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INDICATORS OF CENTRAL HEMODYNAMICS OF QUALIFIED ROWERS

A.V. Il'yutik, D.K. Zubovskij, A.Yu. Astashova
Belarusian State University of Physical Culture, Minsk, Belarus

Annotation. The purpose of this work was to study the functional state of the cardiovascular system of qualified athletes aged 18-20 years, specializing in rowing and canoeing, depending on the types of hemodynamics. The study involved 192 male athletes engaged in rowing and having sports qualifications (candidate for master of sports, master of sports). 73.4% of the examined athletes had a hyperkinetic type of hemodynamics, which is characterized by high indicators of cardiac output, cardiac index and low values of total peripheral vascular resistance. Rowers with hypo- and normokinetic types are characterized by more economical functioning of the cardiovascular system at rest and adequate changes in central hemodynamic parameters during exercise compared to rowers with hyperkinetic type of blood circulation.
Keywords: central hemodynamics, cardiovascular system, types of blood circulation, rowers, qualified athletes.

Introduction. An increase in the level of physical fitness of qualified rowers that ensures the development of needed motor qualities and improvement of technical and tactical training is connected with the process of adaptation of the body's physiological systems. The studies on the compensatory mechanisms of an athlete's body adaptation to strenuous physical activity are of high relevance and have a high practical value for managing and correcting the learning and training process. One of the main directions of the functional diagnosis of athletes is monitoring of the central hemodynamics (CH) indicators. It allows assessing the efficiency of the course of adaptation to the training and competitive activity, since the parameters of blood circulation are highly sensitive indicators of the functional state of the cardiovascular system and the body in whole [1-6]. Depending on the ratio of cardiac index (CI), cardiac output (CO) and total peripheral vascular resistance (TPVR), there are several types of CH: normokinetic, hypokinetic, hyperkinetic and eukinetic (between hypo- and normokinetic). High activity of the sympathoadrenal system is typical for people with the hyperkinetic type. Moreover, adaptation to physical activity is supported by inotropic and chronotropic heart functions with little involvement of the Frank-Starling mechanism [1-4]. It is known that stress on the function of the cardiovascular system can be a substantial factor that limits the sports result. At the same time, the hypokinetic type is the most economical, since in this case, the cardiovascular system possesses a great functional range.

Study on the features of blood circulation of athletes is a relevant issue of sports physiology. The evaluation of the hemodynamic indicators as signs of regulatory and adaptive rearrangements of the body during exercise allows taking a differential approach to the organization of the training process in order to prolong athletic longevity and preserve health of athletes.

The purpose of this work was to study the functional state of the cardiovascular system of qualified athletes aged 18-20 years specialized in rowing and canoeing depending on the types of hemodynamics.

Methods and organization. The study involved qualified athletes specialized in rowing (men, n=192, sports qualification – candidate for master of sports and master of sports, age – 18-20 years). The study took place during the preparatory period of the annual macrocycle.

The central hemodynamics indicators were registered with the differential tetrapolar rheography (the "Impekard-M" computer rheograph). We have studied the following CH indicators: heart rate (HR, beats/min); systolic and diastolic blood pressure (sBP, dBP, mm of HG); stroke volume (SV, ml); cardiac output (CO, l/min×m^2); total peripheral vascular resistance (TPVR, dyn×s×m^{-5}). They were registered at rest and immediately after physical activity. We have applied the submaximal step-based test on the "Concept 2" stationary rower, the test continued up to a heart rate of 170 beats/min.

The mathematical data processing was made with variational statistics methods. The qualitative signs did not follow the law of normal distribution (according to the Shapiro-Wilk's test) and are presented in a form of median (Me) and interquartile range with a description of 25 and 75 percentiles' values: Me (25%; 75%). The significance of differences in the incidence was identified with the Fisher's exact test. The significance of differences between the indicators in the compared groups was identified with the Mann-Whitney U-test (when comparing two independent samples), Kruskal-Wallis H-test (when comparing three independent samples) and the Wilcoxon W-test (when examining differences between two samples of paired measurements). The critical value of the significance level was set to 0.05.

Results and discussion. Among the studied rowers, we have registered the following hemodynamics types. 73.4% of young men had the hyperdynamic type of blood circulation, which is more often than the normokinetic type – 22.4% ($p<0.01$ according to the Fisher's exact test, $\varphi_{emp}=10.5$) and significantly more often that the hypokinetic type – 4.2% ($p<0.01$ according to the Fisher's exact test, $\varphi_{emp}=16.1$).

The hyperkinetic type is characterized by increased values of CO and CI with reduced TPVR [1-4]. This type of hemodynamics indicates the least economical work mode of the heart, as well as reduced compensatory capabilities against the background of high activity of the sympathoadrenal system. However, the change of the blood flow regulation towards the prevalence of the hyperkinetic types may indicate the adaptation to strenuous physical activity of speed-strength nature.

The table below demonstrated the average group values of the cardiovascular system indicators in the highly qualified athletes specialized in rowing and canoeing depending on types of hemodynamics.

Table

Central hemodynamics indicators of the examined rowers
(young men, 18-20 years, candidates for master of sports, masters of sports), Me (25%;75%)

Indicators before/after activity		Groups of examined rowers (young men)		
		Group 1, hypokinetic type (n=8)	Group 2, normokinetic type (n=43)	Group 3, hyyperkinetic type (n=141)
sBP, mm of Hg	before	120 (110; 130)	120 (115; 125)	120 (110; 125)
	after	190 (180; 210)	190 (180; 220)	190 (180; 210)
dBP, mm of Hg	before	70 (60; 70)	65 (60; 70)	70 (60; 70)
	after	20 (0; 45)	50 (0; 60)	40 (0; 50)
HR	before	56 (54; 58)***3**	57 (52; 64)	63 (59; 69)***1**
	after	171 (171; 174)	173 (171; 176)	173 (171; 176)
Bradycardia rate,%	before	100*2, 3	62.8*1, 3	36.2*1, 2
SV, ml	before	**89.0 (82.1; 102.1)*2, 3**	**112.5 (106.5; 123.9)*1, 3**	**150.5 (128.7; 164.7)*1, 2**
	after	**86.8 (71.8; 96.0)*2, 3**	**120.6 (96,7; 133.2)*1**	**144.5 (113.9; 179.2)*1**

Table (continued)

CO, l/min	before	**4.9 (4.8; 5.2)*[2, 3]**	**7.1 (6.7; 7.6)*[1, 3]**	**10.4 (9.3; 11.9)*[1, 2]**
	after	**15.6 (12.1; 17.6)*[2, 3]**	**22.0 (18.3; 26.3)*[1]**	**24.6 (19.0; 28.7)*[1]**
CI, l/min×m^2	before	**2.4 (2.4; 2.5) *[2, 3]**	**3.6 (3.3; 3.7)*[1, 3]**	**5.1 (4.6; 5.8)*[1, 2]**
	after	**7.2 (6.0; 8.1)*[2, 3]**	**10.8 (8.6; 12.7)*[1]**	**12 (9.3; 14.9)*[1]**
TPVR, dyn×s×cm^{-5}	before	**1362.3 (1181.9; 1463.8) *[2, 3]**	**950.9 (885.3; 1012.7) *[1, 3]**	**653.0 (580.0; 731.2) *[1, 2]**
	after	**849.1 (624.0; 1115.5)*[3]**	**640.8 (582.4; 785.8)**	**494.8 (381.0; 617.2)*[1]**
THI, c.u.	before	**131.3 (127.3; 136.0)*[3]**	**142.3 (134.5; 151.5)**	**149.0 (138.7; 155.3)*[1]**

Note: THI – total hemodynamic indicator; according to the Kruskal-Wallis H-test, the significant differences between three groups are highlighted in bold ($p<0.05$); * – significant differences between two groups according to the Mann-Whitney U-test ($p<0.05$), where *[1] – significant differences of this group with the group 1, *[2] – significant differences of this group with the group 2, *[3] – significant differences of this group with the group 3

Mean values of sBP and dBP in rowers at rest before physical activity corresponded with the physiological norm and did not have any differences (table). Athletes with high rate had bradycardia as an indicator of economization in the function of the cardiovascular system at rest. For example, the average value of HR in athletes with the hypokinetic type amounted to 56 (54; 58) beats/min. Moreover, all rowers of this group had bradycardia. The average value of HR in young men with the normokinetic type amounted to 57 (52; 64) beats/min, bradycardia was registered in 62.8% of cases. The average value of HR in athletes with the hyperkinetic type amounted to 63 (59; 69) beats/min, which is significantly higher than those in rowers from the first group ($p<0.05$). Bradycardia in young men of the third group was registered in 36.2% cases, which is significantly rarer compared with the bradycardia rate of the first group rowers ($p<0.01$ according to the Fisher's exact test, $\varphi_{emp}=5.1$) and the second group rowers ($p<0.01$ according to the Fisher's exact test, $\varphi_{emp}=3.1$).

Low HR (less than 60 beats/min) with high SV values can be explained by a high tone of the cardiac wall which is a sign of the adaptive mobilization of the blood circulation system to physical loads of the speed-strength nature.

We have noted that 92.2% of athletes of the third group (hyperkinetic type) and 81.4% of the second group (normokinetic type) had the SV values that were higher than the physiological norm [3-4]. That explains high average group indicators of SV, CO and CI (table, the differences are significant when comparing three groups, $p<0.05$). The average group SV indicators in rowers with the hypokinetic type have amounted to 89.0 (82.1; 102.1) ml; in athletes with the normokinetic type – to 112.5 (106.5; 123.9) ml; in young men with the hyperkinetic type – to 150.5 (128.7; 164.7) ml (table, differences are significant when comparing three groups, $p<0.05$). Both average and individual high indicators of SV in athletes with normo- and hyperkinetic types of hemodynamics indicate a high performance of myocardium, adaptation to physical loads and a high level of physical qualities development.

The common factor of the increased SV in athletes is a reduced peripheral vascular resistance [3-4] that is total resistance of the arterial system to blood flow. The rowers with normo- and hyperkinetic types at rest before exercise had the TPVR indicators reduced below the physical norm (table, differences are significant when comparing three groups, $p<0.05$). The reduced TPVR is identified with post-activity effects in the peripheral vascular beds. A decrease in TPVR is important for ensuring the dismissed recovery processes: lactate metabolism and ketone bodies, glycogen refilling.

