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Study of the Cardiovascular System in Athletes of Various Kinds of Sports

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Abstract

The main goal of this study was to study the effect of sports physical load on the regulatory and adaptive capabilities of the cardiovascular system in students of periodic and non-periodic sports. Heart rate analysis revealed sparing cardiovascular function at rest in the majority of skilled athletes. The heart rhythm was controlled under the influence of the balanced effects of the sympathetic and parasympathetic divisions of the autonomic nervous system. At the same time, an increase in the activity of the parasympathetic autonomic nervous system, moderate metabolic effects on the heart rhythm at the sympathetic and humoral levels were noted in athletes who were under the influence of periodic sports physical loads compared to non-athletes. The increased activity of the autonomic circuit of heart rate regulation in athletics athletes and judokas during rest is an indicator of significant adaptive potential of the cardiovascular system.

Keywords: cardiovascular system, periodic and non-periodic sports, physical activity.

Introduction

Sports play an important role in the lives of some students as an anti-stress factor. In sports, physical loads play an important role in the formation of functional resources of the body [3, 9]. At the same time, training and competition activities, in parallel with study loads at the university, place increasing demands on the body's functional capabilities, which is especially characteristic of sports games, martial arts and athletics. Any inconsistency between the volume and intensity of physical activity and the adaptation capabilities of the organism can cause a number of changes in the functional systems of the homeostatic level, can change the regulatory-adaptive state of the organism, and can predetermine the current and future step of adaptation [1, 11]. As a rule, the impact of physical loads on the body's functional state and adaptation capabilities in sports is considered without taking into account the state of regulatory mechanisms. The analysis of the detected changes in the physiological parameters, even compared to the strength of the work done, if another important indicator of its functional state - the quality of resource management - is not determined, it is not possible to get a comprehensive picture of the adaptation capabilities of the organism. Therefore, the heart rhythm controlled by the two main mechanisms of the leading system - the central and the vegetative system is considered to be a fairly objective indicator in regulating the quality of the whole organism's reserve capabilities [6]. The transition from the immediate adaptation phase to stable long-term adaptation under the influence of physical loads in sports is primarily based on the formation of functional changes in the cardiovascular system and its regulatory mechanisms [8].

Based on the above, it is considered relevant to study the effect of physical loads on the quality of regulation and the adaptation capabilities of the cardiovascular system in various sports. The fundamental problem of adaptive physiology requires a systematic approach. Based on the above, the main goal of the work was to determine the effect of sports physical loads on the regulatory and adaptive capabilities of the cardiovascular system of the students' body.

Methods

A total of 30 students of ASAPES participated in the study, of which 10 athletes were representatives of periodic sports (judoka), 10 athletes were representatives of periodic sports (athletics) and 10 were non-sports students. The general training experience of athletes is from 2 to 5 years, and the age limit is 18-20 years. The average age of the studied students was 18-20, the average height was 176±1.9 cm, and the average weight was 69.4±3.5 kg.

The Rufye test was used to assess the functional status of the students cardiovascular system. As physical activity, 30 times sit-to-stand movement was used for 30 seconds. The integrated indicator of the functional state of the students' body is the Ruffie index (Ri), which is calculated based on the heart rate (HR) at rest (HRr) and in the first (HR_1) and second minutes (HR_2) after the end of the dose load. Adaptation indicators were determined by the increase of the heart rate in the first minute compared to the resting heart rate, which was taken as100%. Adaptation indicators were determined by the increase in heart rate in the first minute compared to the heart rate at rest, which was taken as 100%. Recovery parameters were determined by the residual increase in the second minute relative to the heart rate at rest, taken as 100%. The obtained results were evaluated according to the scale developed by M.G. Garayev and R.G. Gaibov [4] (table 1).

Table 1. Evaluation of the functional state of the organism in terms of HR and Rufye index

Evaluation of the level of functional status	Ri indicator	HR_1 increase in %	HR_2 residual growth in %	
High	0 and below	30 or less	4 or less	
Above average	1-5	31-40	5-9	
Medium	6-10	41-50	10-14	
Below average	11-15	51-60	15-19	

Indicators of the external respiratory system were studied using a portable spirometer. Assessment of the reserve and functional capacity of the respiratory component of adaptation includes the determination of: vital capacity of the lung (VCL) and respiratory rate (RR).In addition, blood pressure (BP) was also measured.

