Peculiarities of vegetative regulation of a cardiac rhythm at young bicycle racers from 12 to 14 years old

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Summary

The work is devoted to the studying of the vegetative regulation of a cardiac rhythm of young bicycle racers from 12 to 14 years old. Longitudinal studies have shown that the influence of occupations by highway cycle races on an organism of a pupil depends on age, training level and nature of the training process. With age the decrease of coefficient of Na/K was noted, that it is related to the reduction of the functional tension of adrenal cortex, testifying to forming complex of the special adaptive reactions for carrying out of the training loadings.

Introduction

The crucial role at all hierarchical levels of adaptation is played by cardiovascular system. Thanks to high lability of physiological mechanisms of its regulation it one of the first joins in the compensatory and adaptive activity aimed at adequate providing fabrics with oxygen. In the numerous literature concerning studying of influence of sports activities on condition of cardiovascular system of children and teenagers, the insufficient attention was paid to research of vegetative regulation of action of the heart of young athletes, researches have fragmentary and incomplete character. In the light of the above studying of features of adaptation reorganizations of structures of management and functioning of cardiovascular system of organism, its adaptive reserves is represented to one of actual problems of age physiology.

It is known that sports activities are followed by considerable metabolic changes which allow to diagnose already at early stage signs of exhaustion, of overfatigue, tension of regulatory systems and to introduce amendments in training process. As the indicator of condition of sympathoadrenal system and mineralokortikoid activity of adrenal glands it is possible to use structure of the mixed saliva.

Positive influence of physical trainings on the organism as a whole and, in particular, on cardio-respiratory system is commonly known, and such activities as approve many researchers, increase the level of the functional state and the non-specific resistance of the organism. It promotes more effective adaptation of the organism to the conditions of the environment, some of which for athletes are training and competitive loads (Pseunok, 2011a; Pseunok, 2011b; Pseunok, 2010; Shlyk, 1991).

The analysis of the main features of creation of educational and training process in this or that sport is important for development of new approaches to its improvement for the
purpose of achievement of the most optimum sports results by athletes.

The problem of increase of efficiency of educational and training process of athletes of different age, specialization and qualification is one of the most actual in the field of physical culture and sport now. Today it is already obvious that achievement of high sports results at the modern level is impossible without development of complex of the relevant activities of the athletes directed on increase of physical, technical and tactical fitness at different stages of their training and competitive activity (Sitnikova, 2010).

Sports training is based on the optimum instruction of way of implementation, duration and intensity. The daily task of trainers consists in planning the program of preparation of the corresponding intensity (Nikolaidis, 2014).

One of the most perspective in this respect the directions is use of complex of the means promoting optimization of process of adaptation of organism to systematic exercise stresses, improvement of system of adaptable mechanisms, increase of its general adaptive opportunities (Malikov, 2001).

Certain interest represents the techniques allowing to receive urgent information on functional condition of the athlete, and also integral and derivative indicators by means of the automated techniques. One of informative parameters in this case are indicators of variation pulse rate (Vovchinskiy & Borkovskiy, 2003).

Recently the tendency to increase in number of the children attracted to regular trainings with sport as a result of which at young athletes is noted the neurohumoral mechanisms of urgent and long-term adaptation, characteristic for each type of sports activity providing fast switching of functions for achievement of the maximum useful result form. At the same time, in children's sport it is necessary to observe the principle of adequacy: loading has to be dosed taking into account age functionality of organism (Pseunok, 2011b).

Materials and methods

In longitudinal mode on the basis of children’s and youth sports school of Olympic reserve in cycling 35 young athletes were examined. All examinees regularly trained, took part in regional and All-Russian competitions. The sports experience by the time of the experiment was from 2 to 6 years. Young athletes regularly passed profound inspection in the center of medical prophylaxis and belonged to the first and second group of health according to the analysis of medical records. The research was carried out in accordance with the requirements of the Declaration of Helsinki of the World Medical Association (2000). For participation in the research the written consent of each respondent was received.

The examination was conducted at the beginning and the end of the training of the macrocycle – in autumn and spring, on the same days of the week in an hour and an hour and a half before training.