Substantial differences are found in the CI value in rowers depending on the hemodynamics type. Average group values of CI in athletes with the hypokinetic type amounted to 2,4 (2.4; 2.5) l/min×m^2, which is significantly lower compared to those in young men with normokinetic 3.6 (3.3; 3.7) l/min×m^2) and hyperkinetic types (5.1 (4.6; 5.8) l/min×m^2) (table, differences are differences are significant when comparing three groups, $p<0.05$).

After exercise, rowers from all groups had increased sBP, HR, CO, CI and decreased dBP and TPVR (table).

Attention should be paid to changes in SV after training activity. It was different between the groups. The SV indicators in rowers with the hypokinetic type slightly changes after physical activity compared to the state at rest: 89.0 (82.1; 102.1) ml before activity and 86.8 (71.8; 96.0) ml after activity (table). SV in athletes with the normokinetic type has significantly increased after physical loads. The increase has amounted to 7.2% compared to the state at rest: from 112.5 (106.5; 123.9) ml to 120.6 (96.7; 133.2) ml (table, $p<0.05$ according to the Wilcoxon W-test).

SV in rowers with the hyperkinetic type reduced (by 4.0%) from 150.5 (128.7; 164.7) ml at rest to 144.5 (113.9; 179.2) ml after testing (table), which is less favorable response to activity. Therefore, CO increase in athletes with the normokinetic type after physical loads occurs due to the both chronotropic and inotropic mechanisms of heart activity. Athletes with hypo- and hyperkinetic types have a predominantly active chronotropic mechanism.

Conclusion. Average sBP and dBp values in qualified athletes specialized in rowing and canoeing corresponded with the physiological norm regardless the initial type of hemodynamics. The examined rowers with high rate had bradycardia as an indicator of the blood circulation economization at rest: it was registered in 100% of athletes with the hypokinetic type, in 62.8% of athletes with the normokinetic type, and in 36.2% of athletes with the hyperkinetic type.

Support of the blood pressure level in case of the hyperkinetic type occurs due to the increased CI, SV, CO values and high power of the left ventricular contraction with low TPVR values, which reflects high performance of the myocardium and is a sign of the cardiovascular system's adaptation to speed-strength physical activity. In case of the hypokinetic type of blood circulation, CI and power of the left ventricular contraction are minimal, while TPVR is maximal. The normokinetic type is characterized by intermediate values of these indicators.

An increase in CO in qualified rowers with hypo- and hyperkinetic types after exercise occurs mainly due to the chronotropic mechanism of heart activity (increase in heart rate) against the background of a decrease in SV, which reflects stress in the mechanisms of the cardiovascular system function.

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INFORMATION ABOUT THE AUTHORS:
Anna Vyacheslavovna Il'yutik – Candidate of Biological Sciences, Associate Professor, Associate Professor of the Department of Physiology and Biochemistry, Belarusian State University of Physical Culture, Minsk, e-mail: anna-iluytik@yandex.ru.
Dmitrij Konstantinovich Zubovskij – Candidate of Medical Sciences, Head of the Laboratory of Functional Diagnostics and Restorative Technologies, Belarusian State University of Physical Culture, Minsk, e-mail: zubovskid@mail.ru.
Anastasia Yur'evna Astashova – Leading Specialist of the Laboratory of Functional Diagnostics and Restorative Technologies, Belarusian State University of Physical Culture, Minsk, e-mail: astashova@mail.ru.

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FEATURES OF THE RESPIRATORY SYSTEM FUNCTION IN YOUNG PEOPLE FROM DIFFERENT REGIONS OF RUSSIA

E.A. Klokotova[1], V.N. Pushkina[2,3]
[1]Northern (Arctic) Federal University named after M.V. Lomonosov, Arkhangelsk, Russia
[2]Moscow City University, Moscow, Russia
[3]Moscow State University of Sport and Tourism, Moscow, Russia

Annotation. The purpose of this study is to examine features of the respiratory system function in young people from different regions of Russia. The study involved 110 boys and 114 girls of working age who were divided in 4 groups: 1 group – boys from European North of Russia (n=50), 2 group – boys from the Central Russia (n=60), 3 group – girls from the European North (n=51), 4 group – girls from the Central Russia (n=63). The study on the external respiration function was made with spirography methods during winter in healthy people who live constantly in their region. The higher indicators of lung capacity and respiratory volume were found in boys and girls from the Central Russia compared to students from the North. The discovered differences between 1 and 2, 3 and 4 groups show that during winter, young people from the Central Russia, without taking into account gender differences, have the respiratory system that is on higher level of adaptive reserves. It is possible that lower results obtained from the test subjects who live in the European North are connected to the time of examination according to the external respiration indicators. During winter, negative temperature behavior is registered in the European North regions. The external respiration system of people from the North, as a response to low temperature effect, is described with activation of defense mechanisms, in our case – a significant decrease in the respiratory volume.
Keywords: external respiration, European North, Central Russia, spirography.

Introduction. The studies of many authors prove that health depends significantly on climate and geographical conditions of the environment [1-2]. Living in conditionally unfavorable climate conditions negatively influences physiological and morphological processes that occur in a human body, provoking stress of compensatory and adaptive mechanisms. Russia is considered as one of the coldest countries in the world. Many territories are unfavorable for constant residence, and they include the European North conditions [3].

The external respiration system, due to its location, primarily suffers from negative environmental factors, in the northern region in particular – from negative temperatures. It is shown that respiratory diseases take the first place in the northern regions of Russia [4-7]. Special attention must be paid to health of children and youth as an important component of our country's well-being and preservation of working-age population.

Therefore, the purpose of our study is and examination of features of the respiratory system function in young people from different regions of Russia.

Methods and organization. We have examined 110 boys and 114 girls of working age who were divided in following groups: 1 group – boys from European North of Russia (n=50), 2 group – boys from the Central Russia (n=60), 3 group – girls from the European North (n=51), 4 group – girls from the Central Russia (n=63). The study was carried out during December-February with healthy people: 1 group (age – 20.72±1.8 years) and 2 group (age – 18.54±1.3 years), 3 group (age – 20.54±1.7 years) and 4 group (age – 18.74±1.2 years), who constantly live in their region. All test subjects were healthy, included in the main medical group, did not have chronic diseases and were not under regular check-up of cardiologist or pulmonologist. In order to define the functional ability of the external

respiration system we used the Spiro-Spectrum spirometer (SSP TU64-1-2267-77) made by Neurosoft. At the beginning, we measured anthropometric indicators (body length and mass) according to generally accepted methods. According to these indicators, there were no statistically significant differences between boys and girls: 1 group: body length – 180.10±7.21 cm, body mass – 71.11±1.62 kg; 2 group: body length – 178.73±7.0 cm, body mass – 69.56±1.93 kg; 3 group: body length – 164.96±5.51 cm, body mass – 56.72±4.92 kg; 4 group: body length – 166.11±4.90 cm, body mass – 57.10±3.12 kg.

The results were processed with the STATISTICA 11.0 software package. The normality of distribution was checked according to the Shapiro-Wilk test ($n \leq 50$). We have found that the parameters do not obey the law of normal distribution. The statistically significant differences between the indicators were identified with the Mann-Whitney test with the Bonferroni correction. The significance level – $p<0.05$-0.001.

Results and discussion. One of the most simple and informative indicators is lung capacity (LC) which is directly dependent on body length and mass, gender, strength of respiratory muscles, bronchi patency and fitness. The conducted analysis of external respiration parameters has revealed that the LC indicator in young boys and girls from the Central Russia was significantly higher by 11% ($p<0.01$) (fig. 1) and 7% ($p<0.05$) (fig. 2) respectively compared to people from the North. It is known that the LC shows the functional state as well as aerobic capabilities of the external respiration system [8], the lower LC in northern youth may indicate a decrease in these parameters.

It is also known that the LV includes following volume characteristics: inspiratory reserve volume (IRV), expiratory reserve volume (ERV) and respiratory volume (RV). When comparing the IRV and ERV, we have found that there were no significant differences between young boys from the North and young boys from the Central Russia. The same dynamics are found in the girls' group. These parameters were within the age standard in all groups.

However, during the analysis of results, we have discovered that there are significant dynamics in the RV indicators. Thus, the RV values in residents of the Central Russia are substantially higher, regardless of gender characteristics. The RV values in young men from the Central Russia is higher by 26% compared to young boys from the European North. The girls have the same, though the less pronounced dynamics – the RV indicator was higher by 19% ($p<0.001$).

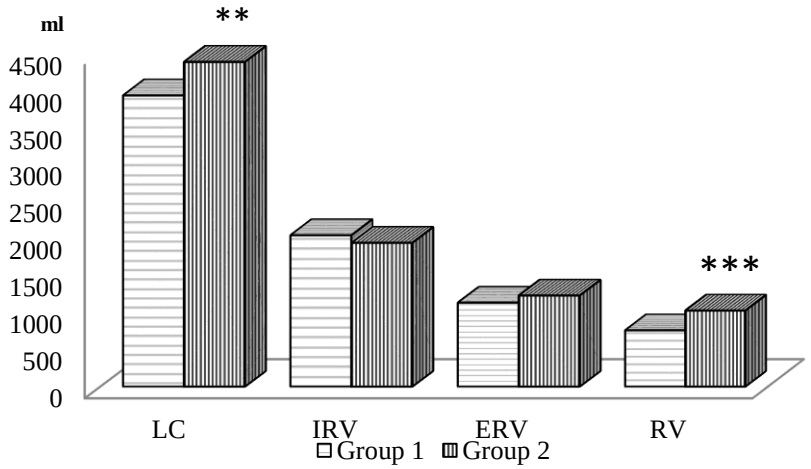

Fig. 1. External respiration indicators in young boys from different regions of Russia

Note: differences between the indicators of young boys from different regions: * – $p \leq 0.05$; ** – $p \leq 0.01$; *** – $p \leq 0.001$

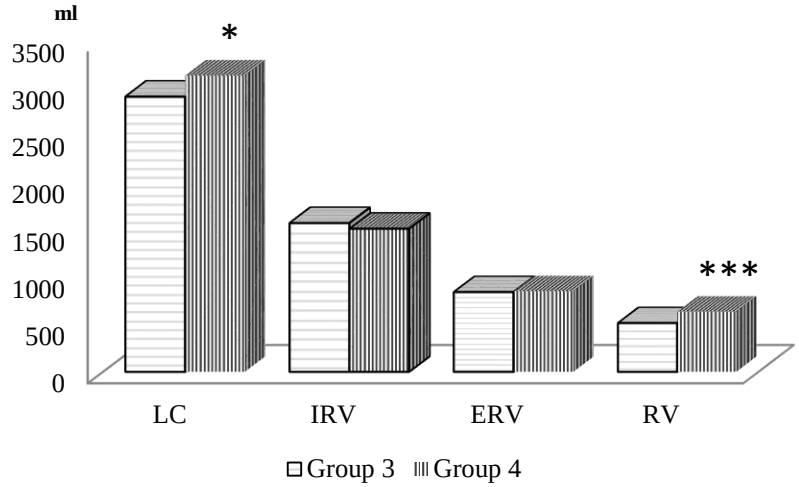

Fig. 2. External respiration indicators in young girls from different regions of Russia

Note: differences between the indicators of young girls from different regions: * – $p \leq 0.05$; ** – $p \leq 0.01$; *** – $p \leq 0.001$

The study of children of different age from the Khanty-Mansijsk Autonomous Okrug – Yugra demonstrated that all 9-11-year old children have the RV average values that are up to more than 2 times higher than the age norm, which may indicate an increased number of functioning alveoli [9]. Moreover, according to the data from other studies, among people who constantly live in low temperature conditions, a decreased RV indicator may be an adaptive mechanism due to the reflex decrease in the inhale depth to optimize function of the respiratory system. This process is related to limitations in the inhale depth and automatic increase of the respiration rate. It strengthens rarefication of breathe air in the respiratory departments which contributes to temperature stabilization in alveoli. Stimulation if decrease in the RV among northern population may occur due to the growth of bronchial resistance/inhibiting action of the respiratory muscles [10].

