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CHANGES IN SPECTRAL ANALYSIS INDICES IN A STABILOMETRIC STUDY OF FEMALE GYMNASTS OF DIFFERENT AGE

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Abstract. Currently, stabilometry is one of the main methods that provide an informative assessment of the ability to maintain the correct posture and purposefully manage the overall body mass center of athletes. The aim of the study is to evaluate the age-related changes of the frequency spectrum indices in a stabilometric study of female athletes specializing in rhythmic gymnastics. 157 gymnasts took part in the study, all athletes were divided into groups by age categories from 3 to 20 years old. The statokinetic function analysis was carried out using the STPL (MERA) force platform. The results of the study showed an age-related decrease in the frequency power of the spectrum in the sagittal and frontal planes away from the zone of medium oscillations to the transition zone, closer to the zone of slow oscillations during static tests. The analysis of the stabilometric indices revealed higher values of the energy intensity parameters of the ballistogram in the athletes of younger age groups. Thus, it was revealed that older athletes have a more advanced system of postural control, as well as better sensory and proprioceptive regulation in comparison with younger gymnasts.
Keywords: stabilometry, spectral analysis, rhythmic gymnastics, postural balance, Romberg test.

Introduction. Currently, stabilometry is one of the main methods that provide an informative assessment of the ability to maintain the correct posture and purposefully manage the overall body mass center of athletes [1-3]. An analysis of stabilometric indices in athletes engaged in complex coordination sports, such as rhythmic gymnastics, is of great importance, since the activity in such sports is closely connected with performing motor actions that differ fundamentally in volume and biomechanical structure from the movements performed by a person in ordinary life [4-7].

High-intensity physical loads combined with an early start of an athletic career of rhythmic gymnasts lead to consolidation of atypical motor stereotypes, resulting in joint hypermobility and ligamental apparatus hypermobility [8-12].

It is necessary to note that frequently, when interpreting results of the stabilometric study, researchers primarily estimate indices of the statokinesiogram surface area and power, as well as the pressure center movement speed, not giving proper attention to the frequency spectrum indices, which reflect the distribution of the signal's energy inside the set frequency range [13-15]. In addition, the assessment of the ballistogram energy intensity that reflects not only the length and speed of the statokinesiogram, but also its complex shape, will allow to reveal how easy or difficult the posture maintenance was for an athlete [16-17].

Aim of the study – to estimate age-related changes of the frequency spectrum parameters in a stabilometric study of female athletes specialized in rhythmic gymnastics.

Methods and organization. The study was carried out in the Center of biomedical technologies, North-Caucasian Federal Research-Clinical Center, during training camps in the Yug Sport center (Kislovodsk), as well as in sports schools in cities of Caucasian Mineral Waters.

The study included 157 female athletes specialized in rhythmic gymnastics with different qualifications: from the 3rd Junior Category to Masters of Sports of International Class and

Honored Masters of Sports. All the athletes were divided into groups by age categories from 3 to 20 years (8 groups total: group 1: 3-4 years, group 2: 5-6 years, group 3: 7-8 years, group 4: 9-10 years, group 5: 11-12 years, group 6: 13-14 years, group 7: 15-16 years, group 8: 17-20 years).

The postural function analysis was conducted using the STPL force platform (MERA). 2 tests were used in the study: the Romberg test in the "heels in, toes out" position, and the combined test that assesses an athlete's ability to maintain a pose according to a visible marker. The Romberg test was performed in two stages: first stage – an athlete holds a vertical pose with eyes open, second stage – with eyes closed, to estimate proprioceptive control. The combined test also included two stages: first stage – mark on a screen is static, second stage – mark on a screen is moving, reflecting the movement of an athlete's pressure center on the platform. The analyzed parameters included: FX – main oscillation frequency in the frontal plane (X-axis) (Hz), FY – main oscillation frequency in the sagittal plane (Y-axis) (Hz), Az – ballistogram energy intensity (J).

The statistical data processing was made in Microsoft Excel, Statistica 13.0 (Mann-Whitney U-test, Kruskal-Wallis test). The data are presented as the mean and mean square deviation.

Results and discussion. For the most complete assessment of body balance control in female athletes of different age groups, the Romberg test was performed. We estimated the main oscillation frequency in the frontal and sagittal planes. In addition, we analyzed the ballistogram energy intensity. Considering the fact that a significant role in maintaining balance is played by the sensory system, i.e. somatosensory, vestibular and visual parts, exclusion of one of these parts (visual analyzer) allows for more accurate estimation of the proprioceptive regulation. The data received from the stabilometric study (Romberg test with eyes open and closed) of rhythmic gymnastics of different age groups are shown in table 1.

Table 1

Comparative description of the spectral analysis indices in the Romberg test of rhythmic gymnasts of different age, M±m (n=157)

№	Indices	Age								P
		3-4, n=8, (1)	5-6, n=18, (2)	7-8, n=35, (3)	9-10, n=39, (4)	11-12, n=25, (5)	13-14, n=6, (6)	15-16, n=11, (7)	17-20, n=15, (8)	
1	FX (eo), Hz	0.192± 0.108	0.224± 0.164	0.175 ± 0.087	0.173± 0.125	0.194± 0.173	0.120± 0.045	0.163± 0.106	0.167± 0.084	1-2,3,4,6,7,8 <0.02; 2-3,4,5,6,7,8 <0.03; 3-5,6,7,8 <0.004
2	FY (eo), Hz	0.192± 0.108	0.148± 0.068	0.18± 0.121	0,146± 0.067	0.161± 0.070	0.140± 0.055	0.130± 0.017	0.117± 0.038	1-4,5,6,7,8 <0.006; 2-4,5, 6,7,8<0.02; 3-4,5,6,7,8 <0.005; 8-4,6<0.01

Table 1 (continued)

3	Az (eo), J	76.2± 52.2	14.3± 12.8	5.3± 3.1	5.31± 9.27	2.99± 2.22	2.87± 0.73	2.58± 0.79	2.49± 0.81	1-2,3,4,5,6,7,8 <0.04; 2-3,4,5,6,7,8 <0.01; 3-5,6,8<0.01; 8-4<0.003
4	FX (ec), Hz	0.375± 0.142	0.295± 0.116	0.217 ± 0.128	0.222± 0.142	0.233± 0.103	0.200± 0.117	0.131± 0.052	0.142± 0.111	1-2,3,4,5,6,7,8 <0.04; 2-5,7,8<0.01; 3-6,7,8<0.02
5	FY (ec), Hz	0.200± 0.135	0.201± 0.101	0.219± 0.139	0.193± 0.121	0.206± 0.100	0.180± 0.110	0.192± 0.120	0.161± 0.061	1-2,3,6,8 <0.02; 2-4,5, 6,7,8<0.01; 3-4,5,6,7,8 <0.006; 8-4,6<0.002
6	Az (ec), J	85.0± 63.5	17.7± 11.3	12.9± 9.6	7.79± 6.72	4.12± 2.51	6.70± 5.29	5.91± 1.12	3.98± 1.07	1-2,3,4, 5,6,7,8 <0,01; 2-4,5, 6,7,8<0.002; 3-5,6,8<0.01; 8-4,5,7<0.004