Highway bicycle racers of 12-14 years old trained 5 times a week. Duration of the training occupation was 2-2,5 hours. The main attention was paid to the development of speed.

The definition of anthropometrical indicators was carried out according to existing rules about carrying out similar inspections (Bashkirov, 1962).

The research of a rhythm of heart rate was carried out by R.M. Bayevsky’s method (Bayevsky, 1997).

The definition of electrolytes in saliva was carried out by a photocolorimetric method with the help of the device KFK-3.

The results of the research are processed by the method of variation statistics with calculation of average arithmetic (M), error of average arithmetic (m), the criterion of reliability (t) by Student’s and the level of probability (P).

Results and discussions

Nature of somatic development of young athletes of 12-14 years old which were engaged in cycling.
Studying of dynamics of anthropometrical indicators of the teenagers who are engaged in highway cycle races, showed that during the whole experiment there was a reliable increase in the length of the body (P<0,05). In the first year of research there was also considerable gain of body weight (P<0,05).

Body weight is an important anthropometrical indicator at childrens of this age. Overstrain of the organism exhaustion of its functional reserves inevitably leads to decrease in a gain of weight, up to negative sizes. The changes noted by us, in total with indicators of a cardiac rhythm, undoubtedly, are the favorable sign testifying to the sensitive period.

During this period restructuring processes in the organs and systems of the body are optimized, coordination of activity of various functional systems is adjusted. Competently constructed training process during this period can optimum influence on the organism, promote expansion of hereditary opportunities of the organism. At the same time excessive loadings can detain the development of the organism, break the physical and mental development.

Estimating the dynamics of physical development of the athletes who were engaged in cycling, it should be noted that the gain of anthropometrical indicators occurs evenly, without sharp jumps. So, length of a body increases at 12-14 by 10,61%; weight is at 20,91%; OGK for 5,06%.

Thus, it is possible to note that inadequacy and excessiveness of training loadings lead to considerable reduction of a gain of the weight of the body at the age of 12-14 years old; somatic development of athletes bicycle racers has uniform and unidirectional character.

Dynamics of indicators of a cardiac rhythm of boy cyclists of 12-14 years old

Variability of cardiac rhythm, that is the sum of fluctuations of heart rate round average heart rate, can be used as the indicator of cardiorespiratory system (Aubert, 2011; Leicht, 2003)

To the third training macrocycle reliable decrease in heart rate (HR) (P<0,05) with the subsequent its stabilization is noted. We have revealed that fact that the carrying out of the dosed loading led to short-term increase, and then to decrease in heart rate below initial sizes (P<0,05) (fig. 1).


When performing identical physical activity the trained heart differs from the unexercised smaller acceleration of the activity: more rare, but powerful reduction (Abzalov, 1985; Sitdikov, 2006; Vakhitov et al., 2006; Bilge & Jobin, 1998; Nakanichi & Yoshimura, 1993; Akselrod, 1995; Plews, 2014; Vanessa Pereira da Silva et al., 2014; Balassiano, 2013).

The test loading leads to a weakening of sympathetic influences with simultaneous strengthening of parasympathetic (P>0,05) (Fig. 2). Domination of the parasympathetic...
influences can be explained by two independent mechanisms: cholinergic induced reduction of noradrenaline release in response to sympathetic stimulation and suppression of cholinergic response to adrenergic stimulation. Rapid return to the original indicators, apparently due to a high content of cholinesterase in the cells of the sinus node and, as a consequence, fast hydrolyzing acetylcholine. Strengthening of parasympathetic influences occurs at rest. It is regarded by us as a favorable change, saying that at this age, young cyclists are already formed type of regulation inherent in highly skilled athletes.

![Fig. 2. Dynamics of indicators of a cardiac rhythm of young athletes of 12-14 years old engaged in highway cycle races after loading. Note: reliability of distinctions between indicators: n – in rest and after loading; m – first and second year of research.](image)

Its main features are the high tone of a wandering nerve and low activation of the cortical-nuclear structures. According to I.A. Vakhitov’s data and others (Sitdikov, 2006) similar shifts in regulation when decrease in an index of tension happens due to relative prevalence of a tone of parasympathetic nerves over sympathetic, testify to the beginning of processes of formation of sports bradycardia. It provides an economization of functions at the level of neurohumoral regulation.