Conclusion. Therefore, the conducted comparative analysis in the external respiration indicators among the European North and Central Russia residents indicates a higher level of adaptive reserves of the respiration system in young people from the Central Russia, regardless gender characteristics. The substantial increase of LV reserves occurs due to more significant RV indicators identified among students living in more southern regions. These differences are possibly related to the examination time (February), when the significant temperature decrease occurs in the European North regions, while higher temperatures are typical for the Central Russia. It is the cold factor that the external respiration of the northern population reflectively reacts to, automatically activating defense mechanisms that provide preservation of the internal homeostasis but also cause stress of the respiratory system [2, 8, 11].

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INFORMATION ABOUT THE AUTHORS:

Ekaterina Aleksandrovna Klokotova – Expert in Educational and Methodological Work, Northern (Arctic) Federal University named after M.V. Lomonosov, Arkhangelsk, e-mail: ekaterina-taurus @yandex.com.
Valentina Nikolaevna Pushkina – Doctor of Biological Sciences, Professor, Professor of the Department of Adaptology and Sports Training of the Institute of Natural Sciences and Sports Technologies, Moscow City University; Leading Researcher of the Department of Project and Scientific Activities, Moscow State University of Sport and Tourism, Moscow, e-mail: taiss43@yandex.ru.

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INFLUENCE OF A WHEY PRODUCT ON THE DAILY DYNAMICS OF HEART RATE VARIABILITY IN SKI RACERS

F.B. Litvin[1], T.M. Bruk[1], P.A. Terekhov[1], I.V. Bykova[2]
[1]Smolensk State University of Sports, Smolensk, Russia
[2]Bryansk State Technical University, Bryansk, Russia

Annotation. Systematic physical activity of large volume and intensity increases tension in the regulatory systems of the body. An accessible and diagnostically significant object for assessing the state of regulation mechanisms is the heart rate. In 16 athletes involved in ski racing, using the method of mathematical analysis of heart rate, we have identified the daily dynamics of temporal and spectral indicators of heart rate variability. A promising direction in reducing tension in regulatory systems is the use of animal-based bioproducts which include a bioadditive obtained from bovine whey. The article discusses modern ideas about the daily dynamics of heart rate variability before and after a course of dietary supplement intake. The state of regulatory systems was analyzed depending on the time of day.
Keywords: athletes, physical activity, circadian rhythm, heart rate variability, bioproduct.

Introduction. In modern sports, nearly extreme and extreme physical activity takes the body to the level of functionality beyond which the premorbid state begins. This is the reason why the scientists search for new ways of optimization in order to improve the adaptive potential. One of these ways is a search for the optimal time of day for the training process, taking into account the daily rhythm of activity of the body's functional systems. It is known that the indicator of rhythmic fluctuation stability of physiological processes in the body (chronoresistance) significantly characterizes its functional capabilities and efficiency of motor activity [1-2]. Special attention is paid to the study in limits in fluctuations of functional characteristics in case of changing time zones. In order to alleviate the case caused by disturbances in the circadian rhythm, the biocorrectors of the functional state are used in sports [3-5]. Among synthetic products, plant-based and animal-based physiologically active substances become more and more recognized [6-7].

The abovementioned has determined the choice of our study's direction. The main purpose of the study – to reveal objective patterns confirming the rhythm-based nature of the daily dynamics of the heart rate variability indicators, as well as the effect of the whey bioproduct intake course.

Methods and organization. The study involved 16 young male ski racers aged 17-25 years. We have registered the heart rate variability indicators with the R.M. Baevskij's cardiointervalography method and the "Varikard 2.51" device ("Ramena", Ryazan). The daily dynamics of these indicators were registered trice: in the morning – from 7 to 9 o'clock, in the afternoon – from 14 to 16 o'clock and in the evening – from 21 to 23 o'clock. Before using the bioproduct based on whey, the registration was carried out for 14 days. Then, for 21 days, the athletes' daily diet included the bioproduct in an amount of 0.5 g per 1 kf of body mass for the first 5 days, and from 6 to 21 days the dosage was increased to 1 g/kg of body mass. We have calculated following standard indicators: heart rate (HR, beats/min), range (MxDMn, ms), mode amplitude (AMo, %), stress index (SI, c.u.), total power (TP, ms^2), high-frequency (HF, ms), low-frequency (LF, ms), very-low-frequency (VLF, ms) spectral characteristics of the heart rate variability in accordance with methodological guidelines. The data obtained were processed with methods of variational statistics.

Results and discussion. The results obtained (table) confirm the daily frequency of the heart rate regulation activity. In the morning, the regulatory systems are minimally

stressed. In the afternoon, the stress increases to maximum values followed by a decrease in the evening. According to time (MxDMn, root mean square of successive differences – RMSSD) and spectral (HF, TP) characteristics, the maximal activity of the autonomic regulation mechanisms and the minimal activity of the central regulation mechanism (AMo, LF) occur in the morning.

Table

Daily dynamics of the heart rate variability indicators in ski racers before and after the course of the bioproduct intake (M±m)

Time of day	HR, beats/min	MxDMn, ms	SI, c. u.	TP, ms^2
before the bioproduct intake				
morning	51.0±2.1	325.1±38.01	96.5±8.2	2448± 555.2
afternoon	68.5±3.65	260.7±30.94	231.4±38.1	1903± 429.1
evening	55.1±3.19	223.5±24.61	199.5±26.3	1498± 392.1
after the bioproduct intake				
morning	46.5±2.20	406.9±51.85	51.9± 12.88*	4892± 771.5*
afternoon	61.3±2.83	259.2±27.33	87.7± 17.7**	4404± 600.5**
evening	50.1±2.64	245.4±24.18	101.2±22.3***	2613± 408.3

Note: * $p<0.05$ (morning); ** $p<0.05$ (afternoon); *** $p<0.05$ (evening)

The stable adaptive state is described with a high level of the activity in cortical and humoral regulation centers (VLF). By the afternoon, the functional stress increases. It is firstly confirmed by the strengthening of the management centralization of the heart rate. Thus, the AMo indicator increases significantly by 70% ($p<0.05$), LF – by 66% ($p<0.05$). The contribution in the autonomic curve regulation declines, as well as the RMSSD indicator by 36% ($p<0.05$), HF – by 42% VLF – by 26% ($p>0.05$). Value of the stress index (SI) also significantly decreases by 138% ($p<0.05$). In the evening, the reduced adaptive potential remains, as evidenced by the continued decrease in autonomous curve the indicators compared to the morning: MxDMn – by 117% ($p<0.05$), RMSSD – by 81% ($p<0.05$), HF – by 46% ($p>0.05$), VLF – by 95% ($p<0.05$), TP – by 63% ($p>0.05$) and the increase in LF by 20% ($p>0.05$), SI – by 107% ($p<0.05$). After the bioproduct intake course, daily fluctuations in the regulatory processes from the minimum stress remain in the morning, followed by the expansion of functional capabilities in the daytime and the "fade" of functional potential in the evening. Moreover, after the bioproduct intake, we have revealed a tendency for enhancing the autonomic curve's contribution to the heart rate regulation in the morning. Compared with the control values, the MxDMn, RMSSD and HF indicators increase by 25% ($p>0.05$), 44% ($p<0.05$) и 437% ($p<0.01$) respectively. Simultaneously, the vascular center of the body (LF) activates – by 86% ($p<0.05$), as well as the cortical and the cortical and humoral curve (VLF) – by 34% ($p>0.05$). The total activity according to TP increases by 99% ($p<0.05$). As a result of enhancing the adaptive potential, the stress index (SI) decreases by 86% ($p<0.05$). In the afternoon, after the bioproduct intake, the functional capabilities of the body, the basis of which includes the increase in the activity of the studied regulation level, significantly enhance. In particular, the following spectral powers increase: TP – by 131%, HF – by 144%, LF – by 150% ($p<0.05$), VLF – by 38% ($p>0.05$), the RMSSD indicator – by 37% ($p>0.05$), SI reduces by 163% ($p<0.05$). In the evening, there is a not so noticeable decrease of stress. The comparative analysis has discovered the statistically reliable increase of the LF value by 94% ($p<0.05$), RMSSD – by 70% ($p<0.05$) and the decrease in SI by 98% ($p<0.05$).

Conclusion. Therefore, daily fluctuations in the activity of the heart rate regulation mechanisms in ski racers have a genetic nature. Moreover, the environmental influencing factors are able to cause changes in the contribution of separate compartments in the

regulatory process of the body and systems' functioning. In particular, the bioproduct intake activated the adaptability of the regulatory systems in the morning, afternoon and evening. In the morning, we have registered the maximum parasympathetic activity. After the bioproduct intake, its contribution in the regulation increases abruptly. The adaptive abilities in ski racers are mainly defined by HF and LF and to a lesser extent – by VLF fluctuations, which is also noted in one of the studies [8]. In the afternoon, the functional potential enhances as a result of the combined increase in the role of central and autonomous mechanisms of the heart rate regulation. The evening segment of the day is characterized by multidirectional dynamics of regulatory processes.

