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Short Communication

Increasing the Physiological Reserves of the Body by Physiological Hypercapnia

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One of the main strategies of modern sports medicine is the use of innovative corrective technologies aimed at preserving, restoring and improving the functional capabilities of the body of athletes. In modern conditions, this problem is most often solved by the use of potent pharmacological preparations, which often have pronounced and numerous side effects on the body, which is highly undesirable, where even a temporary decrease in the reliability of activity is unacceptable. In this regard, the search for new non-drug means and methods - physiological measures that have a minimum side effects and aimed at expanding the functionality of the athlete's body, seems to be relevant and timely.

In this regard, the use of breathing exercises and simulators is firmly entrenched in preventive and restorative medicine. Among them, exercises aimed at creating physiological hypercapnia are very effective.

In this regard, the purpose of our research was to study the effect of physiological hypercapnia on the functional state of the body of martial arts athletes.

The studies were carried out on the basis of JSC "Astana Medical University", in the scientific laboratory of the Department of Preventive Medicine and Nutrition. In the conducted experimental studies, 54 active athletes of martial arts aged 18-23 years old took part (masters of sports - 3, candidates for masters of sports - 5, 1-2 sportsmen - 46). The experimental training period lasted for 1 year. Of the total number of examined athletes, control and experimental groups of 27 people (20 boys and 7 girls) were formed, homogeneous in age, functional indicators and social conditions. The formation of the experimental group took place exclusively on a voluntary basis. Both groups trained according to a single training program, in parallel with the main classes, as an additional training tool, the main group performed physical activity using a device to create physiological hypercapnia, and the control group performed the same physical activity, only without using a device to create physiological hypercapnia.

In the experimental study, the measurement of anthropometric parameters, the study of the functional state of the respiratory system (lung capacity, Stange and Genche tests) and the blood circulation of athletes (blood pressure, heart rate, Martinet test) was carried out in the morning from 10 to 12 hours at rest before the course of hypercapnic training. Under laboratory conditions, bicycle ergometric testing of general performance was carried out. Each athlete completed the PWC_{170} test.

Moderate hypercapnia was created using a device for creating physiological hypercapnia (according to the method of L.Z. Tel, S.P. Lysenkov), which consists of an impermeable elastic periodontal membrane inserted into the oral cavity in front of the teeth, commensurate with the periodontal space, and providing only n o from o to o e breath. The device is made of a bioenergetic elastic material and is equipped on the inside with retainers, made with the possibility of going behind the front teeth. In this position, inhalation and exhalation through the mouth is impossible, but only through the nose. This is the main condition for creating hypercapnia. The increase in physiologically dead space due to the nasal passages and the nose during exercise creates conditions for the creation of physiological moderate hypercapnia.

It has now been proven that moderately elevated concentrations of carbon dioxide in the inhaled air and blood can cause a number of positive effects in the human body: improving blood supply to the heart muscle, normalizing stools, stopping asthma attacks, lowering glucose levels in patients with diabetes mellitus, hypertension, increasing adaptive human ability to adverse effects, increase endurance to hypoxia and physical stress, improve the quality of life.

Before, immediately after the end and 10 minutes after the completion of hypercapnic training, blood was taken from the cubital vein to determine the CO_2 content.

All digital data of the study results were processed by the parametric method according to Student's t test and correlation analysis methods using computer processing using the Statistica and Microsoft Excel software packages on a Pentium III class PC.

Changes in carbon dioxide tension in venous blood in athletes of the control and experimental groups under the influence of physical activity are presented in table 1.

Examined group (n = 27)	**CO_2 voltage indicators, mm Hg**		
	Before loading	**Immediately after loading**	**10 minutes after exercise**
Physical activity without a device	43.0 ± 2.2	42.5 ± 2.8	37.5 ± 3.0
Physical activity + device	42.4 ± 2.1	56.4 ± 4.0	41.0 ± 2.5
	P > 0.05	P < 0.01	P < 0.05

Table 1: Comparative analysis of carbon dioxide tension in subjects using a device to create physiological hypercapnia and without it.

As can be seen from the table, the use of the proposed device significantly increases the CO_2 tension in the blood, followed by normalization of this indicator by 10 minutes, while in the group where the device was not used, there was a significant decrease in CO_2 tension.

Against the background of hypercapnic training, the indicators of weight-height and strength indices did not have significant differences in the control and experimental groups at the beginning and end of the study (Table 2).

