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Functional Response of the Cardiovascular System of Young Track and Field Athletes to Vestibular Stimulation

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Abstract

The study aimed to find out the reaction of the cardiovascular system of track and field athletes with different durations of sports experience to vestibular stimulation. The study was performed on 46 young (19.2±0.64 years old) track and field athletes. All of them were systematically trained twice or thrice a week for at least one hour a day for different lengths of time: 1 year - 15 people, 2 years - 17 people, 3 years - 14 people. The control group, also collected, consisted of 18 clinically healthy individuals at the age of (19.7±0.52 years) who were not fond of sports. The main characteristics of the cardiac and vascular system under conditions of vestibular irritation in the case of rotational test application were revealed. The obtained indices were processed by Student's t-criterion. For participation in any sports activity, especially in athletics, it is necessary to have a good development of the vestibular control mechanism, which allows for optimizing the current position of the body and its parts in space. As the value of athletics experiences increases, strengthening of the heart and vascular system and increasing working capabilities of the vestibular mechanism are found. Maximum pulse stability was found in athletes who had three years of athletic experience and the greatest experience in performing motor actions of sports characters at different angles. It can be considered that athletics develops the heart and vascular system, which contributes to its stable operation under conditions of various vestibular stimuli.

Keywords: Sports, Athletics, Vestibular irritation, Physical training, Heart and vascular system

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Introduction

Increasing physical activity within feasible limits causes a powerful stimulation of biosynthetic processes in the human body and leads to its general strengthening (Bespalov *et al*., 2018). This situation enhances the work of all internal organs (Kotova *et al*., 2017). The vestibular apparatus (Fayzullina *et al*., 2020) is of great importance for the realization of all motor actions, continuously correcting the position of the body in space and helping the rational work of transverse striated muscles (Usha *et al*., 2019). Normal functioning of vestibular mechanisms is always carried out in close connection with the normal work of vital organs, creating a reliable basis for the realization of movements (Kachenkova *et al*., 2020; Zavalishina, 2020b). Serious importance for preserving the optimum physical condition (Vorobyeva *et al*., 2020) and achieving optimal training within any sport is now given not only to the state of vestibular mechanisms but also to their influence on the work of the vascular system and heart (Karpov *et al*., 2020).

The aim of the study: is to find out the reaction of the cardiovascular system of track and field athletes with different durations of sports experience to vestibular stimulation.

Materials and Methods

For the study, 46 young men (19.2±0.64 years old) were recruited, who had regular athletics training 2-3 times a week, with a duration not shorter than one hour. The observed athletes had experience of systematic training: one year - 15 people, two years - 17 people, three years - 14 people. A control group was also formed, which consisted of 18 clinically healthy young men aged 19.7±0.52 years.

All of them had not previously practiced sports and continued to lead a physically inactive life. In all cases, the functional parameters of the heart and vascular system were recorded during the application of rotational tests according to V.I. Voyachek's method. In this case, we evaluated changes in heart rate and arterial pressure before and after the usual rotational test (five rotations for 10 s), as well as in the conditions of the test modified by performing a head tilt to one side and the other (with a frequency of five rotations for 10 s). To increase the severity of the effect of the rotation process on the vestibular apparatus, another modification of the rotation test was used by doubling the duration of the classical rotation test (10 rotations for some time of 20 seconds). The results of the study were processed statistically by Student's criterion.

Results and Discussion

The level of heart rate in track and field athletes with different duration of track and field training experience turned out to be optimal and was equal to 65.6±0.42, 62.6±0.53 and 60.5±0.58 beats/minute, respectively, with one year of experience, two years of experience and three years of experience. In the control group, this index was higher but also was within the norm (72.9±0.67 beats/minute).

Heart rate under conditions of vestibular loading in young track and field athletes and those with poor physical development showed a clear increase. When performing the standard Voyachek's test there was an increase in heart rate in track and field athletes with training experience of 1 year by 3.6±0.36 beats/minute, with training experience of 2 years by 3.3±0.38 beats/minute, with training experience of 3 years by 2.2±0.23 beats/minute. In young men of the control group, this parameter increased by 5.5±0.45 beats/minute **(Table 1)**.

In the course of the study, it was noted that against the background of torso rotation in the conditions of head tilt in different directions, the heart response of the subjects had some differences. The heart rate in the case of a head tilt to the left was higher than in the case of a head tilt to the right.