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INFORMATION ABOUT THE AUTHORS:

Fedor Borisovich Litvin – Doctor of Biological Sciences, Professor, Smolensk State University of Sports, Smolensk, e-mail: bf-Litvin@yandex.ru.
Tat'yana Mikhajlovna Bruk – Doctor of Biological Sciences, Professor, Smolensk State University of Sports, Smolensk.
Pavel Aleksandrovich Terekhov – Candidate of Biological Sciences, Associate Professor, Smolensk State University of Sports, Smolensk.
Irina Vasil'evna Bykova – Candidate of Biological Sciences, Associate Professor, Bryansk State Technical University, Bryansk.

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DYNAMICS OF WATER CHANGES IN THE BODY DURING WEEKLY INTAKE OF CREATINE SUPPLEMENTS: A PILOT STUDY

A.V. Meshtel', A.B. Miroshnikov
Russian State University of Physical Culture, Sport, Youth and Tourism, Moscow, Russia

Annotation. The purpose of the research is to study the dynamics of fluid changes in the body during a weekly course of creatine intake. The study was conducted in the Russian State University of Physical Culture, Sport, Youth and Tourism and included male participants (n=8, age – 26±4.1 years). The fluid level was measured using a bioimpedance analyzer of body composition. The participants took 0.07 g of creatine per 1 kg of body mass daily, and came to the laboratory daily to measure body mass and composition. Statistical analysis was carried out using the Wilcoxon T-test and the Statistica 10 package (StatSoft, USA). The differences were considered significant at $p<0.05$. It was found that the fluid when taking creatine changes in waves – the peak is reached on the 2nd and 5th day of intake, a slight decline occurs on the 4th day, and by the 7th day the body's fluid level returns to normal.

Keywords: creatine, body hydration, intracellular water, total body water, creatine monohydrate supplements.

Introduction. One of the main problem of applying creatine supplements in sports is the oncotic effect of creatine. Despite the abundance of studies that praise creatine as a supplement for its accessibility, safety [1-4] and efficiency [5-10], the athletes have to avoid its intake during competitions due to its strong effect on the body hydration level. However, there is currently no data on what point the fluid level reaches its peak and at what level it declines. The dynamics of fluid changes are rarely shown in studies. For example, Kresta et al took data from the first day, after a week and after three weeks [11], which gives us some ideas on dynamics. However, there is no research that is fully dedicated to the examination of such phenomenon.

Therefore, the purpose of this pilot study is to examine the dynamics of changes in the body hydration level during a weekly course of creatine intake.

Methods and organization. The study took place in the Russian State University of Physical Culture, Sport, Youth and Tourism on August 2022.

Participants. The study involved healthy men aged 21 to 30 years (n=8, age – 26±4.1 years), body length – 181±4.6 cm. They were included in the study if they had not taken creatine or diuretics for the last month. At the beginning, the test subjects signed papers on voluntary participation in the experiment.

Equipment. The participants visited the university every day to measure body mass and composition. Evaluation of body composition was made with the MEDASS AVS-01 bioimpedance analyzer (Russia) and the FIAB 22x34 mm disposable film electrodes (Italy). To measure the body mass, we used the Vitek VT-8078 floor scales (China). Before the study, the participants were given directions that correspond with guidelines described in the MEDASS AVS-01 manual: the measurements were carried out two hours after food intake; during the week, the participants restrained from intense physical activity and alcohol. We measured body mass, Total Body Water (TBW) and Extracellular Water (ECW). Intercellular Water (ICW) was calculated according to the following formula: ICW = TBW - ECW (l).

Diet and creatine intake. During the study, the participants followed the isocaloric diet, all calculations were made by them with the FatSecret app (USA). After the initial measurements, we calculated creatine doses and gave

them in personal portion packers. Each morning, the participants took 0.07 g of creatine per 1 kg of body mass (R-Line Nutrition, Russia), which amounted to approximately 5.9±0.8 g of creatine per day, mixed with 300 ml of water.

Statistical analysis. The statistical characteristics of scale variables were presented as arithmetic means and standard deviations in form of numbers. The statistical significance of differences in the group between days was checked with the Wilcoxon's t-test. All calculations were made with the Statistica 10 software package (StatSoft, USA). The significance level was deemed as significant if $p<0.05$.

Results and discussion. The initial measurement results are presented in table 1. As a result of weekly study, we have received data presented in table 2.

The results are presented more clearly in the diagram of the dynamics of changes in body mass (fig. 1) and body fluids (fig. 2, 3, 4).

Table 1

Initial results

Body mass, kg	Lean body mass, kg	TBW, l	ECW, l	ICW, l
80.7±9.1	65±4.6	47.8±3.3	18.6±1.3	29.2±2

Note: TBW – Total Body Water, ECW – Extracellular Water, ICW – Intracellular Water

Table 2

Results of weekly creatine intake

Indicators	Days (mean value ± standard deviation)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Body mass, kg	80.7±9.1	81±9∗•	81.2±9.2	80.4±8.7•	80.6±9	80.1±8.7∗	80±8.6∗
TBW, l	47.8±4.2	48.6±4,6•	48.8±3.3∗	48.6±4.1∗	49.1±3.6∗	47.8±3.1•	47.8±3.7
ECW, l	18.6±1.6	18.9±2.1	18.5±1.6	18.8±1.6•	18.7±1.4	18.3±1.3∗•	18.5±1.5
ICW, l	29.2±2.6	29.8±2.7∗•	30.3±1.9∗	29.8±2.5∗	30.4±2.6∗	29.5±1.9∗	29.3±2.2

Note: ∗ – significant differences with initial measurements ($p<0.05$); • – significant differences with the previous day ($p<0.05$), TBW – Total Body Water; ECW – Extracellular Water; ICW – Intracellular Water

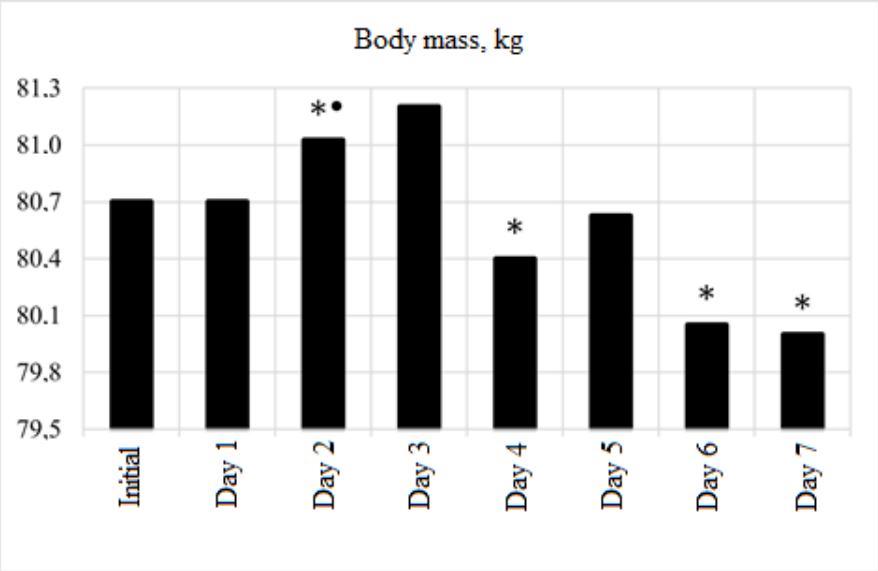

Fig. 1. Dynamics of changes in body mass

Note: ∗ – significant differences with initial measurements ($p<0.05$); • – significant differences with the previous day ($p<0,05$)

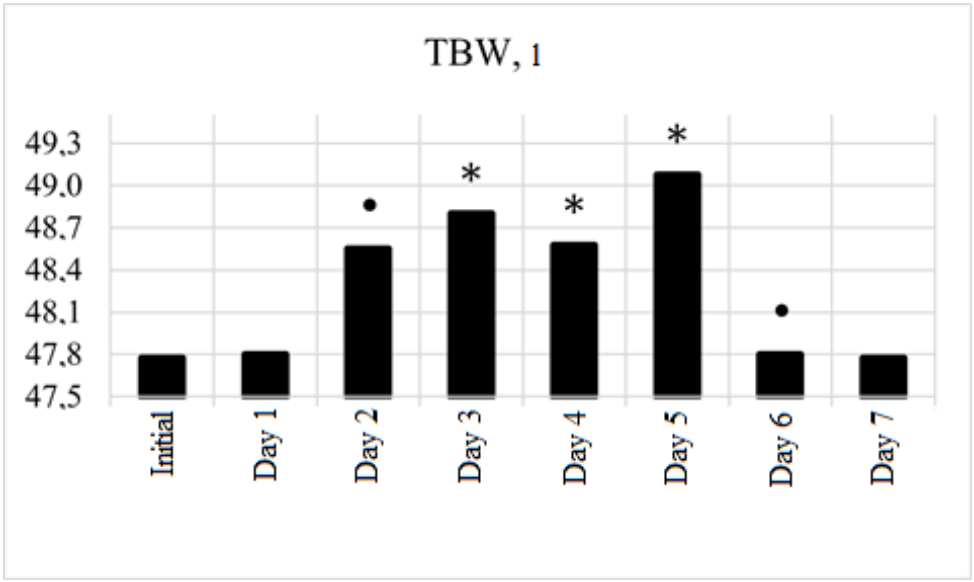

Fig. 2. Dynamics of changes in TBW

Note: ∗ – significant differences with initial measurements ($p<0.05$); • – significant differences with the previous day ($p<0.05$); TBW – Total Body Water

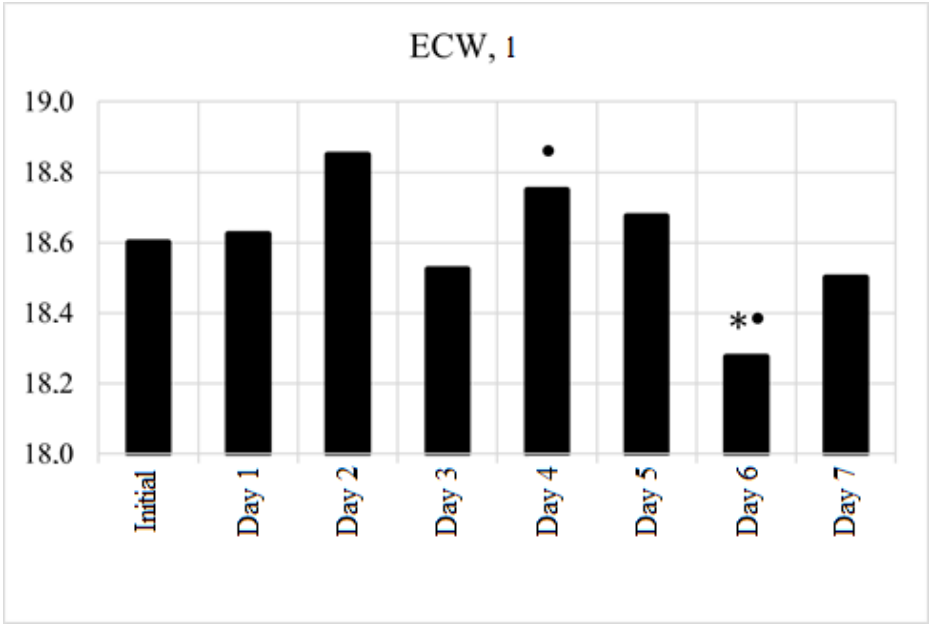

Fig. 3. Dynamics of changes in ECW

Note: ∗ – significant differences with initial measurements ($p<0.05$); • – significant differences with the previous day ($p<0.05$); ECW – Extracellular Water