The measurement of blood oxygen content was carried out using a portable pulse oximeter device - Fingertip Pulse Oximeter - P-01, this method is based on the different reflection of hemoglobin and oxyhemoglobin in the visible part of the spectrum and infrared radiation. This indicator is measured by the maximum saturation % of the blood with oxygen (oxygenation-OKS). Also, the Fingertip Pulse Oximeter-P-01 device measures the heart rate and presents this indicator as the number of heart beats per minute. In normal case, arterial blood is saturated with 95-97% oxygen [2]. As previously proved [7], the combination of blood with oxygen can characterize tissue oxygen saturation with a fairly high reliability, which predetermines the choice of a special research technique. Measurements are made within 10-40 seconds after an episode of interval load in running and swimming, depending on how quickly the device determines the indicated indicators. It should be taken into account that the body is in the phase of rapid recovery after exercise, and therefore the indicators of HR and OKS continue to change for some time after the cessation of the load. The analysis of the obtained heart rate variability and indicators of external respiratory function was carried out depending on age, height, weight, sports specialty and degree.

The analysis of the results was carried out using the variance-statistical method and the non-parametric comparison method of Student-Fisher [12].

Results and discussion

The pulse is the impulse-like vibrations of the walls of the blood vessels of the heart and the tissues located next to it, and it is an exceptionally important indicator related to the disturbance of the heart. In sports practice, the number of heart beats (HRB) is often used as a criterion for assessing physical load. There is a linear relationship between HR and training intensity. For endurance training to be maximally beneficial, it should be performed at such an intensity that the oxygen transport system takes place in the aerobic-anaerobic zone.

In our studies, before the experiment, the HR of each subject was measured in a sitting position under quiet conditions (HRr). This is the accepted HR for the calm state. Training, especially in athletes with high qualities such as endurance, HRr decreases to 56-64 beats per minute at rest (exercise or physiological bradycardia) (Table 2).

Table 2. Study of the state of the cardiovascular system in students engaged in periodic and non-periodic sports

Indicators	Periodic sports	Non-seasonal sports	Those who do not do sports
HR, beats/min	*56,24±1,79	*64,15 ± 1,99	70,38±1,62 *
SBP, mm Hg	110.13 ±2.89	118,87 ±3,12	120.11 ± 2,63
DBP, mm Hg	64.68 ± 1.79	70,46 ± 1,94	72,74 ± 1,41
VCL, l	*6,20±0,56	5,0±0,83	3,8±0,23*
RR, beats/min	14,0±1,72	16,0±2,07	20,0±1,64
OKS %	97,5±0,65	96,8±0,32	95,5±0,25

As can be seen from Table 2, in athletes of both cyclical and non-cyclical sports, low heart rates are associated with low heart rates ($P<0.001$), and it should be noted that it was more common in the group of athletes engaged in cyclical sports and 56.24 It was ±1.79 beats/min. Our observations showed that the highest HR among athletes was observed in the non-periodic group and was 64.15±1.99 beats/min. organized. In the control group, when studying UA, that is, in a group of students who do not do sports, an increase in their indicators (70.38±1.62 times/min) was found compared to UA of periodic and non-periodic sports groups.

During the study of blood pressure, we also studied the values of SBP and DBP. Our research showed that the SBP and DBP values in all sports groups (periodic and non-periodic) were lower than in the control group, i.e. the non-sporting groups. SBP in the BP 70.46 ± 1.94 mm Hg. was the highest. The values of SBP (110.13 ± 2.89 mm Hg) and DBP (64.6 ± 1.79 mm Hg) in the athletes of the periodic sports group are significantly lower than in the control group (120.11 ± 2.63 mm Hg and 72.74 ± 1.41 mm Hg). ($P<0.05$; $P<0.001$).