The increasing of the tension index (TI) to 129, 87±63, 66 in rest by the end of the year reveals the tension of the central mechanisms of regulation. According to N.I. Shlyk (1991), the combination of the high level of sympathetic influences in combination with activation of the central contour of the regulation testifies to decrease in peripheral hemodynamics and response to loading on “brake type” when during the recovery period it is characterized by decrease in parasympathetic influences and strengthening sympathetic, and also activation of the central mechanisms of regulation. Nevertheless, in the second year of experiment for most athletes high sympathetic influences in combination with strengthening of the central contour of regulation are characteristic that can point to tension of adaptable mechanisms. Despite it, the gain of sports skill confirmed with successful delivery of standards of the candidate for the master of sports of 42, 25% of athletes is noted.

In 12-14 years old at athletes-bicycle racers strengthening of parasympathetic influences at stabilization of the heart rate is revealed. We have revealed a decrease with age of the tension index after loading. It is regarded by us as the favorable changes, saying that in this age at young cyclists the type of the regulation peculiar to athletes of high qualification is already formed. Its main features are the high tone of a wandering nerve and low activation of cortical-nuclear structures.

The results of the complex longitudinal research show that though in most cases bradycardia is reflection of physiological adaptation shifts in response to training of the general endurance and provides increase of the chronotropic reserve, in some cases it can be a signal of decrease of the functional and metabolic reserves of the organism. Therefore, identical loading is capable to make unequal impact on a condition of regulatory systems of the organism as at some athletes such loadings promote growth of the functional reserves, and at others – to their exhaustion.

Dynamics of biochemical indicators of young athletes of 12-14 years old engaged in cycling

In the examined groups were not revealed significant differences in the concentrations of Na+, K+. Studying of the dynamics of biochemical indicators revealed decrease in the amount of sodium and potassium in the saliva.

It is proved that decrease in efficiency of the potassium pump can lead to potassium accumulation during a hard work of a myocardium (Nakanichi & Yoshimura, 1993).
Accumulation of potassium in intracellular space can be explained with loading, and also reorganization of the intracardial and the extracardial mechanisms of the regulation of the heart work. Sodium, in turn, due to dysfunction of transmembrane systems accumulates intracellularly, and the important point of it is that accumulation happens in the endothelial cells at which in this connexion sensitivity to the constricting substances (angiotensin, noradrenaline, etc.) increases. The binding of ions inside the cells of endotelia, apparently, reduced their quantity in biological liquids, on what other researchers specify (Yakovlev, 1974; Yamamoto & Hughson, 1997; Molgaard, 1991). The similar assumption will be agreed with the indicators of a cardiac rhythm testifying to the tension of the central mechanisms of regulation which can be caused by hypersensitivity to hormones because of shift of electrolyte balance.

Nevertheless, dynamics of coefficient of Na/K showed its decrease during the year. It speaks about the successful course of the adaptation process to the physical impacts and increase of the share of the specific adaptive reactions directed on formation of regulation, providing optimum functioning of the organism in the conditions of sports training.

Conclusions

The analysis of the anthropometric characteristics of the subjects showed that the training regime has a great influence on the character of the somatic development of the common ontogenetic patterns.

In 12-14 years old at athletes-bicycle racers the strengthening of parasympathetic influences at stabilization of heart rate is revealed. In this group there is a decrease of the tension index after carrying out of the dosed loading of low power, which means the decreasing of the physiological cost of the shown loading that it is provided with a high tone of a wandering nerve and a low activation of cortical-nuclear structures.

The results of the research of cardiovascular system of young athletes have shown that in spite of the fact that increasing of influences of a wandering nerve in many cases testifies to increase of functionality of the heart it can sometimes indicate a cumulation of exhaustion and decrease in metabolic reserves of the organism.