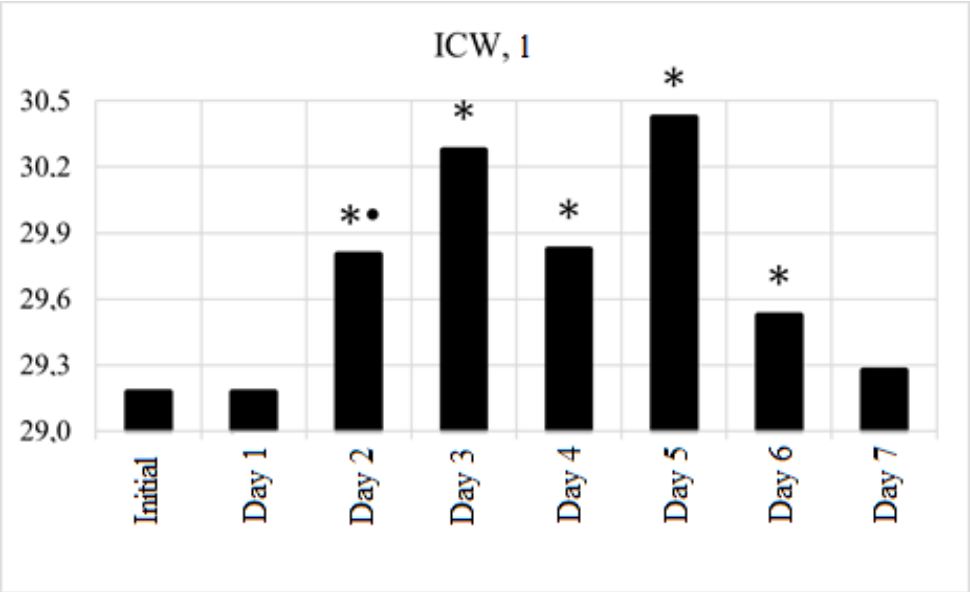

Fig. 4. Dynamics of changes in ICW

Note: ∗ – significant differences with initial measurements ($p<0.05$); • – significant differences with the previous day ($p<0.05$); ICW – Intracellular Water

The participants did not report any side or adverse effects after creatine intake during and after the study.

The receipt of initial results of the experiments can be considered as a feature of this study. After changes, all indicators returned to the level that was before the experiment, or dropped below this value. The data from other studies demonstrate an increased level of fluid even a month after creatine intake [11-12]. This fact suggests that changes in the body fluids after creatine intake occur in waves.

Significant changes in the body fluids begin after a second day of creatine intake: body mass starts to grow, the TBW level increases by ~0.8 l, ICW – by 0.6 l, a ECW – by 0.3 l, reaching their peak values in 18.9±2.1 l. On the third day, the TBW, ICW and body mass levels reach their first peak. Then, on the fifth day, the second peak of TBW and ICW occurs, but body mass values are closer to their initial value. Between the third and the fifth day, we have registered a decline in the body fluid and mass levels. It suggests that the fourth and the seventh day can be favorable for weigh-in, during the first week of creatine intake. Differences in the ICW were significant in comparison with the initial measurements ($p<0.05$) all the time from the second till the sixth day. During the second day, we have registered a rapid growth compared to the first day.

What we find interesting that the TBW and ICV values change the most, while ECW does not change much during the whole experiment. The ECW fluctuations amount to just 0.6 l on average. It grown significantly on the fourth day, relatively – on the third day and on the sixth day compared to the initial measurement and the fifth day. This result correspond with the data discovered by other authors [13-14], who also noted that creatine just slightly influences extracellular water increasing the intracellular water volume. A significant decline of the ECW on the sixth day corresponds with the results obtained by Brilla et al, who also registered the decline, but in case of one-time measurement only [15].

We also would like to note a decline in the TBW, ICW and body mass on the fourth day and rapid decline of all indicators on the sixth day. To explain this, further studies are required.

Conclusion. The obtained results have shown that changes in the body fluids related to creatine intake do not occur linearly, but in waves, if we look as the week profile of the

creatine course. The peak is reached on the 2nd and 5th days, a slight decline – on the 4th day. By day 7, the body fluids level returns to normal.

These results can assist when developing creatine dosage regiments that would contribute of lower fluid retention. Further studies will include more participants and take more time. Furthermore, other studies should include other creatine dosage regiments, different doses in order to evaluate the amount of creatine taken on the body hydration level.

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INFORMATION ABOUT THE AUTHORS:
Aleksandr Vital'evich Meshtel' – Master's Student of the Department of Sports Medicine, Russian State University of Physical Culture, Sport, Youth and Tourism, Moscow, e-mail: meshtel.author@yandex.ru.
Aleksandr Borisovich Miroshnikov – Candidate of Biological Sciences, Associate Professor of the Department of Sports Medicine, Russian State University of Physical Culture, Sport, Youth and Tourism, Moscow, e-mail: benedikt116@mail.ru.

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THE EFFICIENCY OF RECOVERY MEASURES IN THE REHABILITATION OF 7-9 YEARS OLD CHILDREN WITH RESPIRATORY DISEASES IN SANATORIUM CONDITIONS

V.V. Kostyaeva, N.A. Chulyukova
Russian State University of Physical Culture, Sports, Youth and Tourism, Moscow, Russia

Annotation. The article describes the use of restorative measures in a sanatorium in 7-9 years old children with respiratory diseases, the effectiveness of which is expressed in improving the performance of the respiratory system. Positive changes were noted in the study of lung capacity and peak expiratory flow, indicating the effectiveness of the measures used in the study population with bronchopulmonary pathology at the stage of sanatorium treatment.
Keywords: rehabilitation, recovery measures, respiratory system, children, respiratory diseases, sanatorium conditions.

Introduction. Among diseases of respiratory organs in children of different age groups bronchopulmonary diseases account for about 30-40% of cases of the detected pathology [1-2]. In recent years, there has been an increase in the number of patients in the patient group of frequently ill children (FIC) and children with bronchial asthma (BA) [1-3].

There is also an increase of not only in the incidence of respiratory allergic diseases, but also in a number of children with severe allergic diseases [3]. Moreover, the clinical profile has a tendency for progression, which, as the child grows up, would significantly undermine physical and psychoemotional health on further stages of ontogenesis [3-5]. It serves as a factor of social limitation, reduces the quality and entirety of life.

The abovementioned indicates the relevance of applying recovery measures at earlier age possible with the inclusion of subsequent and systemic recovery at all stages of the process, considering the resort potential of sanatorium treatment [6-7].

The purpose of this study – assess the effectiveness of therapeutic physical culture measures in the recovery of 7-9 years old children with respiratory diseases.

Methods and organization. In order to achieve the goal, we have implemented research methods that evaluate the effectiveness of natural and preformed physical factors in the treatment of children with respiratory allergic diseases: analysis of scientific and methodological literature, pedagogical observation, spirometry (identification of lung capacity – LC, l), peak expiratory flow (PEF), math-and-stats methods. The statistical data processing was made with the Statistica 7.0 software. We have calculated mean values (X) of the indicators, as well as derivation values (σ). Significance of results obtained was identified with the Student T-test when $p<0.05$.

The study was conducted in the S.M. Kirov Sanatorium, located in Kislovodsk, during the "Child's health" program.

The study included 16 children of both genders, aged 7-9 years, who had a history of respiratory diseases. When selecting the participants, we have excluded children with severe bronchial asthma, signs of asthmatic state or asthma attacks during arrival for sanatorium treatment.

Results and discussion. Duration of sanatorium treatment for these children varied from 21 to 30 days. Due to the difference in the length of stay in the sanatorium, a single period for conducting the study was determined – 20 days.

Sanatorium treatment was conditionally divided into 3 stages: initial, main and final.

The initial stage (3-5 days) included the study of the functional state of the respiratory system. We have applied the dose-sparing regimen, taking into account the adaptation of children to the effect of natural and climatic factors of the resort area, with the inclusion of natural and preformed physical factors and means of therapeutic physical culture.

The second stage (12-14 days) included application of the whole set of sanatorium treatment exercises, the regime of physical activity was gradually expanded, the effectiveness of rehabilitation in improving the health of children with respiratory diseases was tested. From the 5th to the 10th day, the children were transferred to a tonic motor mode, and subsequently, as health was restored, in the second half of the treatment course – to a training motor mode. At the same time, the choice of the physical activity regime was carried out differentially, depending on the period of sanatorium treatment, the individual features of the child, their state of health and physical fitness level, taking into account the ongoing processes of adaptation of the child's body to the natural and climatic conditions of the resort.

Following procedures were included into the program of therapeutic and health-improving measures:

- climatic treatment, including a long (up to 7 hours a day) stay in the fresh air;
- air- and sunbaths (up to 2 hours a day during the first half). Air baths as an effective way of acclimation and increase of body resistance were carried out right before day and night sleep;
- aerotherapeutics were used both at rest (day sleep on fresh air) and in combination with respiratory activity of the child (dosed walks, dosed mounting, outdoor activities). Aerotherapeutics were used in a dosed manner, twice a day for 20-30 minutes, during the first and the second half of the day at the initial stage. At the next stage, the time spent outdoors gradually increased to 5-6 hours a day;
- balneotherapy in the form of carbon dioxide baths, concentration of carbon dioxide – from 0.7 to 1.4 g/l, water temperature – 36°C. The procedures took place every other day in the morning after breakfast, duration of the procedure – 6-8 minutes. The balneotherapy course consisted of eight baths. Children were recommended to receive the procedures no earlier than 60 minutes after breakfast. They also must rest or lower their motor activity for 30 minutes after the procedure;
- peloid therapy in form of mud applications on the chest with the application of therapeutic mud on the paravertebral block from the cervical to the lumbar spine, temperature of mud applications – 38-40°C. Duration of each mud therapy session was 10 to 15 minutes, 8 procedures total;
- oxygen therapy in form of oxygen cocktails, twice a day – one serving in the morning and one in the evening;
- therapeutic massage was performed in the back area from the shoulder line to the lower corners of the shoulder blades. We have also used techniques of segmental impact on the paravertebral blocks. The massage course consisted of 20 procedures, the time of one session was 8-10 minutes;
- therapeutic physical culture in following forms: morning hygienic gymnastics (MHG), therapeutic gymnastics (TG) during the first half of the day, respiratory gymnastics (RG), outdoor games, everyday walks, terrain cure (only when children are adapted to the sanatorium's climatic conditions), walks on the sanatorium's territory (every other day, during the second part of the day, tempo – 70-80 steps per minute.