Note: FX (eo), Hz – main oscillation frequency in the frontal plane (X-axis), eyes open; FX (ec), Hz – main oscillation frequency in the frontal plane (X-axis), eyes closed; FY(eo), Hz – main oscillation frequency in the sagittal plane (Y-axis), eyes open; FY(ec), Hx – main oscillation frequency in the sagittal plane (Y-axis), eyes closed; Az (eo), J – ballistogram energy intensity, eyes open; Az (ec), J – ballistogram energy intensity, eyes closed

During the Romberg test with eyes open, we have found a tendency for decreasing oscillation frequency parameters both in the frontal and sagittal plane in older groups compared with the younger ones. The age-related changes in the spectral parameters were more pronounced in the estimation of the main oscillation frequency in the frontal plane when conducting the Romberg test with eyes closed. The changes in the main oscillation frequency in the sagittal plane do not so clearly reflect the age-related decrease of values, although the statistical tendency remains.

The ballistogram energy intensity analysis in both test with eyes open and test with eyes closed revealed a statistically significant reduction of values in older groups (11 years and older).

Thus, it is necessary to note an age-related reduction in the frequency power of the spectrum in the sagittal and frontal planes away from the zone of medium oscillations to the transition zone, closer to the zone of slow oscillations, which is most likely the result of a decrease in the influence of proprioceptive control.

The data obtained from the combined test of rhythmic gymnasts of different age are presented in table 2.

Table 2

Comparative description of the spectral analysis indices in the combined test of rhythmic gymnasts of different age, M±m (n=157)

№	Indices	Age								P
		3-4, n=8, (1)	5-6, n=18, (2)	7-8, n=35, (3)	9-10, n=39, (4)	11-12, n=25, (5)	13-14, n=6, (6)	15-16, n=11, (7)	17-20, n=15, (8)	
1	FX (1), Hz	0.233± 0.150	0.190± 0.114	0.197± 0.148	0.202± 0.164	0.217± 0.169	0.200± 0.129	0.163± 0.177	0.167± 0.097	1-2,3,4,5, 6,7,8<0,01; 5-6,7,8 <0,002; 8-4,5,6 <0,002
2	FY (1), Hz	0.283± 0.204	0.195± 0.156	0.164± 0.093	0.166± 0.065	0.167± 0.097	0.161± 0.084	0.155± 0.149	0.133± 0.059	1-2,3,4, 5,6,7,8<0,001; 2-5,6, 7,8<0,002; 8-4,5<0,001
3	FX (2), Hz	0.342± 0.231	0.343 ±0.136	0.378± 0.179	0.395± 0.184	0.489± 0.128	0.320± 0.205	0.413± 0.247	0.372± 0.167	-
4	FY (2), Hz	0.200± 0.104	0.214± 0.135	0.206± 0.153	0.334± 0.213	0.317± 0.158	0.300± 0.108	0.463± 0.130	0.267± 0.178	-

Note: FX (1), Hz – main oscillation frequency in the frontal plane (X-axis), static part of the test; FX (2), Hz – main oscillation frequency in the frontal plane (X-axis), dynamic part of the test; FY(1), Hz – main oscillation frequency in the sagittal plane (Y-axis), static part of the test; FY(2), Hz – main oscillation frequency in the sagittal plane (Y-axis), dynamic part of the test

During the static part of the combined test, we have found a decrease in the oscillation frequency both in the frontal and the sagittal plane in older groups compared to the younger ones. During the dynamic part, no statistically significant differences between different age groups were found.

Analysis of the ballistogram energy intensity parameters in athletes of different age during the static part of the test is presented in figure 1.

A statistically significant reduction in the ballistogram energy intensity was revealed in the athletes of older groups (1-2,3,4,5,6,7,8 $p<0.001$; 2-5,6,7,8 $p<0.004$; 8-3,4,5,6,7 $p<0.001$), which shows how energy consuming a process of maintaining a static pose was in different age groups.

Analysis of the ballistogram energy intensity parameters in athletes of different age during the dynamic part of the test is presented in figure 2.

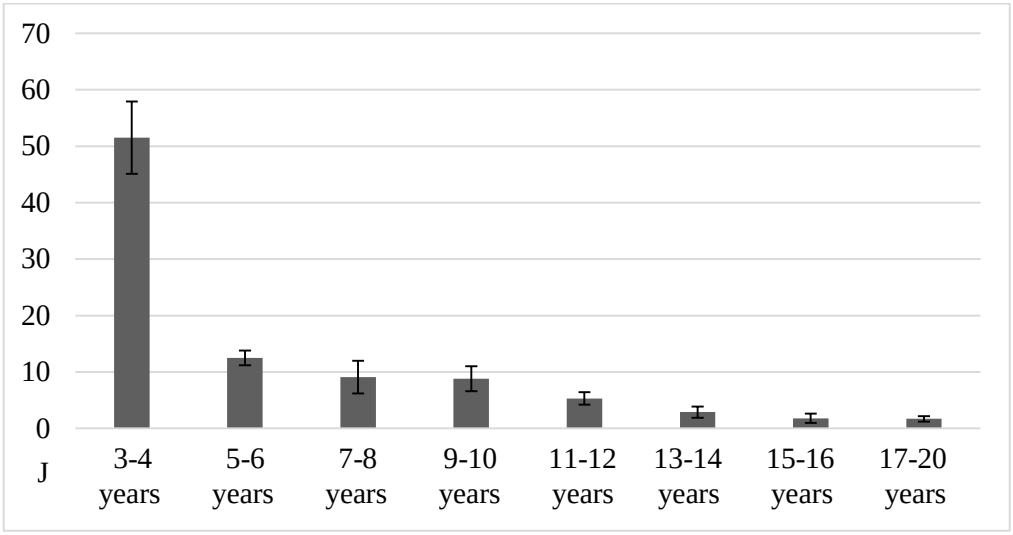

Fig. 1. Ballistogram energy intensity parameters in athletes of different age during the static part of the combined test

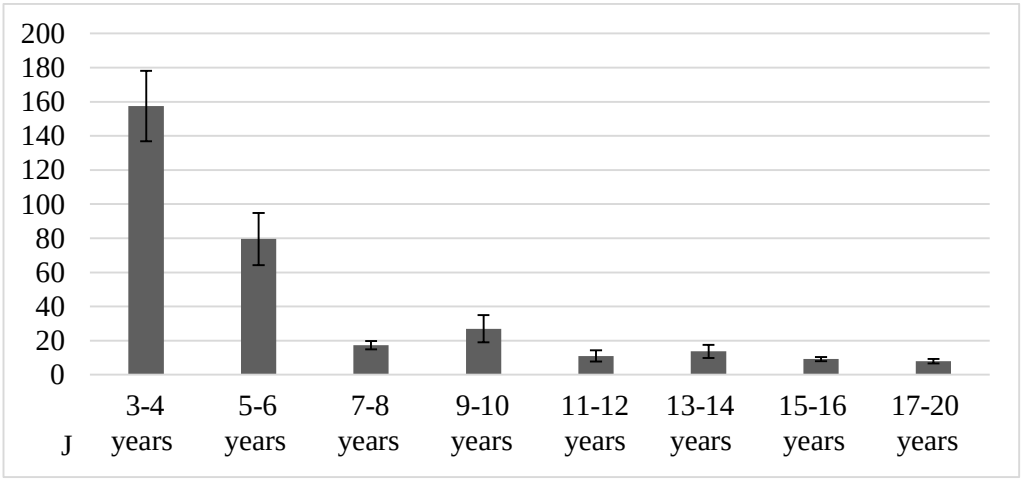

Fig. 2. Ballistogram energy intensity parameters in athletes of different age during the dynamic part of the combined test