The heart rhythm analysis revealed the sparing of HR functions during the rest period in the majority (83.0%) of high-level (qualified) athletes. The heart rhythm is controlled under the balanced influence of the sympathetic and parasympathetic branches of the autonomic nervous system. At the same time, an increase in the activity of the parasympathetic autonomic nervous system (SBP 110.0 ±19.3 mm

Hg) versus (DBP 68.9±7.8 mm Hg), moderate sympathetic and humoral-metabolic effects on heart rhythm are observed (table 2). The increase in the activity of the autonomic circuit of heart rhythm regulation in athletes and judokas during rest indicates a significant adaptation potential of the cardiovascular system.

Indicators of external respiratory function differed significantly in judokas and especially athletes. The indicators of VCL and RR were significantly higher in representatives of periodic sports than in representatives of non-periodic sports. Thus, the representatives of the periodic sport had higher VCL (6.2±0.56 l and 5.0±0.83 l) and respiratory frequency (RR) values than the non-periodic sports representatives (respectively 14,16,20 once a minute). Bronchial permeability indicators have the lowest level in judo players ($p<0.05$), which indicates a decrease in the total capacity of the bronchial branches, which is clearly related to the characteristics of the exercises when judo exercises are performed under tension. Student - light athletes and student judokas with strained adaptive-regulatory mechanisms had significantly higher respiratory volume indicators (VCL and RR) than light athletes ($p<0.05$) (table 2). Athletes and judokas with a high degree of adaptation have a positive balance of functional resources with a sufficient predominance of the category of athletes and judokas with a strain on the regulatory mechanisms of the cardiovascular system (CVS).

The results of the experimental study of oxygen demand indicators (average values and standard deviations), were presented in table 1. As can be seen from the data of Table 1, the oxidation indicators before the performance of physical work remain high and do not differ from the condition before loading. It can also be noted that no significant differences between ÜVS and OKS were found in representatives of periodic and non-periodic sports. In our opinion, the obtained facts show that the developed diffusion capacity of the lungs allows the body to saturate the blood with oxygen, and the oxygenation indicators do not decrease during the transition of the segment, that is, the work takes place mainly in aerobic conditions: the body can combine with hemoglobin with sufficient oxygen. This is evidenced by pulse values after performing physical work - the maximum pulse is about 150-160 beats per minute. It follows that the cardiorespiratory system works efficiently and is able to pump blood and combine with oxygen.

Thus, according to Farfel's classic classification, it is possible to assess the nature of the standard load performed as work in the submaximal power zone or close to maximal aerobic power according to Kots' classification [5]. Slight differences in the presented indicators can be attributed to the individual typological characteristics of the athlete, who mainly specializes in cyclical sports (athletics), rather than non-cyclical - where a sharper reaction of the body to the running version of training can be observed. Rest between segments allows to cause adaptive changes in the body, while at the same time a systematic increase in training speed is observed. Thus, we can conclude that the work is essentially unlimited by the mode of aerobic energy supply.

A comparative analysis of the results of the study (table 2) showed that there were no significant differences in oxidation in both groups before and after exercise. However, it should be noted that under the conditions of performance of the standard load, the increase in oxidation in periodic sports was more intense than in non-periodic sports. Oxidation was directly proportional to physical activity performed.

According to the categories proposed by Astrand [5], the average value of maximum oxygen consumption during the performance of maximum load in representatives of cyclic sports corresponds to high oxygen consumption, and a good level of oxygen consumption in representatives of acyclic sports. When analyzing the dynamics of gas exchange indicators during physical activity, the nature of changes in OKS in the initial stage was almost the same in both groups, then a more noticeable increase was observed in representatives of periodic sports. This is confirmed by an insignificant difference in some values, which describe the dependence of oxidation on the loading power. In terms of RR, it can be said that from the initial stage of the load, a more intense increase was observed in representatives of cyclical sports. In the initial phase of the load, the intensity of changes in RR was almost the same, then a slowdown (decrease) in the growth rate of RR was observed in transitional loads, in representatives of cyclical sports. In a comprehensive analysis of the dynamics of gas exchange indicators with an increase in loading power, the value of oxidation in representatives of cyclical sports is determined by the change of VCL, oxidation and RR in comparison with representatives of non-cyclical sports, where the value of RR is mainly equal. This corresponds to the criteria for determining the functional reserves of the body's gas transport system according to the type of response to physical activity proposed by leading researchers in this field [10].

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