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VARIOUS CHANGES IN BODY ORGANS DURING THE ANNUAL TRAINING CYCLE OF WATER SPORTS ENTHUSIASTS

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Abstract: Preparation for sports is a complex process that includes training athletes before competitions and participation in them, organization, scientific, methodological and logistical support for training and competition processes, creating the necessary conditions for combining sports and work, study and rest. One of the most effective means, widely used in sports to increase the training effectiveness of exercises and improve the level of athletes' performance, is the method of interval hypoxic training.

The aim of our study was to investigate the body composition and heart rate variability, biochemical and hematological parameters during the annual training cycle in young rowers before and after interval hypoxic training in mid-altitude conditions. The study involved six males aged 21-22 years, actively involved in sports and holding the title of master of sports in academic rowing. Before departure, on the seventh day after arrival, the athletes underwent a body composition study with an analysis of venous blood in the morning on an empty stomach. The parameters of body composition at rest and basal metabolism were estimated by the bioelectrical impedance method using an analyzer. 22 hematological parameters - using an automatic hematology analyzer. The results of the study showed that the average hemoglobin content in erythrocytes of the studied rowers increased significantly after hypoxic training in mid-altitude conditions. In addition, hypoxic training aimed at developing endurance led to a decrease in basal metabolism and total muscle mass in the studied rowers.

Key words:training in hypoxic conditions, rowing, hemoglobin content in erythrocytes, hemoglobin, erythrocyte, body composition, basal metabolic rate.

INTRODUCTION.

The problem of human body adaptation to intensive physical activity occupies an important place in the physiology of muscular activity and sports medicine [1,2]. Adaptation of the body to constantly increasing physical activity helps to reveal the training potential [3]. One of the most effective ergogenic means widely used in sports practice to increase the training effectiveness of exercises and improve the level of athletes' performance is the method of interval hypoxic training [4,5]. In the last two decades, hypoxic training (HT) has become very popular, i.e. a method in which athletes live near the mountains and train in hypoxic conditions [6]. It has been established that artificially induced hypoxia in combination with various types of repetitive exercises significantly changes the effectiveness of training and accelerates the rate of adaptation

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to the physical activity used [4,7]. Hypoxia is not only a damaging, but also a training factor that affects the body in a constant mode, forming long-term adaptations to oxygen starvation [8,9].

Tissue hypoxia and the resulting biochemical and structural changes can limit performance, cause fatigue and rapid deterioration of the body. However, if the effects of hypoxia are repeated over a short period of time and hypoxic effects alternate with normoxic conditions, the reversible effects of tissue hypoxia can have a constructive and creative effect [10]. After 3-4 days of hypoxic training, athletes enter a phase of reduced functional capabilities, which lasts up to 6-8 days [11]. The aim of the study was to investigate hematological parameters of blood and heart rate variability, biochemical and hematological parameters during the annual training cycle in rowers before and after interval hypoxic training.

Research methods. For our study, we selected 6 male subjects aged 21-22 years who are actively involved in sports and have the sports qualification of master of sports in academic rowing. They trained in mid-mountain conditions from 28.03.23 to 20.04.23. The average height of the tested athletes before and after hypoxic training was 189.00 (5.90), body weight - 85.63 (5.83) kg and 83.20 (2.72) kg, respectively. Before leaving on the seventh day after arrival, the athletes donated venous blood for analysis in the morning on an empty stomach and underwent a body composition test.

Body composition parameters and basal metabolic rate at rest were assessed by the bioelectrical impedance method using an analyzer. 22 hematological parameters were assessed using an automatic hematological analyzer. Statistical analysis was performed using Student's t-test for related samples, Wilcoxon's test for related samples, Pearson's test and Spearman's test in accordance with the results of the Kolmogorov-Smirnov test. Data processing was carried out in the statistical data processing program "SPSS 20".

RESULTS OF THE STUDY AND THEIR DISCUSSION

Comparative characteristics of the main body composition indices in rowers are presented in table 1.From the results presented in Table 1, it can be noted that rowers do not have statistically significant differences in body composition indices before and after hypoxic training. In our study, we found that as a result of hypoxic training, with a decrease in total muscle mass in kg, the basal metabolic rate, expressed in kcal, decreases, r = 0.9 (p = 0.006). This may be due to the fact that these rowers' hypoxic training was aimed at developing endurance, so there was a tendency for their total muscle mass to decrease.