The differences found in the value of heart rate changes in track and field athletes with different years of athletic training were small but possessed statistical reliability. In all probability, this should be associated with the sporting need to regularly change the location of the head in relation to the body in the conditions of movement realization. Adaptation to these movements increases as the length of athletic training experience lengthens. Track and field athletes with three years of sports experience had the least pronounced heart rate response to their body rotations under conditions of head tilt to the right (2.4±0.12 beats/minute). Head tilt to the left was accompanied by a more pronounced heart rate response of the subjects, also decreasing with increasing sports experience. The maximum heart rate response in this test occurred in the control group, amounting to 6.8±0.48 beats/minute. It can be thought that as the athletic experience increases, the heart increases its adaptive capacity with respect to athletic movements with head tilt and rotational component (Makurina *et al*., 2020). The observed differences in heart rate response with head tilts in different directions are explained by the fact that all athletes were right-handed. In this case, right movements are more habitual for them and the body's reaction to them is minimal.

Table 1. Changes in pulse rate in track and field athletes under different variants of vestibular irritation

Groups of those monitored	Increase in pulse rate, M±m			
	the traditional version of the rotational test	**5 rotations for 10 seconds in a left tilt condition**	**5 rotations for 10 seconds under right tilt conditions**	**10 rotations for 20 seconds in a straight position without inclination**
Group of young control males (n=18), beats/minute	5.5±0.45	6.8±0.48	5.6±0.39	9.7±0.54 p_2<0.01
Group of young male track and field athletes with sports experience of one year (n=15), beats/minute	3.6±0.36 p<0.01 p_1<0.01	4.7±0.28 p<0.01 p_1<0.01	3.8±0.42 p<0.01 p_1<0.01 p_2<0.01	6.2±0.51 p<0.01 p_1<0.01
Group of young male track and field athletes with two years of sports experience (n=17), beats/minute	3.3±0.38 p<0.01 p_1<0.01	4.2±0.29 p<0.01 p_1<0.05	3.2±0.31 p<0.01 p_1<0.01 p_2<0.01	5.4±0.35 p<0.01 p_1<0.01
Group of young male track and field athletes with a sports experience of three years (n=14), beats/minute	2.2±0.23 p<0.01	3.4±0.21 p<0.01	2.4±0.12 p<0.01 p_2<0.01	4.5±0.17 p<0.01

Note: p - reliability of differences between the control group and track and field athletes, p_1 - reliability of differences between the group of track and field athletes with three years of experience and track and field athletes with sports experience of one and two years, p_2 - reliability of differences between the considered indicators in conditions of different head position relative to the body.

In the examination of track and field athletes with different sports experience, differences in the change of heart rate value in case of different durations of rotational influence on the body were found. The pattern found in this test in athletes of all groups was different from that found for the effect of five rotations on their organism. As the sports experience increased, the pulse response increased in

the sample with 10 revolutions (with one year of training experience by 72.2%, with two years of training experience by 63.6%, with three years of training experience by 2.0 times). Thus, in track and field athletes with 1 year of sports experience, this parameter amounted to 6.2±0.51 beats/minute during the test with 10 revolutions. In athletes with two-year experience, the dynamics of growth of this parameter reached 5.4±0.35 beats/minute, and in athletes with three-year training experience, this parameter was 4.5±0.17 beats/minute. It is clear that the changes in cardiac performance in athletes with long training experience have a serious functional basis (Glamazdin *et al*., 2024). They optimally intensify blood flow in all parts of the body in conditions of realization of any sports movements (Zavalishina, 2020a).

Under off-load conditions, the values of systolic blood pressure in track and field athletes with a training experience of one year (118.1±0.34 mmHg), those with a training experience of two years (114.9±0.52 mmHg), and those with a training experience of three years (113.1±0.36 mmHg) were normal. This index was slightly higher in the control group - 128.1±1.32 mmHg, also being within the normal limits. During the standard rotational test and the test in conditions with head tilt in different directions, the changes in systolic blood pressure in all subjects were not reliable.

Under the conditions of the test with twice lengthened rotation period in trainees with different durations of sports experience, the value of systolic blood pressure increased by 20.0-23.4% compared to the off-load condition. In the control group, the increase in systolic blood pressure during the doubling of the rotation time during the test was 67.1% compared to the off-load level.

The value of diastolic arterial pressure in athletes of the compared groups did not differ, on average reaching 67.2±1.17 mmHg (in the group of those who did not physically load themselves this index amounted to 84.2±0.37 mmHg). The value of diastolic blood pressure in the athletes and in the control group under conditions of all types of rotational influences increased very insignificantly. High stability of diastolic blood pressure in different categories of athletes is of great adequate importance, as it provides invariability of the optimum continuous blood supply of tissues under any loads (Vorobyeva *et al*., 2018).

Conclusion

Regular athletic training increases the body's adaptability to loads, especially those that can affect the vestibular apparatus. This is quite true for cardiac function. As the duration of athletic training lengthens, the stability of cardiac muscle performance under different vestibular stimuli increases. In future studies, it is of interest to trace the response of the heart to vestibular loading in track and field athletes.

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