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Attention indicator dynamics of qualified climbers influenced by hypoxic training during the overcoming various altitude levels of Mount Elbrus

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Purpose: *to determine the effect of hypoxic training on the attention indicators at different altitudes when crossing the Mount Elbrus.*

Material & Methods: *the study of various attention indicators with the participation of control (n=16) and experimental (n=12) groups with the use of interval hypoxic training (IHT) in the 15–15 mode with breathing through the system into a confined space in the experimental group and using the methods of mathematical statistics are carried out.*

Result: *studies have made it possible to determine that the use of the regime of discontinuous hypoxia 15–15 in the training process of the pre-competitive period contribute to an increase in attention rates that affect adaptation to the load under hypoxia conditions.*

Conclusion: *results of the conducted studies indicate that the use of IHT in the 15–15 mode in the period before the ascent to Mount Elbrus allows to significantly increase the attention rates of qualified climbers at different altitude levels.*

Keywords: *climbers, hypoxic training, altitude level.*

Introduction

Many mountaineers note the difficulties in performing work in the highlands [4]. With muscle activity of high intensity, there is a discrepancy between the rate of oxygen delivery to the muscles and their increased metabolic needs. This leads to a mismatch in the oxygen delivery of the oxygen request of the tissue, the development of subcompensated and decompensated hypoxia [9].

Effectiveness of the oxygen regimes of the body – the ratio between the speed of the phased delivery of oxygen and the rate of its consumption – increases with exercise [1; 4; 6].

As the saturation of arterial and venous blood with oxygen decreases and the oxygen tension in the blood system decreases, one can assess the degree of hypoxemia, and the oxygen tension in tissues and mixed venous blood – the measure of tissue hypoxia [3; 5], which developed.

State of hypoxia (oxygen deficiency) occurs when the oxygen tension in the cells and tissues of the body becomes below the critical value, at which it is still possible to maintain the maximum rate of enzymatic oxidative reactions in the mitochondrial respiratory chain. Reasons that directly determine the occurrence and development of hypoxia state may be both external (changing gas composition environment, the rise in height, difficulty pulmonary respiration) and an internal character (functional insufficiency or pathological changes in vital organs, abrupt changes in metabolism accompanied by increased oxygen demand of tissues, action of poison and harmful metabolic products, etc.). Regardless of the causes that generate it, hypoxia exerts a pronounced effect on the course of metabolic and physiological processes in the body that determine the health and working capacity of a person [2].

Recently, artificial training of hypoxia is used as an additional training tool for traditional training to enhance the functionality of athletes: training in a hyperbaric chamber, use of various exercises with a delay in breathing, the method of return breathing with the use of masks and tubes with significant dead space, a method that allows breathing a mixture of hypoxia in real conditions of training. These methods allow to achieve a significant increase in the level of fitness of athletes of different levels of preparedness [7].

The effectiveness of hypoxic training depends on the effect of two interrelated factors of hypoxia, caused by a decrease in the partial pressure of oxygen in the inspired air, and hypoxia, is created by performing an exercise load. Each of these factors of hypoxia stimulates the action of another, but this only occurs when the rational choice of the training regime for hypoxia and establishing the correct ratio of loads of different directions [8].

Advantage of this method is that there is no stress stage as when climbing the mountains (normal acclimatization and re-acclimatization phenomena are not observed) normal atmospheric pressure; the possibility of variation and strict dosing of the stimulus of hypoxia, and the fact that IHT does not affect the planned process of sports training.

Purpose of the study: to determine the effect of hypoxic training on the attention indicators at different altitudes when crossing the Mount Elbrus.

Material and Methods of the research

Determination of the effectiveness of the level of preparation of the SP-I IHT method, introduced in the training process of climbers in the 15–15 mode with breathing through the system into a closed air with inhalable, simple, regulated air, was conducted in the integrated training process in the competitive stage – in August 2015. Taking into account the peculiarities of ascent, technical difficulties are possible, as well as the degree of hypoxia influence on the central nervous system, for assessing the degree and quality of IHT influence on hypoxia tolerance and as a reflection – and cognitive functions of athletes, we, in the process of climbing climbers of the control and experimental groups at certain control points (CP), studied the ability to maintain a high level of mental processes in conditions of increasing physical fatigue – visual memory and attention.

Results of the research and their discussion

Taking into account the dynamics of climbing, we identified 5 control points for assessing the special preparedness of climbers, as well as their mental characteristics and sports activities: CP1 (2125 m), CP2 (3800 m), CP3 (4100 m), CP4 (4800 m), CP5 (2125 m).

It is known that the physiological basis of attention is the ratio of the processes of excitation and inhibition in the cerebral cortex. Excitation is due to the fact that the sensory organs are affected by the stimulus. By virtue of the law of negative induction, a zone of inhibition arises around the focus of objective excitability. The focus of optimal excitability provides the direction of mental activity on the object, the zone of inhibition is concentration (I. P. Pavlov, 1947). As evidenced by the results of studies of the attention of climbers of the experimental group, the IHT course caused a positive influence on the components of attention, which is of great importance during the ascent to the summit. Carrying out IHT in the 15–15 course with the increase in the time spent for inhalation of the gas mixture of hypoxia at regular intervals in an amount of 9 times in 6 weeks showed a significant improvement in the attention components at practically all control points in the athletes of the experimental group. Thus, at the 1st and 2nd control points, at the time of the first climbing of the climbers of both groups to a height of 2125 m and at the first acclimatization exit to the «Ice Base» – 3800 m, in assessing the overall performance of the test of the total number of viewed signs, there were no differences between the indices.

