IMPACT OF TRAINING IN SPORTS GAMES AND CYCLIC SPORTS EVENTS ON CARDIOVASCULAR SYSTEM, MOTOR AND SENSOMOTOR ABILITIES OF 11—14 YEAR-OLD BOYS

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ABSTRACT

Individual development depends not only on inherent qualities but also on the effective influence of the environment. The aim of this study was to compare the effect of variable intensity as partially regulated physical loads which are appropriate for sports games performances and cyclic nature as strictly regulated physical loads which is appropriate for cyclic sports events on the dynamics of muscular, cardiovascular and central nervous system (CNS). The contingent of this study was 70 boys of 11—14 years of age: cyclic sports events (track and field athletes) and sports games athletes (basketball, volleyball, football players) were tested for four years. The following methods were used: Tapping test, Roufier exercise test, vertical jump test, 30 s maximal jumping test, measurements of ABP, electrocardiography, dynamometry, measurements of the body mass components.

Sports games athletes were superior over 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 they did not vary statistically significantly among each other. Evaluating the indices of muscle power by dynamometry measurements, it was determined that cyclic sports events had greater influence on muscle power. These results show that 11—14 year-old boys are still developing and are not mature. Long-time research of body components revealed that body fat decreased with age and active body mass and total body liquid mass increased with age, but in case of sports games athletes and cyclic sports events athletes, they did not vary. 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 year-old group. Statistically significant differences were found evaluating JT interval data.

The development rate of muscular, cardiovascular system and performance abilities of CNS increase under the influence of variable intensity of physical load which is appropriate for sports games in contrast to cyclic sports events, which is an essential external factor at the age of 11—13. Decisive influence of endogenous factors on growth and development of boys significantly increases at the age of 13—14 years due to the changes of cardiovascular system, and CNS indices accelerate.

Keywords: *cardiovascular system, central nervous system, cyclic sports, sports games.*

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). Children develop very individually and irregularly (Martin, 1993). Individual development depends not only on inherent qualities but also on effective environmental influence. At first children who mature earlier are also physically superior, they show relatively very high results, they often gain on and overtake those who mature subsequently. During athlete selection coaches have to take notice of those who are potentially strong but mature later (Kozlowski et al., 2001; Docherty, 2002; Armstrong, Welsman, 2005).

The obtained results of macro cycle impact indicated essential adaptive changes in the cardiovascular system (Pober et al., 2004) and skeletal muscles. Regular physical load determines increase

in functional capability of the cardiovascular system. The 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 to ambient environment. While the body grows during the first 10—15 years until the mechanism of blood flow is not developed, the main importance goes to the heart rate (HR) under the influence of the increase in heart capacity during physical load, whereas in adults, after the changes in blood-vessels appear, dominant alternation is determined by changes in arterial blood pressure (ABP). Changes in cardiovascular system determine that at different periods of age physical load activates different physiological adaptive mechanisms, i. e., their different parameters (Winsley et al., 2003; Poderys, 2004). Irregular improvement in muscular power and capability parameters as much as in indices of CNS were established (Taylor et al., 1996).

The results showed that competitive sports have no negative influence on growth before sexual maturation and factors of body constitution, which are essential for children selecting their type of exercising. Children and adolescents' exercising is closely linked to athlete selection process improvement, the discovery of talents and education by scientifically reasonable research methods when their exercising type predisposes their individual features (Кочергина, Ахметов, 2006).

The aim of this study was to compare the effect of variable intensity as partially regulated physical loads which are appropriate for sports games performances and cyclic nature as strictly regulated physical loads which are appropriate for cyclical sports events on the dynamics of muscular, cardiovascular and CNS systems.

RESEARCH ORGANIZATION AND METHODS

The contingent of this study was 70 boys of 11—14 years of age: cyclic (C) sports events (track and field athletes) and sports games (SG) athletes (basketball, volleyball, football players) were tested for four years (every year in 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). All subjects attended particular sport training sessions not less than a year.