The stabilometric analysis has revealed higher values of the ballistogram energy intensity in the athletes of younger age groups (1-2,3,4,5,6,7,8 $p<0.002$; 2-5,6,7,8 $p<0.001$; 4-5,6,7,8 $p<0.002$).

Therefore, taking into account higher values of the oscillation frequency in the frontal and the sagittal planes in the athletes of younger groups combined with higher parameters of the energy intensity index, we can speak about higher stress of their proprioceptive and somatosensory systems in holding static and dynamic pose. However, we need to consider the generally accepted classification, according to which the frequency spectrum in a range of 0-0.3 Hz corresponds with respiratory, fixative movements and can be controlled voluntarily; 0.5-1.5 Hz – result of muscle contraction, cannot be controlled voluntarily; higher than 2 Hz is practically undetectable in a healthy person [1]. Despite the difference in the frequency spectrum and the ballistogram energy intensity indices, it is worth mentioning about a high level of postural control in the athletes of younger age groups.

Conclusion. Thus, it is necessary to notice high informational value of the spectral analysis parameters when conducting a stabilometric research on athletes engaged in complex coordination sports. We have found an age-related reduction in the spectrum frequency power both in the sagittal and frontal plane from the zone of medium oscillations to the transition zone, closer to the zone of slow oscillations, which is

most likely the result of the improvement of the mechanisms of sensory and proprioceptive regulation. There was also a significant decrease in the ballistogram energy intensity in the athletes of older age groups, which indicates a more rational use of energy resources with the growth of sportsmanship.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Romanov Yu.N., Romanova L.A., Batyrshina G.R. The resarch of indices of ballistogrammy and the spectral analysis of the kickboxers in computer stabilometry. *Human. Sport. Medicine*, 2012, no. 28, pp. 44-47. (in Russ.)
2. Ivanova G.E., Skvortsov D.V., Klimov L.V. Postural function evaluation in clinical practice. *Bulletin of Rehabilitation Medicine*, 2014, no. 1, pp. 19-25. (in Russ.)
3. Malichenko A.A., Kostyuchik I.Yu., Nikolaeva Yu.V., Olenskaya T.L., Kruchinskij N.G. Stabilometry in sport: realities and prospects. *Vestnik of Polotsk State University. Part E. Pedagogic Sciences*, 2019, no. 15, pp. 142-146. (in Russ.)
4. Andreeva A.M., Mel'nikov A.A., Skvortsov D.V. Postural stability in athletes: the role of sport direction. Olympic Sports and Sports for Everyone: materials of the XXV International Scientific Congress. Minsk: 2020. pp. 41-48. (in Russ.)
5. Grakhov I.A., Zekrin F.H., Zebzeev V.V., Zekrin A.F., Vetrov V.A. Comparative analysis of stabilometric indicators of athletes of various types of martial arts. *Scientific notes of P.F. Lesgaft University*, 2019, no. 5 (171), pp. 88-93. (in Russ.)
6. Karantysh G.V. Misirov D.N., Dmitrenko L.M., Khakobyan M.A., Khovkhannisyan L.A. Diagnostic criteria for postural control of skilled and unskilled gymnasts and cheerleaders. *Human. Sport. Medicine*, 2022, vol. 22, no. S2, pp. 107-114. (in Russ.)
7. Kolokolneva K.V., Botova L.N. Analysis of stabilometric indices in elite gymnasts. Problems and Prospects of Physical Culture, Sports Training and Adaptive Physical Culture: materials of the III All-Russian Scientific and Practical Conference with international participation. Kazan: 2019. pp. 51-54. (in Russ.)
8. Koryagina Yu.V., Nopin S.V., Abutalimova S.M., Tychinina A.P. Implementation of the Sports orientation of children to rhythmic gymnastics complex to study age-related features of 4-8-year old rhyrhmic gymnasts. *Modern Issues of Biomedicine*, 2022, vol. 6, no. 4. DOI: 10.51871/2588-0500_2022_06_04_26 (in Russ.)
9. Koryagina Yu.V., Nopin S.V., Akimkina O.N. Assessment of changes in morphological status and physical qualities of 4-17-year-old girls engaged in rhythmic gymnastics. *Russian Journal of Sports Science: Medicine, Physiology, Training*, 2024, vol. 3, no. 1, pp. 7-16. DOI: 10.24412/2782-6570-2024_03_01_1 (in Russ.)
10. Medvedeva E.N., Kryuchek E.S. Modern approaches to the systematic analysis of coordination mechanisms of gymnastic exercises. *Nauchno-pedagogicheskie shkoly Universiteta*, 2021, no. 6, pp. 160-173. (in Russ.)
11. Misnikova M.O., Medvedeva E.N., Kivikharyu I.V., Suprun A.A. Features of keeping the vertical posture in the process of performing basic elements with various apparatus in rhythmic gymnastics. *Izvestiya Tula State University. Physical Culture. Sports*, 2023, no. 7, pp. 61-67. (in Russ.)
12. Serebryakov A.I. Identification of student body balance parameters with the method of stableometry. *VSU Bulletin*, 2020, no. 4. (109), pp. 85-90. (in Russ.)
13. Skrzhinskij A.M., Zhigareva S.A., Eremina E.V. Objective analysis of the performance of basic exercises in gymnastics using a stable platform. *Scientific Notes of P.F. Lesgaft University*, 2023, no. 6 (220), pp. 387-392. (in Russ.)
14. Sheshko V.V. The stabilometry method in the assessment and development of postural stability of female rhythmic gymnasts. Values, Traditions and Innovations of Modern Sports Materials of the II International Scientific Congress. Minsk, 2022. pp. 437-440. (in Russ.)
15. Bigoni M., Turati M., Gandolla M. Balance in young male football players: dominant leg versus non-dominant. *Sports sciences for health*, 2017, vol.13 (2), pp. 253-258.
16. Lemos L.F.K., de David A.K., Mota K.B. Equilíbrio postural: correlações com desempenho motor e variáveis antropométricas em crianças de 4 a 10 anos de idade. *Saúde e Desenvolvimento Humano*, 2016, vol. 4, no. 1, pp. 27-36. (in Portuguese)
17. Schmid M., Conforto S., Lopez L., Renzi P., D'Alessio T. The development of postural strategies in children: a factorial study J*ournal of Neuroengineering and Rehabilitation*, 2005, vol. 2, pp. 1-11.

