Influence of normobaric hypoxia on the parameters of mental workability of athletes in cyclic sports

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Abstract

Objective of the study was to study the effect of normobaric hypoxia on the parameters of mental performance of highly qualified athletes of cyclic sports.

Methods and structure of the study. The study was conducted in the laboratory of physiology of muscle activity and recovery of the Research Institute of Sports and Sports Medicine RUS "GTSOLIFK". Psychophysiological tests were used on the basis of the hardware-software complex "Sports psychophysiologist" and the method of hypoxic tests using the hypoxicator "Everest-1, mod.07m".

Results and conclusions. It has been shown that a 30-minute exposure to normobaric hypoxia (10% O2) has a selective effect on individual components of mental performance, in particular on the sensorimotor and motor components associated with a decrease in the time spent on various reactions. According to the parameter of the tapping test, the performance of athletes decreases while maintaining the maximum rate of hand movements. The effectiveness of the normobaric hypoxia method characterizes it as an effective ergogenic remedy.

Keywords: *normobaric hypoxia, mental performance, athletes of cyclic sports, reaction time.*

Introduction. The study of the mechanisms of adaptation and compensation of the human body to changes in the gas composition of the environment is an urgent problem [1, 2]. The use of normobaric hypoxia to improve the physical performance of athletes is well studied and widely used in sports practice [3, 4]. Meanwhile, not so many scientific studies have been devoted to mental performance under the influence of hypoxic factors. It has been proven that the sensitivity of various tissues to a lack of oxygen is not the same, and the nervous system suffers primarily during hypoxia [1, 2, 5-7]. The initial emotional and motor excitation that occurs during prolonged and deep hypoxia is quickly replaced by generalized inhibition, adynamia; there are gross violations of higher nervous activity up to loss of consciousness [1, 2]. The effect of hypoxia on the cells of the cerebral cortex, skeletal muscles, and many other organs is associated with a decreased oxygen partial pressure in the tissues [1]. This state limits the intensity of substrate oxidation and oxidative phosphorylation in mitochondria, which ultimately leads to underproduction of ATP molecules by each mitochondria. The resulting primary acute hypoxia in the cells, causing many functional disorders of the body [1, 3, 7, 8]. Accounting for these negative facts when planning the process of sports training was practically not carried out.

Objective of the study was to study the effect of normobaric hypoxia on the parameters of mental performance of highly qualified athletes of cyclic sports.

Methods and structure of the study. Research observation was carried out on the basis of the laboratory of physiology of muscular activity and recovery of the Research Institute of Sports and Sports Medicine RUS “GTSOLIFK”. The pilot study involved 80 highly qualified swimmers and track and field athletes (EG)

Table 1. *Indicators of the critical frequency of flicker fusion and the critical frequency of flicker discrimination in athletes from the control and experimental groups before and after exposure to normobaric hypoxia*

Indicator	CG (n=10)		EG (n=80)	
	Before NH Me (Q1;Q3)	After NH Me (Q1;Q3)	Before NH Me (Q1;Q3)	After NH Me (Q1;Q3)
CFFF, right eye, Hz	27,0 (23,2;32,5)	26,5 (23,2;32,2)	32,5 (29,0;36,9) ♦	32,0 (28,0;36,0) ♦
CFDF, right eye, Hz	26,0 (19,7;31,2)	25,5 (19,0;31,7)	34,0 (31,1;37,0) ♦	34,0 (31,0;37,0) ♦
CFFF, left eye, Hz	32,0 (26,2;35,0)	31,5 (26,0;35,0)	34,0 (30,0;37,0)	33,8 (31,0;36,0)
CFDF, left eye, Hz	30,5 (25,2;34,0)	30,2 (24,2;33,2) *	36,0 (33,0;38,0) ♦	35,0 (31,0;38,0) ♦*

*Note: * – differences between related samples p<0.05; ♦ – differences between unrelated samples p<0.05; CFFF is the critical flicker fusion frequency; CFDF - critical flicker discrimination frequency*

and a control group (CG) (n=10). The average age of the athletes ranged from 19 to 25 years. At the time of the experiment, the athletes were healthy and gave informed consent to participate in the scientific observation. Psychophysiological tests were applied using the hardware-software complex "Sports psychophysiologist" [4]; method of hypoxic samples using the hypoxicator "Everest-1, mod. 07 m. At the first stage, a preliminary study of psychophysiological indicators of thinking and motor reactions took place. At the second stage, under laboratory conditions, normobaric hypoxia was used for 30 min, where a gas mixture with a content of 10% oxygen was used. At the third stage, a repeated psychophysiological study was performed using a hypoxic stimulus to identify changes in motor reactions and in the function of thinking.