The third, final stage lasted for 3-5 days. The children were still engaged in therapeutic physical culture, did dosed walks and played outdoor games. Among the applied therapeutic and health-improving measures, the children still received climatic treatment and oxygen therapy. During this time, the final research took place. We have also measured indicators of the functional state of the respiratory system of the children, who received rehabilitation.

The table below demonstrates dynamic changes in the studied indicators that occurred during rehabilitation in children aged 7-9 years with respiratory diseases.

Table

Dynamics of the respiratory system indicators in children aged 7-9 years with the bronchopulmonary pathology during rehabilitation in sanatorium conditions

Indicators	Initial stage of rehabilitation (n=16) (Xmean±σ)	Final stage of rehabilitation (n=16) (Xmean±σ)	Significance, Student T-test ($p \leq 0,.05$)
LC, l	1.3±0.2	1.4±0.1	≥0.05
Peak expiratory flow (PEF), l/min	211.9±0.3	215.2±0.2	≤0.05

Functional indicators of the respiratory system of the children with the bronchopulmonary pathology after the rehabilitation course had a positive tendency for improvement.

The LC indicator has increased by 0.1 l ($p \geq 0.05$). The PEF indicator has also significantly increased by 3.3 l/min ($p \geq 0.05$). This indicator demonstrates strengthening of the respiratory muscles that are mainly responsible for exhalation, improvement of the bronchopulmonary tract's patency for exhaled airflow for the studied population of children after the rehabilitation course in sanatorium conditions.

Conclusion. Improvement of results received during the study indicates the effectiveness of therapeutic and health-improving measures in rehabilitation of children with respiratory diseases at the stage of sanatorium treatment.

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INFORMATION ABOUT THE AUTHORS:

Viktoria Vasil'evna Kostyaeva – Senior Lecturer of the Department of Physical Rehabilitation, Massage and Health-Improving Physical Culture named after I.M. Sarkizov-Serazini, Russian State University of Physical Culture, Sports, Youth and Tourism, Moscow, e-mail: borisova-viktoriya@yandex.ru.
Natal'ya Aleksandrovna Chulyukova – Lecturer of the Department of Physical Rehabilitation, Massage and Health-Improving Physical Culture named after I.M. Sarkizov-Serazini, Russian State University of Physical Culture, Sports, Youth and Tourism, Moscow.

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HYDROKINETIC THERAPY IN THE COMPREHENSIVE REHABILITATION OF BASKETBALL PLAYERS AFTER ARTHROSCOPIC SURGERIES FOR TREATING MENUSCUS INJURY

I.V. Sobchuk[1], N.V. Lunina[1,2]
[1]Russian State University of Physical Culture, Sports, Youth and Tourism, Moscow, Russia
[2]FSBI "North-Caucasian Federal Research and Clinical Center of the Federal Medical and Biological Agency", Essentuki, Russia

Annotation. The article describes the use of hydrokinetic therapy in the comprehensive rehabilitation of basketball players after arthroscopic surgery for treating meniscus injury. The efficiency of the rehabilitation treatment with hydrokinetic therapy in athletes is represented by positive dynamics of the results of the flexion-extension amplitude of the injured knee, reduced pain, an increase in the strength of the quadriceps femoris muscle of the operated limb.
Keywords: hydrokinetic therapy, arthroscopic surgery, comprehensive rehabilitation, athletes, basketball players.

Introduction. In sports practice, an injury of the knee joint is the most frequent among other injuries of the musculoskeletal system, which are in 50% associated with ligaments injury [1]. According to the data [2], incidence of the anterior cruciate ligament and meniscus injuries is 70% of cases.

Injuries of the meniscus in basketball are due to a specificity of motor actions of athletes: sudden stops and jerks, speed rotation of body parts on place and in movement, sudden changes of the movement trajectory of athletes, multiple jumps, martial arts elements during defense and ball reception, due to contact, and place increased demands on the musculoskeletal system [2].

Due to significant disorders in support ability of the limb and walking functions that reduce quality of life, rapidly limit motor activity and make it impossible to carry on athletic activity [3], injuries of the meniscus and knee joint are considered as the most complicated ones, which, alongside with the therapeutic indications, determines the choice of arthroscopic surgeries among other ways of treatment. However, even in case of successful surgical reconstruction of the ligamentous system, because of duration of the rehabilitation measures (5 to 12 months in average), there is a high risk of post-surgical complications in a form of biomechanical asymmetry and disorders of the afferent conduction leading to secondary tears in 44% of cases [4], muscle imbalance during locomotion. In 13-42% of cases, the deforming gonarthrosis develops [5], and instability in the knee joint remains for a long period of time [6].

All the aforementioned predetermines the need for searching methods and forms of physical rehabilitation directed towards the maximal recovery of amplitude and strength characteristics of the knee joint in basketball players in conditions of leveling muscle imbalance, impact and axial loads on the injured joint when performing movements at the stage of sports rehabilitation characterized by special activity. Use of hydrokinetic therapy, due to the specificity of water environment and the variability of the body position (horizontal, vertical, diagonal) allows athletes to perform activities on the injured knee in optimal conditions.

The purpose of the study was to increase the efficiency of using hydrokinetic therapy after arthroscopic surgeries for treating meniscus injury in basketball players at the stage of sports rehabilitation.

Methods and organization. The study took place in the "UMGK-Zdorov'e" multipurpose medical center (Ekaterinburg). The inclusion criteria: type of sport – basketball, diagnosis – post-surgical period after

the arthroscopic surgery for treating meniscus injury, recovery stage – the sports rehabilitation stage. The exclusion criteria – combined injuries of the knee joint. The study involved 8 basketball players aged 23-26 years, sports qualification – 1st grade (n=5), candidates for master of sports (n=3).

The functional characteristics of the operated knee and the whole part of the lower limb were identified according to the knee joint amplitude with goniometry in the initial positions – lying on the back, lying on the stomach. Dynamics of trophic changes in the hip muscles was studied with anthropometric measurements (in cm) of the hip muscles from both healthy and injured legs. Pain sensations of the injured part at rest and in case of activity were differentiated according to the 10-point Verbal Descriptor Scale [7]. The 5-point manual muscle testing (MMT) was done to identify strength of the quadriceps femoris muscle during its active contraction in the lying on the back position.

The results obtained were processed with the math-and-stats methods: we were identifying average values of the indicators, standard derivation, the significance level of differences for parametric indicators was calculated with the Student's t-test (when $p \geq 0.05$) and the Wilcoxon's T-test – for non-parametric indicators (when $p \geq 0.05$).

Results and discussion. The preliminary study of the examined indicators has revealed reduced strength of the muscles that flex end extend the calf, as well as the pain syndrome pronounced mostly during exercise (table).

Table

Comparative results of anthropometric, functional and psychological indicators of basketball players after rehabilitation measures including hydrokinetic therapy

Method / Indicators	X±σ		p
	Before	After	
Goniometry			
Knee joint's flexion (degrees)	75±5	130±5	p≤0.05
Knee joint's extension (degrees)	13±2	1±0.3	p≤0.05
Anthropometric indicators			
Girth of the healthy leg's hip (cm)	36±1.5	37±0.5	p≥0.05
Girth of the injured leg's hip (cm)	33.5±1.5	36.5±1	p≤0.05
Verbal Descriptor Scale			
Pain assessment at rest (points)	4.87±0.04	1.67±0.02	p≤0.05
Pain assessment during exercise (points)	6.47±0.01	4.87±0.03	p≤0.05
MMT			
MMT of the quadriceps femoris muscle of the injured leg's hip (points)	1.25±0.25	4.6±0.05	p≤0.05

The main tasks of the physical rehabilitation of the basketball players with hydrokinetic therapy were the improvement of conditions of the reparative and regenerative processes in the injured body part, recovery and improvement of the support function of lower limbs, recovery of the development level and improvement of the main physical qualities, recovery of the optimal level of the total and special performance, recovery of coordination of specialized motor movements in basketball.

The comprehensive recovery measures with hydrokinetic therapy that lasted 6 years were aimed at reducing time of elimination of the injury's consequences and post-surgical complications, the recovery of athletic performance against the background of maximally possible preservation of best athletic conditions and the functional state of the athlete' body. The whole rehabilitation period included 3 stages: introductory (1 week), main (4 weeks) and final (1 week).

Therefore, the main accent of the comprehensive rehabilitation with hydrokinetic therapy was aimed towards the support of the fitness level and preservation of the physiological pattern of special motor actions in basketball. The pool classes included calisthenic exercises (20% of the total physical activity (PA)), respiratory exercises (10% of the total PA), special and special training exercise (70% of the total PA), we have used sports training devices (foam floats, swimming boards, paddles, pull buoy, swimming noodles, flippers, water dumbbells, weights etc.). We have also used training devices and mechanic systems used both on land (different expanders, training device/set for dryland swimming – analog of TRX sets, stair stepper – horizontal and vertical, exercise bicycle, plate load machine – leg press, squat training device, a device for flexion-extension (with/without resistance) in the knee joints from the sitting position (rowing machine) and in the pool (underwater balancing platforms, simulator of "walking in zero gravity", underwater exercise bicycle, underwater treadmill, etc.). Therapeutic swimming in the pool was conducted with all swimming styles following movement biomechanics, which is why at the beginning we used devices for support (foam floats), then we implemented active movements. After that, we used the equipment (flippers, water dumbbells, weights) for poundage and increasing resistance in the injured part of the musculoskeletal system. Special exercises, alongside with the calisthenic exercises in water, were conducted in horizontal, diagonal and vertical initial positions. Alongside with flexing and extending movements in the injured part, we have also applied different types of walking, running, turns on a place and in movement in conditions of the different pool depth. For the recovery and subsequently – for the improvement of amplitude characteristics of the knee joint and the whole part of the musculoskeletal system we used mechanic systems and training devices. We also included volleyball and basketball in the pool with different water levels. The average water temperature was 28-29 ^{o}C. After the most loaded exercises and at the end of the rehabilitation course, we used exercises for stretching and relaxation of the stressed muscle groups combined with respiratory exercises focused on the phase of slow and smooth exhalation, followed by passive rest in conditions of unloading the spine and lifting the injured body part.