The subjects had no hard training sessions two days before the investigation. All the tests were performed at the same time of the day. The following methods were used: Tapping test, Roufier exercise test, vertical jump test, 30 s maximal jumping test, measurements of ABP, electrocardiography, dynamometry, measurements of body mass components.

We divided all investigations into two days (Fig. 1). The first day: all participants' body mass components and dynamometry were measured, and the second — all the subjects underwent Tapping test and vertical jump tests, Roufier exercise test and 30 s maximal jumping test. The period between two investigation days was 24 hours.

On the first day before the measurment of body mass component indices, the boys sat in the laboratory for 10 minutes and were instructed about the investigation process. After measuring body mass components the subjects performed a 10-minute warm-up and then we evaluated their muscular power with a manual dynamometer.

On the second day Tapping test was performed before the vertical jump test, Roufier exercise test and 30 s maximal jumping test. Before the tapping test there was not any warm-up, but the subjects were instructed about the investigation process and

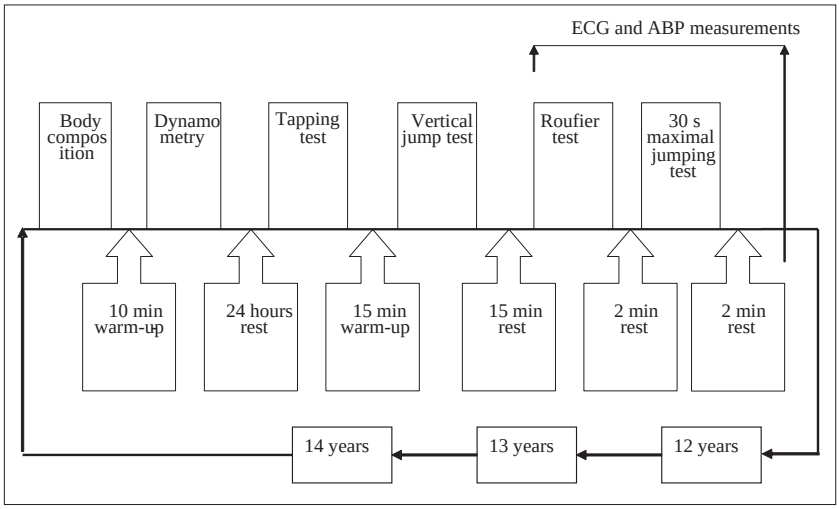


Fig. 1. **Scheme of the research organization**

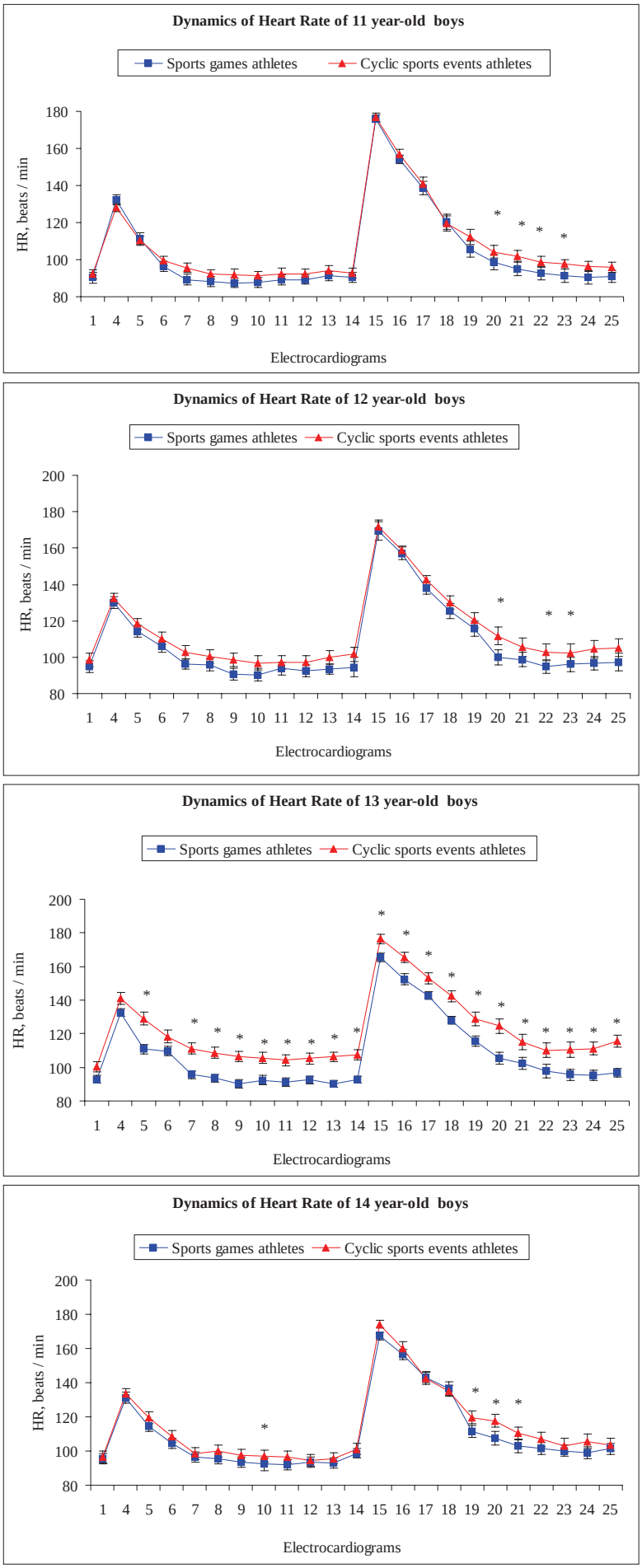
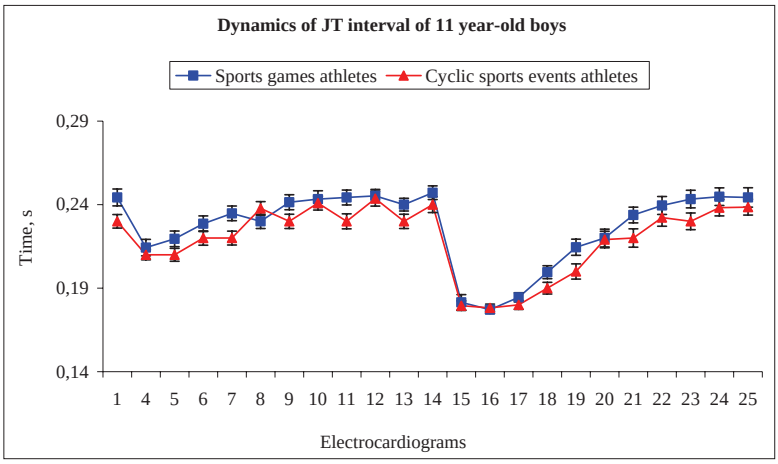
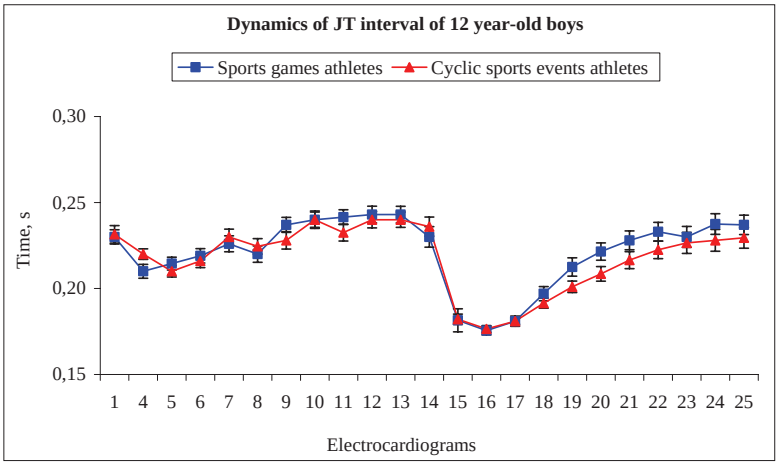