The results obtained were processed using Microsoft Excel 2019.

Results of the study and their discussion. Table 1 presents the results on the critical frequency of flicker fusion and the critical frequency of flicker discrimination (right and left eyes) of athletes from the control and experimental groups.

It was shown that when performing repeated testing, the indicators of the critical frequency of flicker fusion and the critical frequency of flicker discrimination in athletes of the control and experimental groups under the influence of normobaric hypoxia tend to decrease, which may be associated with an increase in fatigue. Table 2 shows the difference between individual parameters in the task of determining the critical flicker fusion frequency and the critical flicker discrimination frequency

The results obtained show that there are no significant differences in the difference between CFFF and CFDF. Based on the assessment of changes in the control and experimental groups, it can be assumed that the 30-minute effect of normobaric hypoxia (10% O_2) on mental performance indicators is selective. In particular, the sensorimotor psychophysiological component has a positive shift and is associated with a decrease in the time spent on various reactions. Meanwhile, when performing the tapping test, the athletes of the experimental group showed a decrease in working capacity while maintaining the maximum rate of hand movements.

Table 2. *The difference between the initial and final parameters of the individual results of the critical frequencies of flicker discrimination and the critical frequencies of flicker fusion in athletes from the control and experimental groups*

Indicator	КГ (n=10) Me (Q1;Q3)	ЭГ (n=80) Me (Q1;Q3)	p level
CFFF right eye, Hz	0 (0;0,25)	0 (-1,37;3)	0,88
CFDF left eye, Hz	0 (0;1)	0 (-1,5;2)	0,84
CFFF left eye, Hz	0 (0;1)	0,15 (-2;2,65)	0,97
CFDF left eye, Hz	0,75 (0;1)	1 (-1;3)	0,71

Note: CFFF is the critical flicker fusion frequency;

CFDF - critical flicker discrimination frequency

Table 3 presents individual changes in the effectiveness of the assessment and recognition of the stimuli presented by athletes in the control and experimental groups.

It was revealed that there are statistically significant differences between the athletes from the EG and the CG according to the parameters of the initial and final testing. Meanwhile, there are no significant differences between athletes in the control and experimen-

Table 3. *The difference between the initial and final parameters of individual results for the assessment and recognition of the presented stimuli in athletes of the control and experimental groups*

Error magnitude indicator (% modulo)	CG (n=10) Me (Q1;Q3)	EG (n=80) Me (Q1;Q3)	p level
Recognizing the angular velocity of an object	0(0;1)	1(0;4)	0,19
Estimating segments	0,5(0;2)	1(-5,2;5,37)	0,99
Measuring segments	0(0;1)	1,5(-4;6)	0,21
Estimating angles	0,5(0;1)	1(-2;7,6)	0,22
Recognition of angles	0,5(0;1)	0(0;1)	1,00

tal groups in terms of the difference in effectiveness for assessing and recognizing the presented stimuli, which, apparently, is associated with the preservation of mental performance in this group of tasks after exposure to normobaric hypoxia. An assessment of the dynamics of the values of sensorimotor reactions performed by the right, left hand and foot in the same athletes under the influence of normobaric hypoxia revealed a statistically significant decrease in the time spent on various types of reactions, with the exception of the reaction time to sound with the left hand, which may be associated with a stimulating effect. hypoxia on the sympathetic-adrenal system.

Thus, our results, which indicate a decrease in the time spent on various reactions under the influence of normobaric hypoxia, are consistent with the data of other scientific works, which show a similar effect with a decrease in oxygenation [1, 5]. Changes detected in individual profiles when performing tests to maintain the maximum rate of movements of the arms and legs indicate a decrease in human motor functions under the influence of normobaric hypoxia.

Conclusions. The nonspecific stress effect of normobaric hypoxia manifests itself in the form of a decrease in the time spent on sensorimotor reactions. Normobaric hypoxia can be used in sports practice with the aim of directing influence on sensorimotor functions to increase the mental performance of athletes.

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