Functional indicators	**Average values of functional indicators**			
	Experienced group		**Control group**	
	At the beginning research	**At the end of the study**	**At the beginning of the study**	**At the end of the study**
Weight-height index	23.49 ± 0.18	23.28 ± 0.16	22.57 ± 0.11	23.1 ± 0.14
Vital index	36.63 ± 0.41	44.7 ± 0.32	37.83 ± 0.27	38.4 ± 0.28
	****			
Power index	48.7 ± 0.69	50.2 ± 0.65	53.5 ± 0.57	52.9 ± 0.57
Coronary index blood circulation	86.2 ± 0.87	79.8 ± 0.76	90.71 ± 0.8	91.8 ± 0.84
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Functional test	108.1 ± 4.1	78.6 ± 3.8	102.5 ± 4.2	104.1 ± 4.7
	****			
Level health	6.4 ± 0.13	7.6 ± 0.12	6.8 ± 0.14	6.6 ± 0.13
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Table 2: The results of the examination of athletes according to the method of Apanasenko.

Note: *- $p < 0.05$; **- $p < 0.01$; ***- $p < 0.005$; ****- $p < 0.001$.

In the dynamics of 1 year, there was a significant increase in the average value of VC, vital index, the duration of the Stange and Genche trials in the experimental group. In the control group, there were no significant differences with the initial data ($p > 0.05$) (Table 3).

Research phase	VC, ml		Bar test, sec		Genche test, sec	
	Experienced group	Control Group	Experienced group	Control Group	Experienced group	Control Group
Start of research	2525 ± 18.27	2550 ± 16.51	53.4 ± 0.64	52.3 ± 0.63	42.7 ± 0.5	41.3 ± 0.53
End of study	2774.2 ± 19.2	2570 ± 18.3	58.73 ± 0.7	53.73 ± 0.64	44.4 ± 0.46	42.7 ± 0.51
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Table 3: Dynamics of indicators of the respiratory system in the control and experimental groups.

Note: *- p < 0.05; **- p < 0.01; ***- p < 0.005; **** - p < 0.001

Analysis of the initial indicators of systolic and diastolic blood pressure did not reveal significant differences in the control and experimental groups ($P > 0.5$). In the dynamics in the experimental group, blood pressure did not change significantly ($p < 0.5$), in the control group, an increase in diastolic pressure up to 72.7 ± 0,46 мм.rt.st was observed. ($p > 0.05$) and systolic blood pressure up to 116.2 ± 0,5 мм.rt.st. ($p < 0.01$) (Table 4).

Research phase	Heart rate, beats in min.		BP system, mm Hg		BP diast, mm Hg	
	Experienced group	Control Group	Experienced group	Control Group	Experienced group	Control Group
Start of research	75.81 ± 0.55	78.88 ± 0.45	113.44 ± 0.54	114.69 ± 0.49	71.56 ± 0.52	70.94 ± 0.46
End of study	65.2 ± 0.2	79.2 ± 0.5	110 ± 0.46	116.2 ± 0.5	71.1 ± 0.6	72.7 ± 0.46
	****		****	*		*

Table 4: Dynamics of indicators of the cardiovascular system in the control and experimental groups.

Note: *- p < 0.05; **- p < 0.01; ***- p < 0.005; **** - p < 0.001

An increase in the efficiency of the cardiovascular system can be judged to a certain extent by a decrease in the heart rate. In the dynamics of studies, the heart rate in the experimental group significantly decreases to 65.2 ± 0.2 ($p < 0.001$), which indicates an improvement in the functioning of the cardiovascular system under the influence of hypercapnic training. Changes in this indicator in the control group are insignificant ($p > 0.5$).

In the control group, there was a tendency for the “double product” index to worsen, the value of which was 91.8 ± 0.84 ($p < 0.01$), in the experimental group there was an improvement in the coronary circulation index in 72 ± 1.59% of cases. The functional state of the cardiovascular system can also be judged by the rate of decrease in recovery time after exercise. In dynamics, the recovery time after performing a functional test in the control group did not change significantly. In the experimental group, there was a significant decrease in recovery time ($p < 0.001$). A faster recovery of heart rate and its lower digital value indicate a better adaptation of the body to physical activity.

The analysis of the integral indicator “level of health” revealed that in the dynamics in the control group its values did not change significantly, while in the experimental group there was an improvement in the indicator “health level” in 72.8 ± 9.95% of the examined ($p < 0.001$).

Thus, the inclusion of hypercapnic training in the process of training athletes allows you to increase the fitness of athletes due to the development of moderate acidosis in the athlete’s body and the associated increase in CO_2 concentration, which leads to an improvement in the functional parameters of the cardiorespiratory system and leads to an increase in the body’s reserve capacity and health level [1-8].

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