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Changes in hemodynamic parameters affected by interval hypoxic exercises during the precontest training stage of qualified climbers

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Purpose: *to study the effects of the use of interval hypoxic training (IHT) in the 15–15 mode with breathing through the system into a confined space with a regulated composition of inhaled air in the integrated training process of climbers of the level of preparation of SP-I.*

Material & Methods: *a study was conducted with the participation of the control and experimental groups using medical-biological methods and IHT in the experimental group with using mathematical statistics methods.*

Results: *conducted studies have allowed to determine that the use of the regime of discontinuous hypoxia 15–15 in the training process of the precompetitive period contribute to an increase in the parameters of hemodynamics that affect the adaptation to the action of the load under conditions of hypoxia.*

Conclusion: *reliable changes that are determined during the research testify to the effectiveness of the use of interval hypoxic training 15–15 in the precompetitive training of qualified climbers.*

Keywords: *interval hypoxic training; climbers, hypoxia.*

Introduction

To consider the problem of lack of oxygen or the emergence of a state of hypoxia in the body makes sense only if the conditions for the normal functioning of the tissue respiration system [6; 12]. From this point of view, many physiological classifications of hypoxic states and quantitative criteria used to evaluate these states are clearly inconsistent with this basic setting. In many physiological classifications, the comparative values of the partial pressure of oxygen at different levels of the oxygen cascade of the organism as the main classification criterion according to «established physiological norms». For example, if the saturation of the hemoglobin of the blood with oxygen drops to 93%, then this condition is designated as hypoxemia, which usually accompanies the development of tissue hypoxia. In fact, this is not always the case. Even with pronounced hypoxemia in Aboriginal mountains, the partial pressure of oxygen in tissues can be near normal values and not accompanied by the development of severe hypoxia [2; 16], which is associated with the adaptation of their body to environmental conditions.

The purpose of the research

To study the effects of the use of interval hypoxic training (IHT) in the 15–15 mode with breathing through the system into a confined space with a regulated composition of inhaled air in the integrated training process of climbers of the level of preparation of SP-I.

Material and Methods of the research

During the experiment, the parameters of hypoxic and orthostatic samples were recorded, fixed at the end of the 4th, 6th and 8 weeks of training, in the morning before the start of the training. It is known that the change in the position of the body in space is one of the strong influencing actions used in the so-called ortho and clinoostatic tests [8]. Orthostability of blood circulation reflects the effectiveness of a complex of tolerant reactions and allows us to judge the functional capabilities of the cardiovascular system [9]. Orthostatic reactions as a result of redistribution of blood between the «upper» and «lower» parts of the body are a constantly acting factor of natural life [11]. Orthostatic stability in all sports is an important condition for athletic performance [14]. The response to the orthostatic test is improved under the influence of athletic training for all athletes, and not only for representatives of those sports in which a change in body position is an indispensable element [5]. The reaction to the orthotropic test is proposed to be used to assess the pre-competition readiness [15].

Results of the research and their discussion

When analyzing the action of physical loads and their effect on the functional condition of climbers, the calculation of the done training work was carried out according to the duration of the load, including both the time of the exercise itself and the rest time between exercises, when there is an active adaptation to the action of the load. Individual diary data were collected, which were competitors of each group every day during the entire study period. In the records, climbers marked loading zones according to the pulse criteria, as well as the duration of the exercises in each of them. Also daily measurements were made of the parameters of the hemodynamics of the functional state of climbers.

The individual data of each athlete was made in a variation series and the average value of each indicator in each of the groups. The first three weeks of the pre-competition stage climbers of both groups were engaged in one program, which made it possible to equalize the parameters of hemodynamics. Later, in 4–8 weeks, the training process of the experimental group was administered interval hypoxic training.

In the pre-competition stage of preparation, interval hypoxic training (IHT) was used as a positive training effect in the experimental group, against a background of a wide range of exercises of different effects.