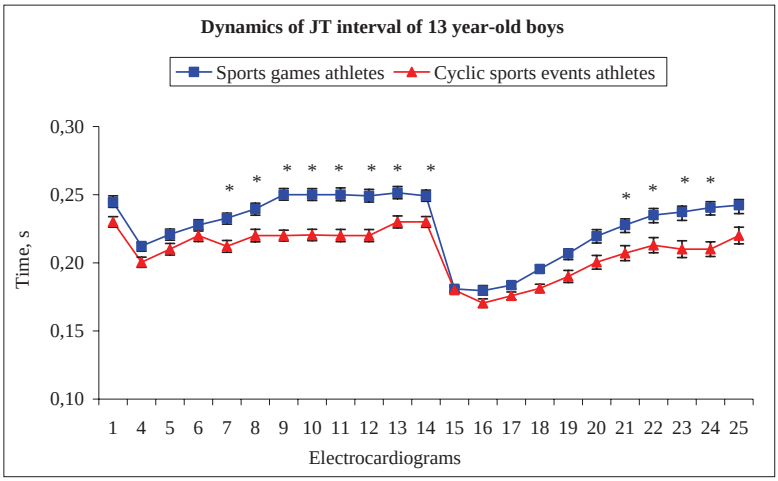
Fig. 2. **Dynamics of HR while performing Roufier test and 30 s maximal jumping test in various age groups of boys atending the training session in sports games and cyclic sports events**

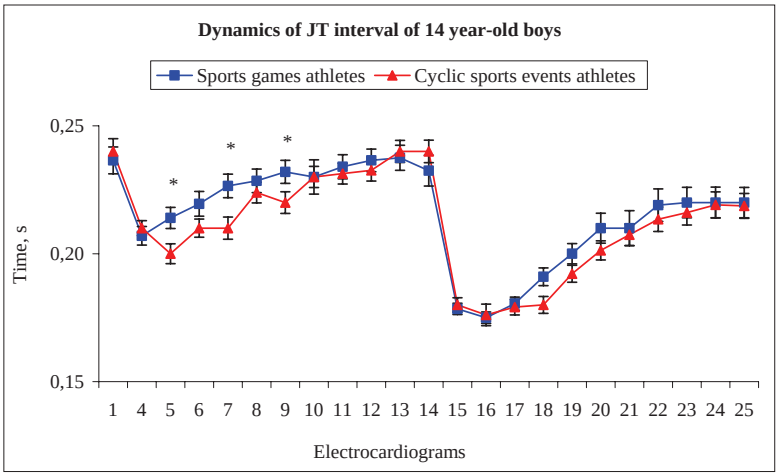
Note. * — statistically significant difference, $p < 0.05$.
1 ECG — before load; 4—14 ECG — recovery after Roufier test; 15—25 ECG — recovery after 30 s maximal jumping test.

Fig. 3. **Dynamics of JT interval while performing Roufier test and 30 s maximal jumping test in various age groups of boys attending the training sessions in sports games and cyclic sports events**









Note. * — statistically significant difference, $p < 0.05$.
1 ECG — before load; 4—14 ECG — recovery after Roufier test; 15—25 ECG — recovery after 30 s maximal jumping test.

they were allowed to try it. Afterwards the boys performed a 15-minute warm-up and then underwent the vertical jump test. They accomplished 3 one-time maximal efforts, vertical jumps selecting the best one. Later all the participants had a 15-minute rest while they were standing and were prepared for ECG registration, ABP assessement. While the subject was sitting ECG and ABP were registered at rest. After the Roufier test was performed and then the subject sat for 2 minutes. Then they underwent 30 s maximal jumping test and at the onset of the rest they performed 10 knee-bends (knee-bend at a 90^{o} angle of knee-joint) and then again they sat for 2 minutes. During all the investigation standard 12-lead ECG and estimated ABP before workouts were registered, straight afterwards and each minute during the recovery.