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EFFECT OF HALOTHERAPY AND HEALTH PHYSICAL CULTURE ON PHYSICAL DEVELOPMENT OF PRESCHOOL CHILDREN

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Abstract. Halotherapy contributes to a stabilization of the autonomic nervous system, has a positive psychoemotional impact, sanogenic, mucolytic, bronchodraining, anti-inflammatory and immunomodulatory effect on the respiratory tract in preschool children. The objective of the study was to identify how halotherapy and health physical culture classes influence physical development and functional status of preschool children. Before and after the course of procedures, we identified the functional state of respiratory, circulatory, musculoskeletal systems, morphological status and level of physical development in 15 preschool children (age – 5.7 (5.3; 6.0) years). As a result, we have revealed that the effect of the complex on the functional state of cardiovascular, respiratory systems and adaptive reserves of preschool children was manifested in a reduced vascular tone and improved functional capabilities of the external respiration system. The course's effect on the functional status of the musculoskeletal system was shown in a reduced fat component of body mass, improved physical development, i.e. strength, flexibility, speed-strength qualities, as well as insignificant improvement in balance function.

Keywords: halotherapy, heart rate variability, anthropometry, physical parameters, state of health, boys, girls, height, weight.

Introduction. Over the last years, health of children is associated with an increased number of risk factors, functional disorders, chronic illnesses and socially significant diseases, physical development impairments, and with rapid decrease in a number of healthy children [1-2].

A great significance is attributed to physiotherapy technologies in health programs, as well as in a comprehensive rehabilitation of children with chronic illnesses. It is known that one of the most important components of natural and man-made physical factors that determine the need to include them into different therapeutic, preventive and rehabilitation complexes, is their non-specific adaptive effect on the main regulatory mechanisms, due to which a rearrangement of all body functional systems occurs [3]. A preliminary assessment of reserve capabilities of a sick child's body followed by a correction of identified disorders through proper use of physical factors allows to improve efficiency of short-term therapeutic and rehabilitation courses and prevent the "failure" of adaptation, which is relevant in terms of modern social and economic conditions. One of the non-drug methods that became popular in Russian healthcare is halotherapy (HT) – a treatment method in conditions of recreated microclimate of salt speleotherapy centers [4]. The main acting factor is the dispersion system of the air gases, in which the smallest sodium chloride particles are suspended. Dry high-dispersed sodium chloride aerosol has a sanogenic, mucolytic, bronchodraining, anti-inflammatory and immunomodulatory effect on the respiratory tract [5]. As a result, positive changes were found in the systemic humoral and cell immunity while the inflammatory process activity is reduced and antigens are eliminated from the body [6-7]. HT procedures contribute to a stabilization of the autonomic nervous system and have a positive psychoemotional impact [4].

Another health and therapeutic factor in preschool age is motor activity that plays an important role in forming the morphofunctional system, mental cognition and moral side of personality [8-9]. Physical exercise for health preservation and improvement are recommended for children who get sick frequently, it contributes to a development of cardiovascular and respiratory systems, improvement of the musculoskeletal system, correct posture and

foot position, i.e. balanced physical development.

Objective of the study: to reveal how HT and health physical culture classes impact physical development and functional status of preschool children.

Methods and organization. In July 2024, researchers of the Center of Biomedical Technologies (North-Caucasian Federal Research-Clinical Center) examined 15 preschool children (5.7 (5.3; 6.0) years), both male and female, height – 113.5 (112; 116) cm, weight – 20.5 (19; 21) kg in the "Rodnichok" Kindergarten (Essentuki). Previously, their parents (or their legal representatives) gave an informed consent in accordance with the 9th Federal law dated July 27, 2006 No 152-FZ "On personal data" for automated (and without automation) personal data processing and use, conducting research and medical interventions. A medical worker was allowed to examine the children to identify the level of physical fitness. Health therapy sessions (HT and health physical culture) took place every day for 2 weeks (10 sessions in total).

Duration of each session was 30 minutes. The sessions took place in a tent, inside which the atmosphere of a salt cave was artificially created using a Galovit device operating in the P2 mode (density of fine salt aerosol was 4 mg per m^3).

During the procedure, the children performed exercises on orthopedic massage devices watching a movie tutorial. In one session, children exercised for 3.5 minutes with massage balls, 3.5 minutes on orthopedic floor mats and 3.5 minutes on balance cushions. Between exercises the children watched cartoons for cultural and moral development.

Before and after the course we identified the children's functional status of respiratory, circulatory, musculoskeletal systems, morphological status and level of physical development.

The functional status of the cardiovascular system was determined with the ESTECK System Complex (LD Technology, USA) (fig. 1). During the anthropometric study, all the standard requirements were met. The body mass composition was registered with the bioimpedance measurement, using the same device. To study the external respiration functions, we used the CareFusion spirometer (CareFusion, USA).

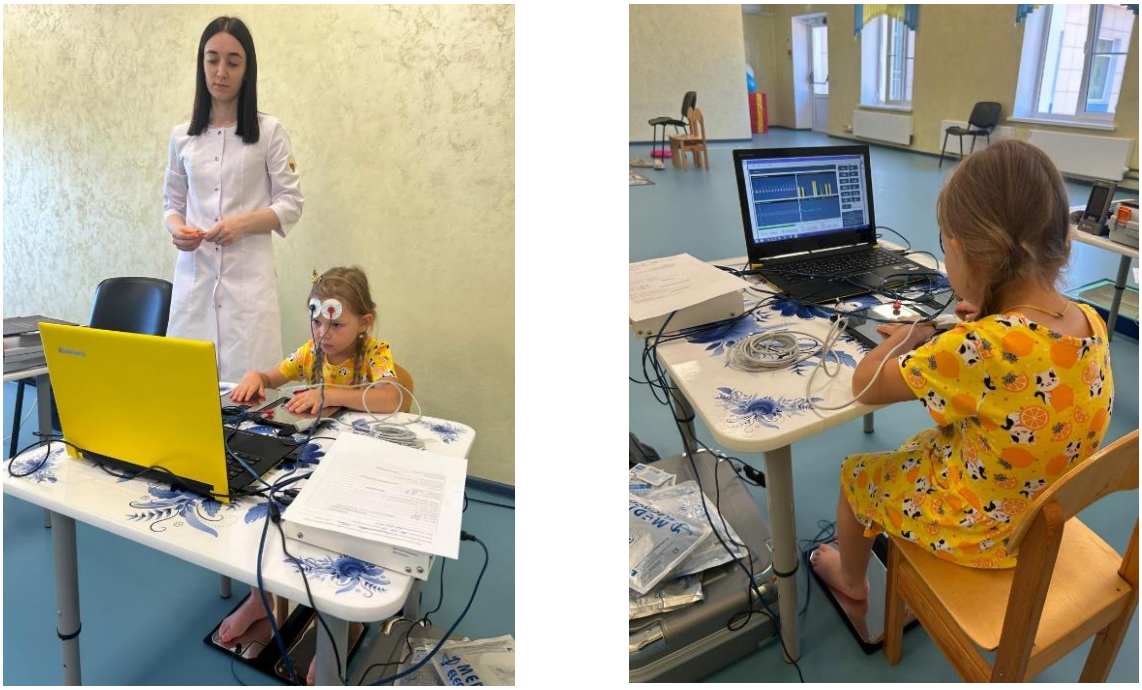

Fig. 1. Study on the ESTECK System Complex (LD Technology, USA)

Physical development study included tests for identifying wrist strength, speed-strength capabilities (standing long jump), and flexibility (seated forward bend). Maximal wrist strength was measured with the EN101 dynamometer (China).