Table 1 – Body composition parameters of rowers before and after hypoxic training

Indicators	Before hypoxic training	After hypoxic training	p
Weight, kg	85,63 (5,83)	83,20 (2,72)	p=0,592
Muscle mass, kg	72,78 (4,21)	70,70 (3,10)	p=0,151
Fat mass, kg	9,08 (3,02)	8,80 (2,46)	p=0,101
Lean body mass, kg	76,55 (4,39)	74,40 (3,24)	p=0,156
Bone mass, kg	3,77 (0,18)	3,70 (0,14)	p=0,391
Protein, kg	18,02 (1,49)	17,68 (1,59)	p=0,391

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Body mass index (BMI)	23,93 (1,67)	23,70 (1,17)	p=0,188
Total body water (TBW), kg	54,77 (3,12)	53,03 (1,51)	p=0,125
Trunk muscle mass, kg	39,18 (2,33)	38,20 (2,10)	p=0,182
Trunk fat, kg	4,87 (2,33)	4,70 (1,91)	p=0,095
Basal metabolism, kcal	2263,17 (137,49)	2191,75 (96,12)	p=0,130
Metabolic age, years	12,00 (0,0)	12,50 (1,00)	p=0,391

The results presented in Table 2 show that the average value of hematological parameters in men before and after hypoxic training is within the medical norms, except for the increased percentage of basophils in the leukocyte formula. Comparative characteristics of the main hematological parameters in rowers are presented in Table 2.

Table 2 – Hematological parameters of rowers before and after hypoxic training

Indicators	Before hypoxic training	After hypoxic training	P
Leukocytes, * 109 /l	4,60 (1,00)	4,97 (0,89)	p=0,207
Neutrophils, * 109 /l	2,52 (0,66)	2,83 (0,76)	p=0,207
Neutrophils, %	54,37 (5,43)	55,40 (9,49)	p=0,917
Lymphocytes, * 109 /l	1,40 (0,35)	1,52 (0,40)	p=0,285
Lymphocytes, %	30,93 (7,27)	31,72 (9,38)	p=0,600
Monocytes, * 109 /l	0,52 (0,21)	0,45 (0,12)	p=0,120
Monocytes, %	10,85 (2,60)	9,10 (0,85)	p=0,074
Eosinophils, * 109 /l	0,10 (0,06)	0,13 (0,10)	p=0,317
Eosinophils, %	2,35 (1,34)	2,72 (1,43)	p=0,115
Basophils, * 109 /l	0,07 (0,05)	0,03 (0,05)	p=0,157
Basophils, %	1,50 (0,53)	1,07 (0,34)	p=0,343
Erythrocytes, *1012/l	4,60 (0,23)	4,60 (0,16)	p=0,917
Hemoglobin, g/l	139,67 (4,84)	141,67 (4,46)	p=0,344
Hematocrit, %	40,32 (1,22)	40,32 (1,20)	p=0,917
Mean corpuscular volume, fl	87,70 (2,29)	87,65 (2,17)	p=0,833
Mean corpuscular hemoglobin content, pg	30,38 (0,89)	30,80 (0,90)	p=0,042
Mean corpuscular hemoglobin concentration, g/l	346,50 (4,42)	351,50 (4,46)	p=0,078
Degree of anisocytosis, %	12,55 (0,23)	12,25 (0,33)	p=0,066
Platelets, * 109 /l	211,33 (58,11)	227,50 (52,14)	p=0,116

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Statistical data processing revealed that the average hemoglobin content in the erythrocyte of the rowers under study significantly increased after hypoxic training (p=0.042). A tendency toward an increase in the average concentration of hemoglobin in erythrocytes (MCHC) in athletes (p=0.078) and a decrease in the degree of anisocytosis in athletes was noted, i.e. there is a tendency toward a decrease in the heterogeneity of the erythrocyte population, all this may indicate an improvement in the processes of hemoglobin formation in erythrocytes after hypoxic training. Some authors have established that a complex of adaptive changes in the functional systems of the body develops in a practically healthy person under the influence of interval hypoxic effects: an increase in oxygen consumption and efficiency, a decrease in the reactivity of the sympathoadrenal system, stimulation of the central nervous system, cardiorespiratory and hormonal systems, erythropoiesis and antioxidant enzymes, and increased capillarization of tissues of vital organs [8,12].

The functional state of the cardiovascular and respiratory systems of the body largely determines human adaptation to changing environmental conditions. The authors of the review article note that the use of mid-altitude conditions, as well as artificial hypoxia, causes hematological adaptation of the athletes' body, increasing the concentration of the following indicators: erythropoietin, hemoglobin, erythrocytes. Also, the use of the training strategy LH + TH (live high + train high) affects the athlete's performance: the first 2-4 days - an increase, then a slight decline, 2-3 weeks after returning, good athletic form is noted. However, the authors recommend studying the dynamics, based on the position of individualization: it is necessary to take into account the number of days spent in hypoxic conditions, the structure of the training process, the genetic characteristics of athletes [13]. Therefore, further research is needed for a deep understanding of the physiological and biochemical mechanisms of adaptation of athletes to hypoxia.

Conclusions:

1. The average hemoglobin content in the erythrocyte of the rowers studied after hypoxic training in mid-mountain conditions increased significantly.

2. As a result of hypoxic training aimed at developing endurance, the rowers studied showed a decrease in their basal metabolic rate in kcal with a decrease in their total muscle mass in kilograms.

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