In the course of the studies, certain features of the response of hemodynamic parameters to their measurements in skilled climbers in the supine position and standing of the control and experimental groups under the influence of IHT were revealed (Table 1).

It is known that when moving to a vertical position (orthoprobe), gravity improves the flow of blood from veins located above the heart level, but leads to a delay in blood in the veins located below the heart, especially in the lower limbs [10]. The inclusion of the functioning of the muscles holding the posture standing (active orthostasis) led the athletes of the experimental group to a change in the functioning of the blood circulation, primarily by increasing the SBP, HR, which indicated in favor of improved adaptogenicity of the circulatory parameters in comparison with the control group. As can be seen from Table 1, significant changes in the parameters of hemodynamics in athletes of the experimental group in comparison with the control group with reliability ($p<0,05$) higher ones, starting from the 6th week of control – were preserved until the end of the pre-competition stage.

Thus, the change in systolic blood pressure at the end of the 6th training week showed that the SBP in the prone position of the athletes of the experimental group was reliably ($p<0,05$) lower compared to the control group and was 117,4±1,6 mmHg and 123,1±2,8 mmHg respectively. In the standing position in the 6th and 8th week of the control, differences between the groups in the SBP indicator were not reliable ($p>0,05$). Similar changes were made at the end of the 8th training week. Thus, in the supine position of the climbers of the experimental group, the value of SBP was 113,7±1,9 mmHg, that significantly ($p<0,05$) differed from this parameter in the control group – 121,3±2,5 mmHg.

The dynamics of the DBP indices was identical and reliably ($p<0,05$) differed in the groups, they were investigated, the differences were in both the prone position and the vertical position of the body. So, DBP at the end of the 6th training week of the pre-competition stage in the prone position in the control group was 70,1±2,2 mmHg in the experimental – 67,1±0,7 mmHg. ($p<0,05$), at the end of the 8th training week – 70,5±2,1 mmHg and 65,1±1,2 ($p<0,05$) respectively. A similar significant difference between the groups was in the standing position after 6 and 8 weeks: 70,4±1,9 mmHg and 67,2±0,9 mmHg ($p<0,05$), 70,1±1,8 mmHg and 66,9±1,0 mmHg ($p<0,05$) respectively. Changes in pulse pressure (PP) were consistent with the dynamics of DBP in both groups and were also significantly ($p<0,05$) higher for the benefit of the experimental group. At the same time, the oxygen capacity of the blood – SaO2, despite the steady tendency to increase in the athletes of the experimental group, significantly ($p<0,05$) differed only at the end of the 8th training week only in the prone position and was 97,1±0,2% and 98,1±0,3% ($p<0,05$).

The data obtained by us in the process of studying hemodynamic parameters in climbers of both groups in the pre-competition stage at a fixed time of control using the ortho-test showed a tendency towards the development of tolerance to hypoxia in the athletes of the experimental group.

It should be noted that "Oxygen debt", which occurs with intense muscle and mental activity, brings fatigue. In recent years, a number of drugs have been tested that contribute to increasing the body's resistance to a lack of oxygen, namely the effect of delayed breathing in the course of muscle activity [3; 4; 6]. It was found that holding the breath during sports activity causes significant changes in the internal environment of the body. This increases the tissue resistance to lack of oxygen and requires a compensatory response of the body. Stability to hypoxia is an important indicator of the athlete's fitness for prolonged cyclic work, and the severity of the increase in resistance to hypoxia in athletes depends on the orientation of the training process. The cyclical nature of physical training contributes to a higher tolerance to hypoxia compared with the training of speed-strength and complexity-coordination orientation [13]. According to A. S. Glazachev

Table 1

Dynamics of hemodynamics in climbers of the control and experimental groups during the pre-competition period, $\bar{X}\pm m$