An average ($\overline{x}$) and standard deviation (S) were calculated in all the cases for the evaluation of the results. The Student t test for independend samples was employed to evaluate significant differences between the mean values of the parameters. Significant difference between compared values was indicated if the standart error was less than 5% ($p < 0.05$). Also we assessed correlation between parameters by Pearson's correliation coeficient.

RESULTS

Considering the results of the third investigation, it could be maintained that under the influence of applied regular physical loads during sports games training sessions functional preparedness indices of cardiovascular system and CNS were expeditiously improved: improvement of muscle efficiency indices depends on the applied physical load type — muscle power indices more increased in athletes groups who attended cyclic sports events, whereas capability indices — in 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. 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 the investigation statistically significant differences were observed in 13 year-old age group (Fig. 2). Statistically significant differences were found evaluating JT interval data (Fig. 3).

Apparently, endogenous factors influence the child's growth and development increases at the age of 13—14 years as essential changes of cardiovascular indices are observed. While considerable changes of functional indices proceeded at the age of 13—14 years it is necessary to mark that muscle functional preparedness indices increased more steadily. It can be explained as follows: optimal physical loads are those which have more influence on muscle 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 in muscle preparedness indices confirmed that exercises have influence on growth and development processes.

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 the 11—13 years of age period as well. Accordingly ECG JT interval values varied during investigations. These results confirmed 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 muscle preparedness indices significantly improve.

DISCUSSION

Completeness and interaction of endogenous and exogenous factors determine physical efficiency and health of a person (Szopa, Žychowska, 2001). When children choose particular sport (event), attend training regularly and for a long time, dominant exercising type becomes an essential factor in training (Платонов, 2004). In this study we investigated and evaluated the effect of sports games and cyclical sports events on 11—14 year-old 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 strictly regulated physical loads of cyclic nature are appropriate) have different effect on cardiovascular system adaptation peculiarities, motor and sensomotor abilities development in growing and expeditiously developing organism.

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 over cyclic sports events athletes taking into account CNS mobility, anaerobic efficiency and anaerobic work capacity. However CNS directed commands determine the extent of muscle efforts and other intramuscular coordination characteristics (Taylor et al., 1996). In addition, the alteration of CNS efficiency and functional state always is observable by muscle work indices (Busso, Benoit, 2002; Shephard, 2001). 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 groups of sports games athletes and cyclic sports events athletes, but did not vary statistically significantly among each other. Evaluating the indices of muscle power by dynamometry measurements, it was determined that cyclic sports events had greater influence. These results show that 11—14 year-old boys are still developing and are not mature (Kozlowski et al., 2001; Munchmeier, 2001).

While the subjects underwent physical load tests, registered changes of ECG indices statistically significantly differed only after the 30 s maximal jumping test. HR values differed significantly between non-athlete 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 (Winsley et al., 2003). Respectively, during the investigation the altered values of ECG JT interval, which is related to metabolic rate in myocardium. Long-time research of body components revealed that body fat decreased with age and active body mass and total body liquid mass increased with age, but in case of sports games athletes and cyclic sports events athletes, they did not vary.

To sum up, we may say that studies of others scientists cited above and results obtained during this research manifested that interaction of external and internal factors, which determine the 11—14 year-old boys' functional potential development of muscles and cardiovascular systems 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 to sports games training and is an essential external factor. Differences between functional indices of different sports type athletes were assessed as a result of their distinct preparedness (Rowland, 1996; Wilmore, Costill, 2001; Philippaerts et al., 2006) and physical load ype.

