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Changes in the functional state of athletes under the influence of physical load

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Abstract: The main goal of the presented research is to study the effect of sports physical activity on the quality of regulation and adaptive capacity of the cardiovascular system of athletes and non-athletes. The obtained results showed that the number of heart beats decreases during the rest period. Changes in the number of heart rates when performing a physical load correspond to the age norms of athletes. In addition, no significant changes were founding in the number of heart rates and systolic blood pressure, but diastolic blood pressure significantly decreased, and pulse pressure increased.

Keywords: *Diastolic blood pressure, Number of heart rates, Systolic blood pressure.*

1. Introduction

The processes of adaptation to physical activity are the main components for achieving high sports results in athletes. Based on the structural features, complexity and level of development of the functional adaptation system, a general strategy of adaptation to physical activity is formed [1]. The cardiovascular system plays a major role in ensuring the athlete's body adapts to physical activity, actively participating in the processes of adaptation to the smallest changes in the needs of individual organs and systems [2, 3]. It has been argued that higher training loads lead to higher injury rates. However, there is evidence in the scientific literature that consistent (chronic) exercise protects against injury. Intense chronic sports load reduced the risk of injury and increased the adaptability of the athlete's body. In addition, well-developed physical skills and abilities help reduce the risk of injury. Taken together, these results highlight that reducing workloads may not always be the best approach to injury prevention [4].

Based on the above, the main goal of the presented research is to study the effect of sports physical activity on the quality of regulation and adaptive capabilities of the cardiovascular system of athletes and non-athletes.

2. Method

A total of 40 students of Azerbaijan Sports Academy participated in the study. At the time of the study, the average age of the students was 18-20 years, the average height was 176±2.9 cm, and the average weight was 71.5±3.8 kg. The research was carried out during the period of 2 years. To assess the functional status of the students' cardiovascular system, the Harvard test, a functional probe, was used to measure the number of heart beats (HRS) and arterial blood pressure (systolic blood pressure - SBP, diastolic blood pressure - DBP). The essence of this test is that the athlete repeatedly climbs a step with a height of 50 cm for 5 minutes by making 30 ascents (120 steps) per minute. Each ascent and descent consist of 4 steps: 1st step - put the right foot on the step, 2nd step - put the left foot, 3rd step - put the right foot on the floor, 4th step - put the left foot on the floor. reaction was determined based on the index of the Harvard step test, pulse frequency, as well as systolic, diastolic and pulse pressures (the difference between systolic and diastolic pressures). The number of heart rates (HR) and arterial pressure (BP) were determined. After the physical work, the registration of HR was done every minute, and AT every odd minutes.

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3. Results and Their Discussion

In order to determine the signs of changes in the cardiovascular system, we decided to measure the number of cardiac stresses (HRV) before and after physical activity in freestyle wrestling athletes. Thus, in 2023, the average heart rate of athletes practicing freestyle wrestling was 71.55 beats per minute. In 2024, that indicator was already 66.45 accents per minute (Table 1).

Table 1.
Changes in the number of heart rates in athletes during the rest period.

Indicator. Unit of measure.	**2023**	**2024**
	$X_{cp.} \pm \delta$	**$X_{cp.} \pm \delta$**
Number of heart rates per minute	70.18±2.09	64.46.±2.08
t	5.713	
P	P<0.001	

Our results clearly show that in 2024, compared to 2023, there is a decrease in the number of heart attacks of athletes. We assume that these changes may occur due to the increase in the training loads of the athletes, the ranks of the athletes, as well as their sports experience. It should be noted that the decrease in the number of heart beats and even in some cases a strong decrease before physical load - during the rest period is not recognized by doctors as a pathological condition, it is a natural process of saving energy of the body and its systems [5, 6, 7].

Next, we examined another indicator of the cardiovascular system - blood pressure (systolic blood pressure and diastolic blood pressure) of athletes at rest. Diastolic blood pressure is the pressure at maximum relaxation of the heart; systolic blood pressure is the pressure during maximum contraction of the heart. The results of the conducted studies are presented in Table 2.