Indicators		Control group (n=16)			Experimental group (n=12)		
		Weeks of measurement					
		4-th	6-th	8-th	4-th	6-th	8-th
SBP, mmHg	L	120,6±2,1	123,1±2,8	121,3±2,5	120,8±1,9	117,4±1,6*	113,7±1,9*
	S	121,4±3,3	123,1±3,1	121,9±2,1	121,1±1,7	119,1±2,1	118,1±1,8
DBP, mmHg	L	68,9±1,1	70,1±2,2	70,5±2,1	69,1±1,9	67,1±0,7*	65,1±1,2*
	S	67,2±0,9	70,4±1,9	70,1±1,8	68,4±1,2	67,2±0,9*	66,9±1,0*
PP, mmHg	L	51,7±1,0	53,0±0,6	50,8±0,3	51,7±1,0	50,3±0,6*	48,6±0,7*
	S	54,2±2,4	52,7±0,3	51,8±0,3	52,7±0,7	51,9±0,2*	51,2±0,2*
HR, beats per·min^{-1}	L	67,1±3,7	63,1±3,2	62,6±4,1	65,1±3,1	62,1±3,3	58,5±1,8
	S	74,2±4,1	70,4±2,8	66,9±3,3	73,9±3,8	69,4±2,2	65,2±2,1
SaO_2, %	L	96,9±0,3	96,7±0,2	97,1±0,2	96,5±0,4	97,6±0,8	98,1±0,3*
	S	97,0±0,3	96,9±0,4	97,3±0,2	96,9±0,6	97,7±1,0	98,1±0,2

Note. ** – p<0,05, reliability of the difference between groups in individual weeks; measurements: L – lying; S – standing.*

Table 2

Dynamics of hemodynamics in climbers of the control and experimental groups during the pre-competition stage, $\bar{X}\pm m$

Indicators		Control group (n=16)			Experimental group (n=12)		
		Weeks of measurement					
		4-th	6-th	8-th	4-th	6-th	8th
Test	Genci, s	36,3±0,8	35,7±0,9	36,2±1,1	42,8±0,8*	45,1±0,7*	47,6±0,9*
	Stange, s	109,2±2,7	111,2±3,2	112,0±4,3	114,4±3,9	119,6±3,1*	125,4±3,8*

***Note.** * – p<0,05, significance of differences between groups in some weeks.*

et al [1], the duration of an arbitrary breath-hold on inhalation accurately reflects the degree of satisfaction of the oxygen request of the central nervous system [7].

A study was also conducted to study the degree of satisfaction of the oxygen request of the brain tissue at the end of the 4th, 6th and 8th week of training, which in the groups before the start of the training did not have a significant difference. For this purpose, the duration of an arbitrary delay in breathing was determined (Stange and Genci tests, respiratory arrest respectively on inhalation and exhalation) (Table 2).

The determination of the breath retention on inspiration and on exhalation showed a significant ($p<0,05$) difference in the results of the study in all weekly microcycles. Thus, a significant ($p<0,05$) increase in the respiratory arrest time on inspiration (Genci test) was detected in the climbers of the experimental group as compared to the control group at the end of the 4th, 6th and 8th training weeks, which was 42,8±0,8 s and 36,3±0,8 s, 45,1±0,7 s and 35,7±0,9 s, 47,6±0,9 s and 36,2±1,1 s ($p<0,05$) respectively. At the same time, the comparison of adaptation for hypoxia in athletes of both groups, Stange test parameters (breathing retention on exhalation, increase in the time of adequate oxygen capacity of blood (SaO2)) was significantly ($p<0,05$) higher in the experimental group at the end of 6th and 8th weeks of training, which accounted for 119,6±3,1 s and 111,2±3,2 s, 125,4±3,8 s and 112,0±4,3 s .

Conclusions

Based on the presented experimental data, it can be argued that the development of anaerobic functions of athletes is significantly affected by the use of intermittent hypoxia 15–15, which can be applied taking into account the individual characteristics of the athlete's body, the focus of the previous training session and the period of preparation in macrocycles for the development of anaerobic work capacity of the athlete's organism and maintaining the achieved level of anaerobic efficiency.

The prospect of further research. It is planned to determine the effect of interval hypoxic training on indicators of physical readiness

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