The efficiency of the conducted rehabilitation measures for the participants was presented as a significant improvement of the studied indicators (table).

According to the goniometry results, the flexion amplitude of the injured leg's hip joint has increased from 75±5 to 130±5 degrees ($p \leq 0.05$), the extension amplitude has also increased from 13±2 to 1±0.3 degrees ($p \leq 0,05$).

The dynamics of anthropometric measures of the healthy hip's girth has insignificantly increased from 36±1.5 to 37±0.5 cm ($p \geq 0.05$). Meanwhile, there are significant changes when measuring the hip's girth of the injured leg from 33.5±1.5 to 36.5±1 cm ($p \leq 0,05$), reaching values that insignificantly differ from the indicators of the healthy limb.

During the recovery measures including hydrokinetic therapy, we assessed pain level with the Verbal Descriptor Scale that allows evaluating presence of pain sensations at the present moment [8]. Before the recovery, the results at rest have amounted to 4.87±0.04 points, corresponding to the excess of moderate pain, pain during exercise was estimated by athletes at 6.47±0.01 points and interpreted as very severe pain. After the recovery, pain sensations in the injured part have reduced and were estimated at 1.67±0.02 points ($p \leq 0.05$) at rest, corresponding with weak pain, during exercises they corresponded with moderate pains and were estimated at 4.87±0.03 points ($p \leq 0.05$).

The MTT, rated with the 5-point scale, has reflected an increase in the myotatic reflex of the quadriceps femoris muscle in the injured leg during isometric activity. In the course of the rehabilitation measures with hydrokinetic therapy, the MTT has increased from 1.25±0.25 to 4.6±0.05 points ($p \leq 0.05$), almost corresponding with the normalized values of 5 points and demonstrates the efficiency of the rehabilitation measures carried out.

Conclusion. The recovery measures with the hydrokinetic therapy at the stage of sports training for basketball players in the late and long-term post-surgical period after arthroscopic surgeries on the knee joint have contributed to the increased flexion-extension amplitude of the injured limb's knee joint, the reduced intensity of pain sensations at rest and during exercise, the increased myotatic reflex activity of the quadriceps femoris muscle during isometric activity. The aforementioned demonstrates the recovery measures' efficiency and serves as a justification for transition of athletes to full-fledged training activity.

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INFORMATION ABOUT THE AUTHORS:

Irina Vladimirovna Sobchuk – Senior Lecturer of the Department of Physical Rehabilitation, Massage and Health-Improving Physical Culture named after I.M. Sarkizov-Serazini, Russian State University of Physical Culture, Sports, Youth and Tourism, Moscow.
Natal'ya Vladimirovna Lunina – Candidate of Biological Sciences, Associate Professor, Associate Professor of the Department of Physical Rehabilitation, Massage and Health-Improving Physical Culture named after I.M. Sarkizov-Serazini, Russian State University of Physical Culture, Sports, Youth and Tourism, Moscow; Senior Researcher Center for Biomedical Technologies, FSBI "North-Caucasian Federal Research-Clinical Center of Federal Medical and Biological Agency", Essentuki, e-mail: natalya-franc@mail.ru.

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THE ROLE OF THERAPEUTIC PHYSICAL CULTURE IN ACTIVE LONGEVITY PROGRAMS FOR ELDERLY PEOPLE WITH ARTERIAL HYPERTENSION

V.V. Kostyaeva
Russian State University of Physical Culture, Sports, Youth and Tourism, Moscow, Russia

Annotation. The article presents the results of the effectiveness of the influence of regular physical activity on the quality of life and the preservation of active longevity of the elderly with arterial hypertension. Use of forms of therapeutic physical culture in combination with an adequately chosen drug therapy significantly increases adaptive capabilities of the elderly with arterial hypertension, contributes to a decrease in blood pressure, improvement of blood vessels, normalization of main hemodynamic indicators, impact quality of life, self-assessment of the functional state of health, influences physical and mental health.
Keywords: therapeutic physical culture, arterial hypertension, active longevity.

Introduction. One of the most important social transformations of the population at the moment is aging. The main tasks for suspending this process are the preservation of the active longevity of an elderly person, their ability to work and prolonging professional activity [1-2]. In order to achieve these tasks, elderly people need to lead a healthy lifestyle, foster personal responsibility for their life and health, set their mindset for longevity. Active longevity directly depends on their social activity and regular physical work, state of their health and quality of life [1]. However, most of the elderly, who has a history of chronic diseases, maximally limit physical activity. According to the WHO, non-infectious diseases of the elderly, such as ischemic heart disease and hypertonic disease, become the cause of other diseases and deaths in the course of last years [3-4]. Regular cyclic activity of aerobic nature is able to influence effectively the cardiovascular and respiratory systems, good state of which determines health and longevity of the elderly [5-6]. Thus, there is a need to develop and actively implement non-drug methods of treating arterial hypertension in the comprehensive rehabilitation of the elderly, depending on their physical activity level.

Aim of this study – to assess the effectiveness of therapeutic physical culture measures in the comprehensive recovery of the elderly with arterial hypertension, directed towards the preservation of active longevity of the studied population.

Methods and organization. We have assessed the functional state of the elderly with arterial hypertension according to the following indicators:

- Heart rate (HR, beats/min);
- Systolic (SBP, mm of Hg) and diastolic (DBP, mm of Hg) blood pressure;
- Lung capacity (LC, l);
- Adaptive potential of the cardiovascular system (AP, c.u.), calculated analytically with the R.M. Baevskij's method [3];
- Assessment of the quality of the patients' life (points) was made with the B.P. Vojtenko's health assessment questionnaire.

The statistical analysis of the results obtained was made with the SPSS 21.0 for Windows. We have calculated mean values (X) of the studied indicators, as well as the standard derivation value (σ). The significance of the results received was processed with the Wilcoxon signed-rank test when $t \leq 0.05$.

The study involved the elderly who engaged in the "Active longevity" program made by the "Health" club located in Moscow. It included women (n=5) aged 68±0.5 years with the stage 1-2 arterial hypertension, who have a doctor's permission to perform moderate physical activity with hypotensive medications.

All women were at the initial stage of sessions according to the program, the group included people with approximately the same level of physical fitness, as the data from the preliminary testing shows.

Duration of health-improving group sessions was five months. The main physical activity of the program was therapeutic gymnastics (TG), taking into account the diagnosis and age features of those engaged. It contributed to an improvement of the cardiorespiratory system's function.

The most appropriate and easily dosed forms of therapeutic physical culture (TPC) were morning hygienic gymnastics (MHG), therapeutic gymnastics (TG) and dosed walking. The program participants were recommended everyday home tasks of MHG for 15-20 minute with physical exercises for small muscle groups, with the obligatory alternation of dosed efforts and relaxation combined with respiratory exercises.

During group sessions held daily for 40 minutes during the first half of the day, the TG set included all muscle groups into physical activity with the "scattered load" method and alteration of motor activity with a subsequent rest phase. The suggested exercises were recommended to perform without holding breath and rigid movements in the joints. Motor consistency of these sessions did not exceed 40%. The developed TG set included performance of callisthenic exercises for all muscle groups combined with respiratory exercises, posture correction exercises, aimed at strengthening the back and abdominal muscles, performed in initial positions – standing at the wall bars, sitting with support on the back of a chair, using a wand. In order to decrease load on the back muscles, the set included mixed hang positions and exercises for stretching the body and limb muscles when standing at the wall bars. The final part of the TG session also included a significant number of exercises for the relaxation of all muscle groups. After the session, passive rest for 1.5 hours was recommended.

Recommendations for the second half of the day included dosed walking as a natural and accessible form of TPC both on the club's territory and on park zones adjacent to the place of residence according to standard routes. The recommended time of everyday walks was 20 minutes at the beginning of the course with a subsequent increase to 30 minutes at the end, at a pace that is accessible to the participants.

Results and discussion. The effectiveness of the health-improving program for the patients with arterial hypertension was assessed according to the dynamic of studied indicators (table).

Table

Functional indicators of the patients with arterial hypertension during the "Active longevity" program

Indicators	Before the program's beginning (n=15) (Xmean±σ)	At the end of the program (n=15) (Xmean±σ)	Significance, Wilcoxon signed-rank test (t)
LC, l	2.8±0.2	2.9±0.1	≥0.05
SBP, mm of Hg	160.3±0.3	152.0±0.01	≤0.05
DBP, mm of Hg	90±0.4	79.4±0.3	≤0.05
HR, beats/min	82.5±0.3	78.9±0.2	≤0.05
AP, c.u.	3.7±0.02	3.5±0.01	≤0.05
Health assessment index, points	22.5±0.2	20.1±0.01	≤0.05

The analysis of the cardiorespiratory system's functional indicators has revealed that LC has improved by 0.1 l (t≥0.05). Other values of the studied indicators had a significant (t≤0.05) dynamic for improvement, which reflects the effectiveness of health-improving sessions.

Assessment of the hemodynamics indicators has revealed a significant decrease ($t \leq 0.05$) of heart rate (by 3.6 beats/min), as well as systolic (by 8.3 mm of Hg) and diastolic (by 10.6 mm of Hg) blood pressure. According to the adaptive potential data, we have found that at the beginning, 11 patients had values that characterize failure in adaptation mechanisms. At the end, the AP indicators were mainly presented as an unfavorable adaptation, but showed a tendency for improvement, which also reflected on subjective values of the health assessment index.

Conclusion. The use of therapeutic physical culture combined with adequately selected drug therapy significantly increases adaptive capabilities of the elderly with arterial hypertension, improvement of blood vessels, normalization of the main hemodynamic indicators, influences quality of life, assessment level of the functional state of health, impacts physical and mental health. The forms used in the "Active longevity" program, such as morning hygienic gymnastics, therapeutic gymnastics, dosed walking are accessible for the elderly people, do not require high physical fitness, are simple, which is the key to systematic training in commitment to maintaining motor and communication activity, improving the quality of life [7] for the elderly.

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INFORMATION ABOUT THE AUTHORS:

Viktoria Vasil'evna Kostyaeva – Senior Lecturer of the Department of Physical Rehabilitation, Massage and Health-Improving Physical Culture named after I.M. Sarkizov-Serazini, Russian State University of Physical Culture, Sports, Youth and Tourism, Moscow, e-mail: borisova-viktoriya@yandex.ru.