With age there was a decrease of coefficient Na/K that is probably connected with the reduction of the functional tension of adrenal cortex, indicating the formation of a complex of adaptive reactions to carry out training loadings. In 12-14 years old we noted strengthening of a tone of a wandering nerve, reliable increase in length and body weight. The dosed loading was carried out due to a change in the tone of the vagus nerve. It was regarded by us as the evidence of the formation at young athletes like the regulation peculiar to highly skilled athletes.

Essential feature of correlation field of teenagers of 12-14 years which were engaged in cycling is that many indicators cardiovascular, physical development are connected with variation scope. It specifies that when forming the functional system directed on performance of work of cyclic character, strengthening tone of vagus nerve is of great importance. Availability of the expressed correlation bonds between parameters of somatic development and cardiovascular system biologically reasonablly as reflects integrative mechanisms of forming in ontogenesis of integrity of organism and increase of its compensatory and adaptive opportunities, on what also other researchers specify (Bayevsky, 1997). Negative correlation communication between BP and AMO indicates the reciprocal relations between these departments of VNS that answers the principle of "functional synergy".

Studying of dynamics and degree of stability inside - and intersystem correlation bonds at young athletes bicycle racers of 12-14 years has revealed increase of density of correlation bonds between indicators of somatic development and cardiovascular system. It is biologically reasonable adaptive reaction for the purpose of increase in compensatory opportunities of organism.

Thus, the research of the adaptive opportunities of the young athletes who are engaged in highway cycle races showed that
the increase in functional reserves of the organism necessary for carrying out of training and competitive loadings is connected with strengthening of parasympathetic influences on a cardiac rhythm. The gain of sports skill occurs at the expense of tension of the central contour of regulation that we regard as negative process. The crossing of education including in the training process of exercises to which the child owing to the age still functionally isn’t ready, can negatively affect physical development and a condition of young athletes.

The conducted complex longitudinal researches have shown that the influence of occupations by highway cycle races on the organism of the schoolboy depends on age, a training level and nature of the training process. Doing a lot of work in the area of cyclical character in the zone of high and moderate power leads to specific changes of regulatory mechanisms for a shorter term than the quasi-periodic loading which are carried out by athletes involved in sports acyclic.

Final Conclusions
1. At athletes-bicycle racers of 12-14 years old strengthening of parasympathetic influences on the stabilization of heart rate and decrease the influences of the central contour of regulation are revealed in the conditions of the testing load to the third training macrocycle that provides an economization of cardiac activity at rest and high resistance to the training loads.
2. At highway bicycle racers of 12-14 years old throughout the third and fourth macrocycle the coefficient of Na/K it is reliable above, than at the athletes who were engaged in acyclic sports that characterizes the high adaptive opportunities of the organism and testifies to effective response to the loading.

Practical recommendations
The conducted researches have allowed to reveal features of adaptive opportunities of children and teenagers at different stages of ontogenesis. It allows to predict the possible tension of regulatory systems and to plan the optimum training mode.

Researces can be used for creation of the effective concept of creation of loadings which would allow to provide positive dynamics not only in the field of growth of sports results, but also ensuring due level of health, physical and intellectual efficiency. Thus the regular assessment of functional condition of cardiovascular system as one of markers of functional condition of regulatory systems and degree of their tension is important.

Training programs have to correspond to age and functional features of organism of school students. At each individual, necessary for modeling of training process and forecasting of sports result, studying of variability of warm rhythm can give information on condition of adaptation and compensatory mechanisms. It is necessary to use new forms and methods of training of physical qualities; to carry out search of effective measures of the prevention of complications of adaptation processes at young athletes.

Studying of basic physiological indicators under the influence of the testing loading of low power allows to improve system of the admission to sports activities, to carry out dosing and correction of training exercises taking into account functional condition of organism. It will provide high performance and sports growth without harm for the developing child's the organism.

This research will promote creation of modern physiological technology of forming of morphofunctional development of the child, justification from physiological positions of actions for strengthening and preservation of health of the children and teenagers playing sports.

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