Functional status of the musculoskeletal system was estimated with computer stabilometry (balance and muscle tone functions) (fig. 2A) and computer plantography (fig. 2B). Before the test, following parameters were measured: height, foot length and ankle-to-toe distance. Stabilometry was conducted on the ST-150 force platform, using the STPL software (Mera-TSP, Moscow) (fig. 2A). The study on the force platform was performed barefoot, with the feet placed in a "heels together" position, toes apart at an angle of 30° (European foot position). Plantography was done on the PODOSKAN – MBN device (fig. 2B). Following parameters were measured: the Godunov index (flat feet degree), the Sztriter index (%) and hallux valgus angle (°).

A B

Fig. 2. A) Study on the ST-150 force platform,
B) Study on the PODOSKAN – MBN device

The statistical data processing was carried out with the Statistica 13.0 software. We calculated standard descriptive statistics indices (median, 1st and 2nd quartiles). The indices were compared using the Wilcoxon's signed rank test. The difference deemed statistically significant when $p<0.05$.

Results and discussion. Analysis of the heart rate variability (HRV) indices associated with total functional status and adaptive reserves before and after the HT and health physical culture course (table 1) has shown, that all the values remained within the physiological norm. However, after the course we have found increased heart rate (HR), reduced power of high-frequency waves and mean square deviation of R-R intervals. Such changes may be associated with an increased stress in the children, which was caused by novelty of surroundings and interventions.

Table 1

Heart rate variability of preschool children before and after the course

№	Indices	Before	After	P<
1	HR, beats/min	98.9 (93; 109.1)	106 (92; 109)	-
2	HF, %	31.7 (30.2; 34.8)	25.1 (21; 27.1)	0.009
3	LF, %	32.65 (30.2; 56.3)	47.9 (27.8; 51)	-
4	LF/HF	1.05 (0.8; 1.6)	2.1 (1; 2.2)	0.02
5	VLF, %	28.96 (13.48; 38.02)	31.58 (26.23; 44.88)	-
6	Stress index, c.u.	161.5 (118.1; 256.2)	188.25 (128; 232.9)	-
7	SDNN, ms	48.4 (43.8; 56.4)	37.25 (33.9; 49.6)	0.02

Note: HR – heart rate; HF – power of high-frequency waves; LF – power of low-frequency waves; VLF – power of very-low-frequency waves; SDNN – mean square deviation of N-N intervals

Analysis of the cardiovascular system parameters has shown that the central hemodynamics indices, i.e. stiffness index, retraction index, augmentation index, peripheral vascular resistance, volumetric blood flow, systolic and diastolic blood pressure remained within the physiological norm, and after the course we have registered a decrease in systolic blood pressure and peripheral vascular resistance (table 2).

After the course, functional capabilities of the external respiration system also improved: vital capacity of the lungs increased (fig. 3).

Table 2

Cardiovascular system indices of preschool children before and after the course

№	Indices	Before	After	P<
1	Stiffness index, m/s	4.4 (4.06; 4.78)	4.12 (4; 4.37)	-
2	Retraction index, %	30 (25; 30)	27.5 (25; 30)	-
3	Augmentation index, c.u.	1.03 (0.95; 1.1)	1.1 (0.95; 1.1)	-
4	PVR, MPa*c/m³	1816.5 (1678.4; 1970.4)	1581.7 (1508.8; 2608.7)	-
5	Cardiac output, l/min	3.55 (3.4; 3.7)	3.6 (2.5; 3.8)	-
6	CI, l/min/m^2	4.4 (4.1; 4.6)	4.35 (2.8; 5.1)	-
7	meanBP, mm Hg	78.5 (71.3; 88.7)	71.7 (70; 74.7)	-
8	sBP, mm Hg	106 (97; 112)	93 (90; 96)	0.005
9	dBP, mm Hg	67 (55; 77)	62 (60; 65)	-

Note: PVR – peripheral vascular resistance; meanBP – mean blood pressure; CI – volumetric blood flow; sBP – systolic blood pressure; dBP– diastolic blood pressure

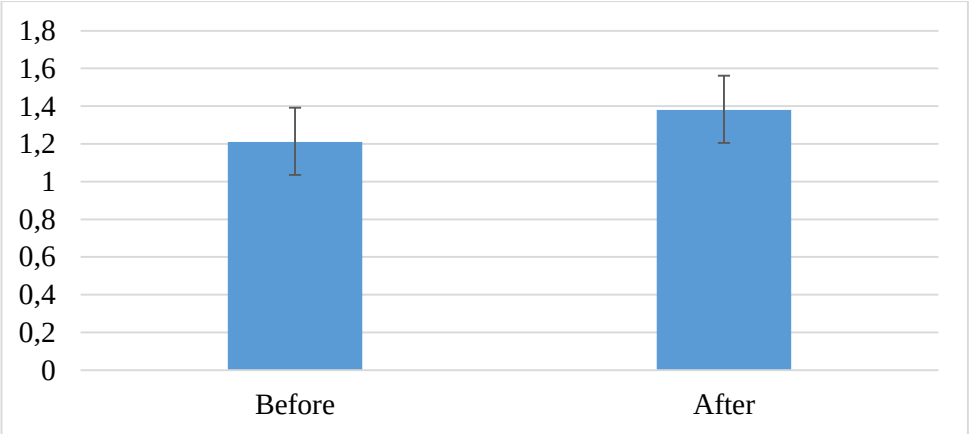

Fig. 3. Vital capacity of the lungs in preschool children before and after the course, l

Therefore, the effect was manifested in a decreased vascular tone and improved functional capabilities of the external respiration system.

Comparison of body mass composition using bioimpedance measurement has shown that after the course children had lost some weight, had increased body mass index and total body water (table 3). Also parameters of physical development have improved: left and right wrist length, flexibility (seated forward bend) and speed-strength qualities (standing long jump) (table 4).

In terms of stabilometry parameters, slight changes were registered: statokinesiogram length, mean velocity of the total pressure center, mean X-axis pressure center position (in the frontal plane), mean square deviation of the X-axis pressure center position and mean square deviation of the Y-axis pressure center position decreased, but mean Y-axis pressure center position increased (table 5). Plantographic foot assessment showed minor flat feet in almost all children (grade 1 flat feet) participating in the study. Plantographic indicators: Godunov foot score and hallux valgus angle did not change significantly, which is probably due to the short duration of the course.