This indicates in favor of identical compensation of the process of fatigue in the period 1–4 days from the start of the ascent (Table 1).

In the future, when approaching the moment of conquest of the summit, which is associated with a set of altitude and voltage of the general operability at the 3 point of control, on the 8th day of entry at an altitude of 4100 m and at the 4 point of control, on the 10th day at an altitude of 4800 m ($p<0,05$) the differences between climbers of both groups. Thus, the total number of scanned characters in the experimental group on the 8th day of ascent was 461,2±10,4, significantly ($p<0,05$) differed from that in the control group – 429,2±10,7. On the 10th day of the ascent, the changes in the indicator of the total number of scanned characters were kept identical ($p<0,05$), which was 445,6±12,4 in the control and 488,6±12,1 in the experimental ($t=2.48$; $p<0,05$) groups. It should also be noted that there was a significant ($p<0,05$) tendency for the indicator to increase in the experimental group in time against the background of climb, in CP3 and CP4 which were 461,2±10,4 and 488,6±12,1, respectively. This is evidence in favor of rapid adaptation of the organism of climbers of the experimental group to a gradual increase in the level of hypoxia and a more pronounced tolerance for it under the influence of the IHT course in the pre-competition period in the 15–15 mode. Significant also information about the total number of scanned marks for athletes of both groups at the 5 point of control (2125 m), after the conquest of the summit. Thus, this index significantly ($p<0,05$) differs among climbers of the experimental group 493,3±12,7 in comparison with the control group 451,8±12,1 ($t=2,37$, $p<0,05$), which indicates a faster recovery in the experimental group.

When assessing the level of performance of the task in the indicator of the total number of correctly marked signs, significant changes ($p<0,05$) between the groups were investigated, were found starting from CP2 and the whole competition period was kept (Table 2).

Table 1

Attention indicators (the total number of characters viewed) of climbers of the control and experimental groups at different altitudinal levels in Mount Elbrus

Control points	Control group (n=16)	Experimental group (n=12)	Fidelity assessment	
	$\bar{X}_1 \pm m_1$	$\bar{X}_2 \pm m_2$	t	p
CP1 (2125 m)	447,1±19,2	446,0±22,9	0,04	>0,05
CP2 (3800 m)	429,7±18,1	441,1±35,9	0,28	>0,05
CP3 (4100 m)	429,2±10,7	461,2±10,4	2,15	<0,05
CP4 (4800 m)	445,6±12,4	488,6±12,1	2,48	<0,05
CP5 (2125 m)	451,8±12,1	493,3±12,7	2,37	<0,05

Table 2

Attention indicators (the total number of correctly marked signs) of climbers of the control and experimental groups at different altitudinal levels Mount Elbrus

Control points	Control group (n=16)	Experimental group (n=12)	Fidelity assessment	
	$\bar{X}_1 \pm m_1$	$\bar{X}_2 \pm m_2$	t	p
CP1 (2125 m)	219,6±4,8	222,6±5,2	0,42	>0,05
CP2 (3800 m)	210,5±4,6	238,4±5,7	3,81	<0,01
CP3 (4100 m)	215,4±5,5	235,2±6,2	2,39	<0,05
CP4 (4800 m)	216,2±6,8	234,9±5,8	2,09	<0,05
CP5 (2125 m)	214,4±6,2	236,5±7,9	2,20	<0,05

Thus, in CP2, the number of correctly marked signs in the control group was 210,5±4,6 and the experimental 238,4±5,7 group (t=3,81; p<0,01), in CP3 – 215,4±5,5 and 235,2±6,2 (t=2,39; p<0,05), in CP4 – 216,2±6,8 and 234,9±5,8 (t=2,09; p<0,05), in CP5 – 214,4±6,2 and 236,5±7,9 (t=2,20; p<0,05) respectively. At the same time, despite the tendency to increase the total number of correctly marked signs among the climbers of the experimental group, the authenticity of the entire ascent was not detected (p>0,05).

Identical reversible character changes were also determined in the total number of erroneously marked signs (Table 3).

Thus, in the experimental group, the error rate at all points of control was not significantly different in time. At the same time, in the control group on CP3 at an altitude of 4100 m, this figure was 2 times higher than the figures in the experimental group, 7,2±0,8 i 3,1±0,2 respectively (t=5,00; p<0,001). In CP3 (4100 m) and CP4 (4800 m) similar changes between groups were found, the total number of mistakenly marked signs was 7,2±0,8 and 3,1±0,2 that 4,3±0,3 and 2,1±0,3 respectively, in favor of the experimental group (t=5,00; 5,23; p<0,001). In CP5, there were no significant differences between these indicators. However, in the control group there was only a tendency to reduce errors at the control points 3, 4, 5 (from 8 to 12 days ascent) against the background of a consistently low number of errors in the climbers of the experimental group.