Table 2.
Changes in blood pressure in athletes during rest.

Indicator. Unit of measure.	**2023**	**2024**
	$X_{a.} \pm \delta$	**$X_{a.} \pm \delta$**
SBP in mm of m.c.	127.34±3.52	120.15.±1.63
t	8.105	
P	P<0.001	
DBP in mm of m. c.	88.21±1.59	82.15±1.71
t	9.713	
P	P<0.001	

Comparing the indicators of systolic and diastolic blood pressure in athletes, we can say that in 2023, the values of these indicators in athletes were slightly higher, but after one year - in 2024, their results decreased slightly. It should also be noted that the change in diastolic pressure corresponds to the dynamics of changes in systolic blood pressure and does not allow us to talk about significant differences in indicators during observation. After measuring the indicators of the cardiovascular system in athletes during the rest period, we began to study the system under consideration after moderate Table 3 and submaximal Table 4 physical load.

As our research shows, the response of the cardiovascular system to physical load in 2024 has improved compared to 2023, which can indicate the positive effect of physical loads on the heart muscle of athletes and the functional state of the whole body. The indicators of systolic and diastolic pressure show a tendency to worsen, which may indicate a long recovery period and accumulation of fatigue in the athlete's body. When studying blood pressure, we observe a positive trend in the effect of physical activity on this indicator. But not every load can lead to similar results.

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Table 3.
Measurement of the number of heart beats and arterial blood pressure after moderate physical load in athletes.

Indicator. Unit of measure.	**2023**	**2024**
	$X_a.\pm\delta$	**$X_a.\pm\delta$**
HR (Beats per minute)	127.54±2.87	130.14±2.52
t	2.586	
P	P < 0.05	
SBP in mm of m.c.	131.57±2.21	133.07±2.39
t	1.941	
P	It is invalid	
DBP in mm of m.c.	94.08±1.59	88.43±2.34
t	7.513	
P	P < 0.001	

Table 4.
Measurement of heart rate and arterial blood pressure after submaximal physical load in athletes.

Indicator. Unit of measure.	**2023**	**2024**
	$X_a\pm\delta$	**$X_a.\pm\delta$**
HR (Beats per minute)	159,43±1,92	165,08±1,96
t	2,579	
P	P < 0,05	
SBP in mm of m.c.	150,29±1,92	149,21±4,15
t	0,813	
P	It is invalid	
DBP in mm of m.c.	95,61±1,27	92,77±2,27
t	4,597	
P	P < 0,001	

With the increase in physical activity, we can increase the diastolic pressure, which will lead to unfavorable results, and under the condition that the load remains at the same level, the athletes' body adapts to it and the pressure can return to the previous level. The obtained results of the dynamics of heart rate at rest between loads are presented in Table 5. Our data on the dynamics of heart rate recovery do not contradict the data available in the literature, but there is a tendency for the heart rate to increase at submaximal load and the recovery time of this indicator. This feature can indicate the accumulation of fatigue in athletes as their sports experience increases and loads increase [8, 9].

Table 5.
Results of changes in the number of heart beats during rest and recovery periods.

Indicator. Unit of measure.	**2023**	**2024**
	$X_a\pm\delta$	**$X_a\pm\delta$**
HR (Beats per minute) the first minute of rest	117.46±1.58	114.42±1.49
t	5.129	
P	P < 0.001	
HR (Beats per minute) the first minute of rest	127.49±1.91	129.61±1.56
t	3.493	
P	P < 0.01	
HR full recovery, min.	2.81±0.03	2.93±0.08
t	9.298	
P	P < 0.001	

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4. Conclusion

The number of heart rates and arterial blood pressure indicators were found to be in accordance with the generally accepted norms for athletes. From 2023 to 2024, a slight decrease in the indicators of the cardiovascular system activity was revealed, which is manifested by a decrease in blood pressure after physical load during the rest period, an increase in the number of heart rates and its recovery time.

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