Table 3

Body composition indices of preschool children before and after the course

№	Indices	Before	After	P<
1	Fat-free mass, kg	17.55 (16.8; 19.3)	17.5 (16.9; 20.1)	-
2	Fat mass, kg	15.9 (7.1; 17)	13.5 (5.9; 17)	0.01
3	Total body water, %	61.55 (60.8; 68)	65.5 (60.8; 68.9)	0.01
4	Body mass index, c.u.	25.65 (25.3; 28.3)	27.3 (25.3; 28.7)	0.01
5	Muscle mass, kg	15.95 (15.1; 16.5)	15.7 (14.3; 16.2)	0.01
6	Phase angle, °	6.7 (6.7; 7)	6.6 (6.4; 7)	-

Table 4

Physical development indices of preschool children before and after the course

№	Indices	Before	After	P<
1	Standing long jump, cm	116.5 (101; 124)	119.5 (108; 128)	0.005
2	Seated forward bend, cm	4.5 (2; 6)	5 (4; 6)	-
3	Right hand dynamometry, kg	7.9 (6.5; 8.7)	8.95 (8.8; 9.8)	0.005
4	Left hand dynamometry, kg	7.05 (6.2; 7.3)	7.65 (6.8; 8.7)	0.01

Table 5

Stabilometry indices of preschool children before and after the course

№	Indices	Before	After	P<
1	L, mm	582.35 (507.3; 631.7)	513.5 (376.5; 731.3)	-
2	V, mm/s	19.4 (16.9; 21.1)	17.15 (12.5; 24.3)	-
3	S, mm²	442.25 (289.6; 1106.2)	495.45 (304.8; 1186.4)	-
4	X, mm	0.25 (-2.4; 1.3)	-5.15 (-6.3; -3.2)	0.01
5	Y, mm	14.65 (5.5; 20.7)	27.3 (20.7; 37.8)	0.01
6	x, mm	6.6 (5.9; 8.1)	5.45 (5.1; 6.4)	-
7	y, mm	6.1 (5.2; 10.1)	5.75 (5.4; 13.1)	-
8	FX, Hz	0.1 (0.1; 0.1)	0.1 (0.1; 0.2)	-
9	FY, Hz	0.1 (0.1; 0.2)	0.1 (0.1; 0.2)	-

Note: L – statokinesiogram length; V – mean velocity of the total pressure center; S – statokinesiogram surface area; P – statokinesiogram power; X – mean X-axis pressure center position (frontal plane); Y – mean Y-axis pressure center position (sagittal plane); x – mean square deviation of the X-axis pressure center position; y – mean square deviation of the Y-axis pressure center position; FX – basic oscillation frequency along the X axis; FY – basic oscillation frequency along the X axis

Table 6

Plantography indices of preschool children before and after the course

Indices		Indices	Before	Norm
Godunov index, degree	Left	1 (1; 3)	1 (1; 2)	0
	Right	1 (1; 3)	1 (1; 2)	0
Hallux valgus angle, °	Left	16 (15; 17)	15 (11; 16)	4±9
	Right	16 (15; 17)	14.5 (7; 17)	4±9

Therefore, effects of HT and health physical culture on the functional status of the musculoskeletal system of preschool children was shown in a decrease of fat mass component, improved physical development, i.e. flexibility and speed-strength qualities, as well as insignificant improvement of the balance function.

Conclusion. The conducted studies with HT and health physical culture on preschool children have shown a proven positive effect on the functional status of cardiovascular, respiratory systems, body mass composition and physical development of the children.

According to the results, after the course of health procedures every day for 2 weeks (10 sessions total) with recreation of a climate similar with one of a salt cave, and a set of exercises with orthopedic massage devices, we have registered the effect on the functional status of cardiovascular, respiratory systems and adaptive reserves of preschool children, which was manifested in a decreased vascular tone and improved capabilities of the external respiration.

Influence on the functional status of the musculoskeletal system of preschool children was shown in a decreased fat mass component, improved physical development, i.e. strength, flexibility and speed-strength qualities, as well as insignificant improvement of the balance function. Such changes were caused by an enhancement of mechanisms of muscle and vestibular coordination due to exercise on orthopedic massage devices.

The aforementioned changes were due to a combined application of HT and health physical culture, which thanks to comparant and potentiating effects have a general health-improving and therapeutic effect. It is especially helpful for children who get sick very often, since improvement of functional capabilities of body systems contributes to an increase of adaptive potential, prevention of possible illnesses and balanced morphofunctional development.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Preventive pediatrics. Guide for doctors. Baranov A.A., Namazova-Baranova L.C., ed. Moscow: Pediatr, 2015. 744 p. (in Russ.)

2. Kuchma V.R., Zvezdina I.V., Zhigareva N.S. Medical-social aspects of health forming in children in junior school. *Current Pediatrics*, 2008, vol. 7, no. 4, pp. 9-12. (in Russ.)

3. Konova O.M., Dmitrienko E.G., Dmitrienko T.G., Sakharova E.V., Mamedyarov A.M., Taybulatov N.I. Aromaphytobalneotherapy in treatment and prophylaxis of frequent respiratory infections in children with chronic and disabling diseases. *Pediatric Pharmacology*, 2016, vol. 13, no. 5, pp. 482-487. (in Russ.)

4. Chervinskaya A.V., Konova O.M., Khan M.A. Halotherapy for prevention and medical rehabilitation in pediatric health care. *Current Pediatrics*, 2017, no. 16 (5), pp. 406-412. DOI: 10.15690/vsp.v16i5.1805. (in Russ.)

5. Sanatorium-resort treatment: national guide. Razumov A.N., Staroduboc V.I., Ponomarenko G.N. Moscow: GEOTAR-Media, 2021. 752 p.

6. Khan M.A., Ivanova I.I., Mikitchenko N.A., Dedyurina A.V., Lyan N.A. Halotherapy in the rehabilitation of children in educational institutions. *Physiotherapist*, 2020, no. 2, pp. 30-36. (in Russ.)

7. Khan M.A., Liang N.A., Korchazhkina N.B., Chervinskaya A.V., Ivanova I.I. Halotherapy in pediatric practice. *Physiotherapist*, 2019, no. 6, pp. 15-24. (in Russ.)