CONCLUSIONS

The development rate of muscular, cardiovascular system and performance abilities of CNS increases under the influence of variable intensity of physical load which is appropriate for sports games in contrast to cyclic sports events, which is an essential external factor at the age of 11—13 years. Decisive influence of endogenous factors on growth and development of boys significantly increases at the age of 13—14 years due to the changes of cardiovascular system, and CNS indices accelerate.

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SPORTINIŲ ŽAIDIMŲ IR CIKLINIŲ SPORTO ŠAKŲ PRATYBŲ POVEIKIS 11—14 METŲ BERNIUKŲ ŠIRDIES IR KRAUJAGYSLIŲ SISTEMAI, MOTORINIAMS IR SENSOMOTORINIAMS GEBĖJIMAMS

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SANTRAUKA

Individuali žmogaus raida priklauso ne tik nuo įgimtų ypatybių, bet ir nuo aplinkos poveikio. Tyrimo tikslas — 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 pratybose, poveikį berniukų širdies ir kraujagyslių sistemos, motorinių ir sensomotorinių gebėjimų raidai. Tiriamųjų kontingentą sudarė 70 11—14 metų amžiaus berniukių, kurie buvo tiriami ketverius metus. Visi tiriamieji suskirstyti į 2 grupes: ciklinių sporto šakų (lengvaatlečiai bėgikai) ir sportinių žaidimų (krepšininkai, rankininkai, futbolininkai). Tyrimo metu taikyti šie metodai: tepingo testas, Rufjė fizinio krūvio mėginys, verikalaus šuolio testas, 30 s vertikalaus šuoliavimo testas, arterinio kraujospūdžio matavimas, elektrokardiografija, dinamometrija, kūno masės komponentų tyrimas.

Žaidėjai buvo pranašesni už ciklinių šakų sportininkus, vertinant jų centrinės nervų sistemos paslankumą, anaerobinį darbingumą ir anaerobinio darbo talpą. Vertinant berniukų motorinius gebėjimus (kai jie atliko vertikalaus šuolio ir 30 s vertikalaus šuoliavimo testą) nustatyta, kad šie rodikliai tiek žaidėjų, tiek ciklinių šakų sportininkų dėl amžiaus poveikio gerėja, tačiau tarpusavyje statistiškai reikšmingai nesiskiria. Geresnių jėgos rezultatų, matuojant dinamometru, pasiekė ciklinių šakų sportininkai. Ilgalaikiai kūno masės komponentų tyrimai atskleidė, kad riebalinio audinio kiekis metams bėgant mažėjo, o aktyvioji kūno masė ir bendra kūno vandens masė dėl amžiaus didėjo, tačiau statistiškai patikimo skirtumo tarp žaidėjų ir ciklinių šakų sportininkų rodiklių nebuvo. Širdes susitraukimų dažnio rodikliai buvo geresni žaidėjų nei ciklinių šakų sportininkų ir 13 metų grupėje statistiškai patikimai skyrėsi viso tyrimo metu. Toks pat statistiškai patikimas skirtumas buvo nustatytas ir vertinant JT intervalo duomenis.

Kintamo intensyvumo fizinių krūvių pobūdis, kaip būdingas sportinių žaidimų pratybų bruožas (skirtingai negu ciklinio pobūdžio), yra reikšmingas išorės veiksnys, turintis įtakos greitesnei raumenų, ŠKS ir CNS funkcinių rodiklių kaitai 11—13 metų amžiaus tarpsniu. Endogeniniai veiksniai berniukų augimą ir vystymąsi ypač paveikia 13—14 metų amžiaus tarpsniu, dėl to reikšmingų ŠKS ir CNS rodiklių pokyčiai pagreitėja.

Raktažodžiai: širdies ir kraujagyslių sistema, centrinė nervų sistema, ciklinės sporto šakos, sportiniai žaidimai.

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