Analyzing the data of each group at separate altitude levels, their various indicators are also defined. So, in the control group, the most errors are defined in CP3 (4100 m), which are significantly lower in other altitude levels (p<0,05–0,001). At the same time, in the experimental group the errors in the marked signs were the largest in the KT3 (4100 m) and amounted to 3,1, significantly more than in the CP2 (3800 m), CP4 (4800 m) and CP5 (2125 m) (p<0,05–0,001).

In determining the dynamics of concentration of attention in athletes of the experimental group, beginning with CP2 (from the 4th day of ascent), there was a steady tendency to increase it with a significant difference (t=3,89, p<0,01) for 12 days in CP4 (4800 m) In relation to the control group (Table 4).

Upon returning to CP1, the concentration of attention in alpinists in the experimental group had significantly higher values (t=2,11, p<0,05). This suggests a more rapid adaptation of the central nervous system to changes in oxygen content in the inspired air and an active perception of the course of ascent, an analysis of the changes occurring and adaptation to them in the climbers of the experimental group.

At the same time, the rate of the test was reliable (p<0,05) differed in the experimental group, starting with CP3, CP4 and CP5, and amounted to 79,4±2,7; 81,9±2,7 and 82,2±1,8 (p<0,05), respectively, which indicates a greater tolerance to hypoxia in athletes of the experimental group (Table 5).

Table 3

Indicators of attention (mistakenly marked signs) of climbers of the control and experimental groups at different altitudinal levels in Mount Elbrus

Control points	Control group (n=16)	Experimental group (n=12)	Fidelity assessment	
	$\bar{X}_1 \pm m_1$	$\bar{X}_2 \pm m_2$	t	p
CP1 (2125 m)	2,3±0,1	2,4±0,2	0,46	>0,05
CP2 (3800 m)	3,2±0,2	2,2±0,4	2,24	<0,05
CP3 (4100 m)	7,2±0,8	3,1±0,2	5,00	<0,001
CP4 (4800 m)	4,3±0,3	2,1±0,3	5,23	<0,001
CP5 (2125 m)	2,5±0,3	1,9±0,3	1,43	>0,05

Table 4

Attention (concentration) of climbers of the control and experimental groups at different altitudinal levels in Mount Elbrus, %

Control points	Control group (n=16)	Experimental group (n=12)	Fidelity assessment	
	$\bar{X}_1 \pm m_1$	$\bar{X}_2 \pm m_2$	t	p
CP1 (2125 m)	98,3±0,8	98,3±0,5	0	>0,05
CP2 (3800 m)	97,2±1,2	98,6±0,8	0,97	>0,05
CP3 (4100 m)	97,5±1,2	98,8±0,6	0,97	>0,05
CP4 (4800 m)	98,2±0,3	99,6±0,2	3,89	<0,01
CP5 (2125 m)	98,6±0,4	99,8±0,4	2,11	<0,05

Table 5

Attention indicators (rate of performance) of climbers of the control and experimental groups at different altitudinal levels in Mount Elbrus, signs min^{-1}

Control points	Control group (n=16)	Experimental group (n=12)	Fidelity assessment	
	$\bar{X}_1 \pm m_1$	$\bar{X}_2 \pm m_2$	t	p
CP1 (2125 m)	74,5±3,2	74,3±3,8	0,04	>0,05
CP2 (3800 m)	71,6±3,1	75,1±3,2	0,67	>0,05
CP3 (4100 m)	71,8±2,2	79,4±2,7	2,18	<0,05
CP4 (4800 m)	74,5±2,2	81,9±2,7	2,13	<0,05
CP5 (5642 m)	76,1±1,9	82,2±1,8	2,33	<0,05

Conclusions

1. The results of the conducted studies indicate that the use of IHT in the mode of 15–15 in the anterior period allows to significantly increase the attention rates of qualified climbers during the overcoming of altitudinal levels in the Mount Elbrus. So, starting with CP3 (4100 m), significantly higher indicators of the total number of characters seen by the climbers of the experimental group (CP3 – t=2,15; CP4 – t=2,48; CP5 – 2,37; p<0,05). In this case, the total number of correctly marked signs is much larger for the athletes of the experimental group starting from CP2 (t=3,81; p<0,001) and in the future – in CP3 (t=2,39; p<0,05), CP4 (t=2,09; p<0,05), CP5 (t=2,20; p<0,05) with a smaller number of mistakenly marked signs in CP2 (t=2,24; p<0,05), CP3 (t=5,00; p<0,001), CP4 (t=5,23; p<0,001). Level of concentration in the experimental group of climbers is significantly higher in CP4 (t=3,89; p<0,01) and CP5 (t=2,11; p<0,05).

2. This indicates that in the pre-competitive training of climbers, in addition to rational planning of the training process, the use of IHT is effective, which will promote hypoxic adaptation.

Prospect for further research is to determine the impact of IHT on HAM indicators.

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