8. Kopejkina T.E. Health physical culture for pre-school children: learning guide. Arkhangelsk: SAFU, 2019. 102 p. (in Russ.)
9. Tychinina A.P., Koryagina Yu.V., Akimkina O.N. Comparative and structural analysis of physical development indices of girls of the first and second childhood. *Russian Journal of Sports Science: Medicine, Physiology, Training*, 2024, vol. 3, no. 1. Available at: https://intsport.ru/en/journal-issues/2024-1e/tychinina2024e (accessed 03.06.2024)

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EFFECTS OF IMPLEMENTING A THERAPEUTIC PHYSICAL CULTURE PROGRAM FOR OSTEOCHONDROSIS OF THE LUMBAR SPINE IN A FITNESS CENTER

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Abstract. The article presents the effects of implementing the program of therapeutic physical training for osteochondrosis of the lumbar spine in a fitness center. The 6-month study took place in a fitness center and included 30 men and women aged 35-45 years with osteochondrosis of the lumbar spine, confirmed with ray diagnosis data (X-ray, computed tomography or magnetic resonance imaging) and a doctor's medical report. The studied parameters changed reliably ($p<0.05$): the range of active movements in the lumbar spine improved by 40.6-64.1% according to goniometry, the intensity of pain syndrome according to visual analogue scale decreased by 65.1-68.1%, the functional test results improved in the range of 61.5-85.3%, the degree of disability according to the Osvestry questionnaire decreased by 58.6%. The results obtained after implementing the program of therapeutic physical training in a fitness center reflect its effectiveness in osteochondrosis of the lumbar spine.

Keywords: therapeutic physical training, osteochondrosis of the lumbar spine, fitness center.

Introduction. Osteochondrosis of the lumbar spine is one of the most common pathologies of the musculoskeletal system, affecting up to 90% of the population over 30 years of age. These diseases are characterized by degenerative-dystrophic changes in the intervertebral discs, ligamentous apparatus and muscles of the trunk, which leads to severe pain syndrome, limited mobility and a decrease in the quality of patient's life [1-3].

The highest incidence of osteochondrosis of the lumbar spine is observed among people of working age (35-45 years), which causes significant economic losses to society due to temporary and permanent loss of ability to work. Modern sedentary lifestyle, excessive static and dynamic loads on spine and excessive body weight are the main risk factors for the development of this pathology [4].

Despite the wide range of conservative and surgical methods of treating osteochondrosis, the leading role in restoring the functional state of patients is played by health-improving motor programs [1, 2, 5]. However, existing rehabilitation programs don't always take into account the individual characteristics of the signs of the disease, the level of physical fitness and motivation of patients, as well as the conditions for carrying out health improving measures.

The problem of the study is the insufficient effectiveness of standard approaches to therapeutic physical training of people aged 35-45 with osteochondrosis of the lumbar spine in fitness centers. There is a need to develop a program of therapeutic measures based on the combined use of various means and forms of motor therapy, taking into account the specifics of the disease and the capabilities of the fitness industry.

Aim of the study: to determine the effectiveness of the implementation of a program of therapeutic physical training for osteochondrosis of the lumbar spine in a fitness center.

Methods and organization. The study was conducted at the World Class Kashirskij fitness center during 6 months, with the inclusion of 30 fitness center clients aged 35-45 years with a diagnosis of "osteochondrosis of the lumbar spine", confirmed by radiation diagnostic data (X-ray, computed tomography or magnetic resonance imaging (MRI)) and a doctor's medical report.

Criteria for inclusion of participants in the study: gender – men and women; age – 35-45 years; diagnosis – osteochondrosis of the lumbar spine, stage II according to Osna-Popelyansky; period of the disease – chronic relapsing course outside of exacerbation; intensity of pain syndrome according to the visual analogue scale (VAS) – no higher than 40 mm; absence of contraindications to physical rehabilitation and hydro-kinesiotherapy; informed voluntary consent to participate in the study.

Exclusion criteria: presence of concomitant diseases in the acute or decompensated stage (arterial hypertension, ischemic heart disease, diabetes mellitus, etc.); history of injuries and surgeries on the spine; signs of spinal stenosis and sequestered intervertebral disc herniation according to MRI data; severe radicular and pain syndrome requiring drug correction; presence of contraindications to physiotherapy, therapeutic physical culture, massage; regular classes in other therapeutic physical culture routines or swimming at the time of the research.

The research methods included: assessment of pain intensity according to VAS (mm); goniometry to determine the mobility of the lumbar spine (degrees); functional tests (Schober test, fingertip-to-floor test, back (s) and abdominal (s) muscle endurance test); assessment of life activity disorders according to the Oswestry questionnaire (points). Statistical methods were used for mathematical processing of the data, the following indicators were calculated: arithmetic mean (M), standard deviation (σ). The data were checked for normality of distribution with the Kolmogorov-Smirnov test. The reliability of differences between groups and within groups was assessed using Student's T-test for dependent and independent samples, differences were considered statistically significant at $p<0.05$. Calculations were performed using the Microsoft Excel 2019.

Participants were divided into two equal groups: the main group (MG, n=15) and the control group (CG, n=15). Distribution into groups was carried out by simple randomization using a random number generator. Classes in both groups were held 3 times a week for 60 minutes for 24 weeks. Participants in the CG were engaged in a standard health program of the fitness center. The program was designed for 8 weeks and included general health classes in the gym and the pool.

The participants of the MG were trained according to the developed program of therapeutic physical culture (TPC) for osteochondrosis of the lumbar spine, consisting of 3 periods, including therapeutic gymnastics, health-improving means of physical culture (hydro-kinesiotherapy, training on exercise machines), massage and myofascial release. The preparatory period (2 weeks) included group classes in aqua aerobics (2 times a week for 45 minutes) and Pilates (1 time a week, 60 minutes). Aqua aerobics classes were held in a deep-water pool using support equipment (noodles, aqua belts) aimed at increasing overall endurance and strengthening the main muscle groups. Pilates classes included stretching, breathing exercises, and relaxation elements performed from the starting positions of standing, sitting, and lying on a mat. In the main period (4 weeks), the program was supplemented with strength training in the gym (2 times a week for 60 minutes), including basic exercises on exercise machines for the main muscle groups (leg press, bench press, upper block pull, leg extension while sitting) in 2-3 sets of 10-15 repetitions with moderate weights. Aqua aerobics (1 time per week) and Pilates (1 time per week) classes continued. In the final period (2 weeks), strength training in the gym was reduced to once a week, aqua aerobics and Pilates classes were held with the same frequency, and basic elements of aqua stretching were additionally mastered (1 class per week, 45 minutes), aimed at improving flexibility and joints mobility.

Results and discussion. The effects of TPC are presented in the dynamics of the studied indicators (table 1-4).

Results of goniometry of the lumbar spine in the main (MG) and control (CG) groups before and after the course of therapeutic physical culture are shown in table 1.

Table 1

Dynamics of the range of motion in the lumbar spine according to goniometry data before and after the use of TPC (M±σ), °

Spinal movements	Group	Before	After	P<
Flexion	MG	34.8±8.2	52.2±6.4	0.05
	CG	35.2±8.6	43.1±7.3	0.05
Extension	MG	13.1±4.5	21.5±3.8	0.05
	CG	13.4±4.8	16.8±4.2	0.05
Side bend to the right	MG	13.8±3.7	19.4±2.9	0.05
	CG	14.1±4.0	16.3±3.5	-
Side bend to the left	MG	14.3±3.9	20.1±3.1	0.05
	CG	14.6±4.2	17.0±3.7	-

Note: TPC – therapeutic physical culture; MG – main group; CG – control group

The initial values of the lumbar spine flexion amplitude were 34.8±8.2° in the MG and 35.2±8.6° in the CG, indicating a significant limitation of mobility. The extension amplitude was significantly reduced and was 13.1±4.5° in the MG and 13.4±4.8° in the CG. The amplitude of side bend to the right was 13.8±3.7° in the MG and 14.1±4.0° in the CG, to the left – 14.3±3.9° in the MG and 14.6±4.2° in the CG, indicating significant disruption of the lateroflexion of the spine.