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HUMAN SECURITY OF STUDENTS DURING FIREARMS TRAINING

V.D. Panachev, L.A. Zelenin
Perm National Research Polytechnic University, Perm, Russia

Annotation. At the present moment, the mobilized soldiers, being in constant interaction with negative phenomena, are subjected to psychological and physical risks (the danger for life and health). There are cases of deadly danger as well. One of the main causes of death is an insufficient level of firearms training for the upcoming fight, as well as special, professionally applied physical training and low mental stability. Therefore, there is a need to solve a following problem, i.e. a development of more efficient comprehensive methods for improving special physical fitness to perform service and combat tasks and survival in extreme conditions on land and in water, especially in case of combat encounters. In this case, it is impossible to disregard means of physical training and sports, including professionally applied physical and firearms training as well as the experience of Special Forces training.
Keywords: firearms, physical training and sport, physical security.

Introduction. Firearms and physical training are the basis of the main training of experts. The need in professional competencies became more urgent during the partial mobilization, when the training process carried on in complicated conditions.

Methods and organization. The study took place in 2022 and included more than 150 people. The study on stress and hypoxic resistance, dynamics of the respiratory system included 54 test subjects. The testing of the developed method included 50 students of the Perm National Research Polytechnic University (PNRPU).

The research consisted of three stages. The first one included the study on the features of stress resistance, the respiratory system regulation in conditions of stress. We have also concluded the preliminary experiment on the possibility of improving stress and hypoxic resistance with swimming and physical activity on land. At the second stage, we have chosen specific exercises for improving stress resistance with the respiratory system regulation. A test of the developed method for improving firearms, special physical fitness of students to perform complex tasks and survive on land and in water was carried out. The third stage consisted of an analysis of results and description of the data received. We have made corresponding conclusions, formed practical guidelines and prepared the article.

As a result of the analysis of publications on this topic [1-4], we have also examined innovations and many years of experience of training the PNRPU experts for task clearance in extreme conditions. The features of the firearms training for a specific professional training were revealed. The direction of the developed method, as well as ways to rationalize the improvement of stress resistance with respiratory exercises, special firearms training exercises, the features of teaching pistol shooting techniques and the improvement of body resistance to hypoxia were justified.

The statistical data processing included the examination of the received data for the distribution normality according to the Kolgomorov-Smirnov test and the data comparison according to the Student's t-test.

Results and discussion. An expert with an improved hypoxic resistance during a firearm encounter has following advantages against an enemy: with a sufficient amount of oxygen, their body can change from the aerobic mode into the anaerobic mode (with oxygen shortage, high-intensity carbohydrate burning and worsened body energy distribution) much later than their opponent can. In order to improve the blood respiration function, we tried to

stimulate the hemoglobin creation function using game exercises, high-loaded ascends over rough terrain of the PNRPU complex, diving (with the search for objects at the bottom of the pool) and jumping exercises. In whole, it improved the blood function, which is necessary for the student in pursuing an enemy on land and neutralizing them in water. The data from the laboratory and field experiment that describes dynamics of the hemoglobin level are shown in table 1.

After a month of training, the hemoglobin content in blood has increased in test subjects of the experimental group by 13.1% (from 108.6 to 121.7 g/l) ($p<0.01$), in the control group – by 1.4% (from 125.3 to 126.7 g/l) ($p<0.05$). It shows an important role of using hypoxic means of physical culture to stimulate hemoglobin creation. Apart from the efficient improvement of the hemoglobin level, the experimental group also has a significant improvement in the functional state indicators (table 2).

Table 1

Changes of hemoglobin in blood

Indicator	Group	Number	Average value		Changes		p
			before the experiment	after	±absolute	±%	
Hemoglobin, g/l (standard: 132.6-144.5)	E	115	109.69	121.9	±17.18	+12.21	<0.05
	C	115	129.38	126.38	±1.77	+1.27	>0.05

Note: E – experimental group; C – control group

Table 2

Dynamics of the functional state indicators in students

Indicators	Group	Number		Average value		Changes		p
				before	after	±absolute	±%	
LC, ml	E	17		1616	1676	+60	+3.7	>0.05
	C	17		1333	1360	+27	+2.0	>0.05
Breath holding, s	on exhale	E	17	11.53	16.09	+4.56	+39.6	<0.05
		C	17	13.37	7.57	-5.80	-43.4	<0.05
	on inhale	E	17	23.86	29.89	+6.03	+25.3	<0.05
		C	17	31.90	29.50	-2.40	-7.5	>0.05
Tapping test, taps/5 s	E	17		25.07	29.43	+4.36	+17.4	<0.05
	C	17		25.67	25.33	-0.34	-1.3	>0.05

Note: LC – lung capacity; E – experimental group; C – control group

In the experimental group, LC has increased from 1310 to 1365 ml (by 3.7%) ($p<0.05$), in the control group – from 1335 to 1365 ml (by 2.0%) ($p<0.05$). It shows a tendency for a significant increase of LC in case of applying hypoxic physical activity and an accompanying improvement of the lungs' functional state. Breath holding on inhale increases from 23.8 to 29.8 s (by 25.5%) ($p<0.01$) in the experimental group, in the control group – from 31.9 to 39.5 s (by 7.4%) ($p<0.05$). It demonstrates the fact that hypoxic physical activity effectively increases breath holding on inhale, i.e. hypoxic resistance. Breath holding on exhale has increased from 11.5 to 16.9 s (by 39.4%) ($p<0.05$) in the experimental group, in the control group – from 13.3 to 17.5 s (by 43.5%) ($p<0.05$), which also shows improvement of hypoxic resistance of test subjects. The tapping test results have improved from 25.2 to 29.4 taps/ 5 s (by 17.5%) in the experimental group, the control group had the results that decreased from 25.69 to 25.35 taps/ 5 s (by 1.3%) ($p>0.05$). All these changes show

that training for improving stress and hypoxic resistance also positively influence mobility of the nervous system.

The method of improving firearms and special physical fitness of students included the following (table 3): the main feature of the method is a maximal use the enemy's energy against themselves. Moreover, the combat techniques were applied not only on land, but also in water and underwater. At the same time, explosive physical abilities and the body's resistance to hypoxia increased to minimize the anaerobic mode in conditions of fighting with an enemy. The interaction with stress resistance in extreme situations was especially improved. The experiment involved fifty 3-year students, who were divided into three groups. The control and experimental groups included 25 test subjects each. The experiment lasted during 2021-2022. The average age of participants – 20.5 years. In both groups, students visited 90-minute applied physical culture classes 2 times a week, according to the curriculum, as well as 90-minute sambo classes 3 times a week. At the end of the year, we have conducted a control assessment. The control group was training according to the standard method during preparations to the university sambo contest. The experimental group was training according to our developed method of improving stress resistance and physical fitness for performance of service tasks and survival in extreme conditions on land and in water. Both groups were training for the same amount of time during the semester. The evaluation of physical qualities was made at the beginning and at the end of each semester of the academic year in accordance with the curriculum. The more advanced testing was carried out at the beginning and at the end of the semester.

The results are presented in table 3.

Table 3

Efficiency of using the method for improving physical fitness of students

Indicators		Average value		Changes		p
		before	after	±absolute	±%	
Average body mass, kg	C	70.1	70.0	-0.1	-0.14	>0.05
	E	71.8	70.4	-1.4	-2.00	<0.05
HR, beats/min	C	75.7	74.2	-1.5	-1.9	<0.05
	E	73.5	69.8	-3.7	-4.9	<0.05
LC, l	C	4.3	4.4	0.1	0.43	<0.05
	E	4.1	4.4	0.3	7.30	<0.05
Breath hold on inhale, s	C	52	61	9	17.3	>0.05
	E	57	72	15	26.3	<0.05
Standing long jump, cm	C	216	222	6	2.8	>0.05
	E	217	230	13	5.9	<0.05
Push-ups for 1 min, number	C	29	30	1	3.4	>0.05
	E	31	38	7	22.6	<0.05
3000m, s	C	12.42	12.40	8	1	>0.05
	E	12.21	12.15	-6	-1	>0.05
10x10m shuttle run, s	C	25.8	25.5	-0.3	1.2	<0.05
	E	25.5	25.0	-0.5	2.0	<0.05
100m run, s	C	14.5	13.9	-0.6	4.1	<0.05
	E	14.2	13.0	-1.2	8.4	<0.05
Pull-ups, number	C	13.0	13.5	0.5	3.1	>0.05
	E	15.1	15.7	0.6	10.6	<0.05

Note: HR – heart rate; LC – lung capacity; E – experimental group; C – control group

As a result of using the developed method, we have achieved more significant effects in comparison with the generally accepted means in increasing the economization of the cardiovascular system at rest, the capabilities of the respiratory system, stress resistance and hypoxic resistance, speed-strength (explosive strength), specific speed and coordination abilities, speed, strength, speed-strength endurance. The method, when applied in experimental conditions, provides a positive shift in the functional state and professionally important physical qualities and abilities of students.

Conclusion:

1. Study and analysis of shooting techniques allowed us to reveal that each student should use these techniques in stressful situations. The latter is not sufficiently covered in scientific and applied literature.

2. The hypoxic resistance can be increased by 15% in a month of hypoxic activity that increases hemoglobin content, lung capacity level and improves the blood respiration function in general, which is especially important in conditions of the pandemic.

3. The main features of the developed method are the maximal application of sambo techniques not only on land but also in water and underwater with a parallel improvement of explosive physical abilities and hypoxic resistance in order to minimize the anaerobic mode when fighting an enemy. We have paid special attention to the interaction in extreme conditions to improve stress resistance.

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INFORMATION ABOUT THE AUTHORS:

Valerij Dmitrievich Panachev – Doctor of Sociological Sciences, Professor, Head of the Physical Culture Department, Perm National Research Polytechnic University, Perm, e-mail: panachev@pstu.ru.
Leonid Aleksandrovich Zelenin – Doctor of Pedagogical Sciences, Professor, Professor of the Physical Culture Department, Perm National Research Polytechnic University, Perm, e-mail: zelenin-doz48@mail.ru.

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SKFNKC
FMBA Russia
North-Caucasian federal
research-clinical center

Contacts:

Phone number: 8 (906)-471-14-05
Phone number/fax: 8 (87974) 63-150
e-mail: int@skfmba.ru

Address: Russia, Stavropol Region,
Essentuki, Sovetskaya St., 24
Postal code: 357600