies ir kraujagyslių sistemos adaptacijos ypatybes, motorinių ir sensomotorinių gebėjimų raidą. Todėl sportuojančių šio amžiaus tarpsnio vaikų tyrimai gali atskleisti sudėtingą įgimtų ir įgyjamų (*endogeninių ir egzogeninių*) veiksnių sąveiką.

Darbo tikslas – nustatyti 11–14 metų berniukų motorinių ir sensomotorinių gebėjimų raidą, širdies ir kraujagyslių sistemos ypatybes adaptuotis reguliariam ilgalaikiam sportinių žaidimų ir ciklinių sporto šakų poveikiui.

Darbo uždaviniai:

1. Nustatyti nesportuojančių asmenų širdies ir kraujagyslių sistemos, motorinių ir sensomotorinių gebėjimų raidą 11–14 metų amžiaus tarpsniu.
2. Nustatyti ciklinių sporto šakų poveikį 11–14 metų berniukų širdies ir kraujagyslių sistemos, motorinių ir sensomotorinių gebėjimų raidai.
3. Nustatyti sportinių žaidimų poveikį 11–14 metų berniukų širdies ir kraujagyslių sistemos, motorinių ir sensomotorinių gebėjimų raidai.
4. Palyginti kintamo intensyvumo iš dalies reglamentuoto fizinio krūvio, būdingo sportinių žaidimų veiklai, ir ciklinio pobūdžio griežtai reglamentuoto fizinio krūvio, būdingo ir vyraujančio ciklinių sporto šakų treniruotėse, poveikį vaikų funkciniam parengtumui.

Darbo originalumas:

Išsamesnės žinios apie vaiko augimo ir brandos netolygumą. Parodyta, kad raumenų jėgos ir galingumo rodiklių bei CNS darbingumo rodiklių gerėjimas nėra tolygus: 13–14 metų amžiaus tarpsniu gerėjimo sparta sulėtėja. Su amžiumi gerėja ir ŠKS funkcinės būklės rodikliai bei jų kaita atliekant fizinius krūvius, o 13–14 metų amžiaus tarpsniu ŠKS funkcinių rodiklių gerėjimas spartėja.

Parodyta, kad kintamo intensyvumo fizinių krūvių pobūdis, kaip būdingas sportinių žaidimų treniruotės bruožas, yra reikšmingesnis išorės veiksnys nei cikliniai pratimai, spartinantys raumenų, ŠKS ir CNS funkcinių rodiklių kaitą 11–13 metų amžiaus tarpsniu.

Lyginant sportuojančių ir nesportuojančių vaikų funkcinių rodiklių kaitos ypatybes vertinta endogeninių ir egzogeninių veiksnių sąveika vaiko organizmo brendimo procese. Parodyta, kad endogeninių veiksnių poveikis labai sustiprėja 13–14 metų amžiaus tarpsniu, dėl to ŠKS ir CNS funkcinių rodiklių gerėjimas reikšmingai paspartėja ir nesportuojantys vaikai pagal šiuos rodiklius beveik prilygsta sportuojantiems bendraamžiams.

Išvados:

1. Nesportuojančių vaikų motoriniai ir sensomotoriniai gebėjimai 11–14 metų amžiaus tarpsniu lavėja: didėja raumenų jėgos ir galingumo, tai pat CNS darbingumo rodikliai. Rodikliai gerėja netolygiai: 13–14 metų amžiaus tarpsniu gerėjimo sparta sulėtėja. Dėl amžiaus gerėja ir ŠKS funkcinės būklės rodikliai bei jų kaita atliekant fizinius krūvius. 13–14 metų amžiaus tarpsniu ŠKS funkcinių rodiklių gerėjimas spartėja.

2. Berniukų, sportuojančių ciklines sporto šakas, motoriniai ir sensomotoriniai, taip pat ŠKS rodikliai sparčiau gerėja 11–13 metų amžiaus tarpsniu nei nesportuojančių bendraamžių. 13–14 metų amžiaus tarpsniu ŠKS ir daugelis CNS rodiklių nesiskiria, o raumenų funkcinio parengtumo rodikliai yra daug geresni nei nesportuojančiųjų.

3. Berniukų, lankančių sportinių žaidimų treniruotes, funkciniai parengtumo rodikliai 11–13 metų amžiaus tarpsniu gerėja reikšmingai sparčiau nei nesportuojančiųjų bei asmenų, sportuojančių ciklines sporto šakas. 13–14 metų amžiaus tarpsniu rodiklių kaita sulėtėja ir, išskyrus raumenų parengtumo rodiklius, statistiškai patikimo skirtumo tarp grupių nėra.

4. Dėl reguliarių fizinių krūvių poveikio gerėja raumenų, ŠKS ir CNS funkcinio parengtumo rodikliai:
   a. raumenų darbingumo rodiklių gerėjimas priklauso nuo krūvio pobūdžio: raumenų jėgos rodikliai daugiau didėjo besitreniruojančių ciklinių sporto šakų grupėse;
   b. ryškus ŠSD polinkis mažėti ramybės būklėje, o reikšmingai ŠSD sumažėja atliekant dozuoto ir maksimalaus krūvio testus, didėja EKG ir AKS rodiklių atsigavimo greitis;

c. reikšmingai gerėja CNS funkcinio paslankumo ir funkcinio pastovumo rodikliai, yra ryškus polinkis gerėti bendro darbingumo ir anaerobinio darbingumo rodikliams, vertinamiems pagal tepingo testo metodiką.

5. Kintamo intensyvumo fizinių krūvių pobūdis, kaip būdingas sportinių žaidimų treniruotės bruožas, yra reikšmingas išorės veiksnys, turintis įtakos greitesnei raumenų, ŠKS ir CNS funkcinių rodiklių kaitai 11–13 metų amžiaus tarpsniu. Lemiama endogeninių veiksnių įtaka vaiko augimui ir vystymuisi ypač sustiprėja 13–14 metų amžiaus tarpsniu, dėl to reikšmingų ŠKS ir CNS rodiklių pokyčiai pagreitėja ir nesportuojantys vaikai pagal šiuos rodiklius beveik prilygsta sportuojantiems bendraamžiams.

Praktinės rekomendacijos:

1. 11–13 metų amžiaus tarpsniu ŠKS ir CNS funkcinių rodiklių lavėjimą labiau paveikia kintamo intensyvumo fiziniai krūviai, todėl per moksleivių pamokas, taip pat įvairių sporto šakų treniruotės turiniui rekomenduotina priemonė – judrieji ir sportiniai žaidimai.
2. 11–14 metų amžiaus tarpsniu raumenų funkcinių rodiklių gerėjimą labiau paveikia cikliniai (*dinaminiai*) pratimai nei žaidimų treniruotės, todėl sprendžiant vaiko raumenyno funkcinio parengtumo gerinimo problemas, rekomenduotina daugiau taikyti vadinamosios funkcinės treniruotės principus.
3. Kūno kultūros mokytojams ir treneriams rekomenduotina, kad 11–13 metų amžiaus tarpsniu viena iš pagrindinių strateginių fizinio rengimo krypčių būtų raumenų funkcinių galimybių lavinimas ir kiek mažiau svarbi – ŠKS.

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