After TPC the flexion volume significantly ($p<0.05$) increased by 49.9% in the MG and by 22.4% in the CG, reaching 52.2±6.4° and 43.1±7.3°, extension significantly ($p<0.05$) increased by 64.1% in the MG and by 25.4% in the CG, reaching 21.5±3.8° and 16.8±4.2°, respectively. The volume of lateral bending to the right significantly ($p<0.05$) increased by 40.6% in the MG, reaching 19.4±2.9°. In the CG, the increase was 15.6% and was statistically insignificant. The amplitude of lateroflexion to the left increased by 40.6% ($p<0.05$) in the MG and by 16.4% in the CG, reaching values of 20.1±3.1° and 17.0±3.7°.

The VAS was used to study the dynamics of pain syndrome in the MG and CG during the implementation of TPC (table 2). Pain intensity was assessed before the course, in the middle (after 3 weeks) and after its completion. The subjects noted the average level of pain in the lumbar region at rest and during movement over the past three days.

Table 2

Dynamics of pain intensity according to VAS in patients of the MG and CG before, in the middle and after the application of TPC (M±σ), mm

Indicator	Group	Before	Middle	After	P<
Pain at rest	MG	38.5±10.2	25.4±8.6	12.3±6.4	0.001
	CG	37.9±9.8	31.2±9.1	23.7±7.5	0.01
Pain when moving	MG	62.7±12.4	41.8±10.5	21.9±7.8	0.001
	CG	61.5±11.9	52.6±10.8	39.2±9.4	0.01

Note: TPC – therapeutic physical culture; VAS – visual analogue scale; MG – main group; CG – control group

Before the start of TPC, the pain intensity at rest was 38.5±10.2 mm in the MG and 37.9±9.8 mm in the CG, which corresponds to moderate pain syndrome. In the middle of the course, the pain index significantly ($p<0.05$) decreased by 34.0% in the MG and by 17.7% in the CG, reaching values of 25.4±8.6 mm and 31.2±9.1 mm, respectively. After completion of the TPC program, pain at rest decreased by 68.1% ($p<0.001$) in the MG and by 37.5% ($p<0.01$) in the CG, reaching the level of mild pain – 12.3±6.4 mm and 23.7±7.5 mm.

The initial values of pain intensity during movement were 62.7±12.4 mm in the MG and 61.5±11.9 mm in the CG, indicating severe pain syndrome. In the middle of the TPC course, the indicator significantly ($p<0.05$) decreased by 33.3% in the MG and by 14.5% in the CG, reaching 41.8±10.5 mm and 52.6±10.8 mm, respectively. After completing the program, pain during movement decreased by 65.1% ($p<0.001$) in the MG and by 36.3% ($p<0.01$) in the CG, reaching the level of mild and moderate pain – 21.9±7.8 mm and 39.2±9.4 mm.

The results of functional testing of patients in the MG and CG before and after the course of TPC are presented in table 3.

The initial values of the Schober test were 2.6±0.8 cm in the MG and 2.7±0.9 cm in the CG, indicating a significant limitation of the mobility of the lumbar spine. After the TPC course, the indicator significantly ($p<0.001$) increased by 61.5% in the MG and by 25.9% ($p<0.05$) in the CG, reaching values of 4.2±0.6 cm and 3.4±0.7 cm, respectively. The initial distance in the "fingertip-to-floor" test increased significantly – in the MG 18.4±6.3 cm and in the CG 17.9±5.8 cm, indicating a pronounced impairment of the flexibility of the spine and hamstring muscles. After TPC, the indicator significantly ($p<0.001$) decreased by 66.3% in the MG and by 35.8% ($p<0.01$) in the CG, reaching 6.2±4.1 cm and 11.5±4.6 cm, reflecting an increase in spine flexibility.

Table 3

Dynamics of functional test indicators in patients of the MG and CG before and after the use of TPC (M±σ)

Test	Group	Before	After	P<
Schober test, cm	MG	2.6±0.8	4.2±0.6	0.001
	CG	2.7±0.9	3.4±0.7	0.05
Fingertip-to-floor test, cm	MG	18.4±6.3	6.2±4.1	0.001
	CG	17.9±5.8	11.5±4.6	0.01
Back muscle endurance test, s	MG	28.5±12.4	52.8±14.6	0.001
	CG	29.2±11.7	38.6±12.9	0.05
Abdominal muscle endurance test, s	MG	32.7±11.8	58.3±12.2	0.001
	CG	33.4±12.3	44.9±11.5	0.05

Note: TPC – therapeutic physical culture; MG – main group; CG – control group

The initial body holding time in the back muscle endurance test in the MG was 28.5±12.4 s, in the CG 29.2±11.7 s, reflecting the weakness of the muscular corset. After TPC, the indicator significantly ($p<0.001$) increased by 85.3% in the MG and by 32.2% ($p<0.05$) in the CG, amounting to 52.8±14.6 s and 38.6±12.9 s. The body holding time in the abdominal muscle endurance test before TPC was 32.7±11.8 s in the MG and 33.4±12.3 s in the CG. After completion of TPC, the indicator significantly ($p<0.001$) increased by 78.3% in the MG and by 34.4% ($p<0.05$) in the CG, reaching values of 58.3±12.2 s and 44.9± 11.5 s.

The exploration of the dynamics of functional limitations and life activity disorders in the CG and MG was conducted using the Oswestry questionnaire (table 4).

Before the start of TPC, both groups of subjects had a high level of disability associated with lower back pain. The total score on the Oswestry questionnaire was 26.3±8.2 points in the MG and 25.3±7.6 points in the CG, which corresponds to significant limitations. Patients experienced the greatest difficulties when lifting, standing, walking, and sitting. Pain syndrome significantly reduced the quality of sleep, limited sexual activity, and the ability to participate in social

life. After the course of exercise therapy, both groups showed a statistically significant ($p<0.05$) reduction in life activity disorders in most sections of the Oswestry questionnaire, with the exception of sex life in the CG.

Table 4

Dynamics of the Oswestry questionnaire indicators in the MG and CG before and after the use of TPC (M±σ), points

Phase	Group	Before	After	P<
Pain intensity	MG	2.8±0.9	1.2±0.6	0.001
	CG	2.7±0.8	1.9±0.7	0.01
Personal care	MG	2.1±0.8	0.8±0.5	0.001
	CG	2.0±0.7	1.4±0.6	0.05
Lifting	MG	3.2±1.1	1.4±0.7	0.001
	CG	3.1±1.0	2.2±0.8	0.05
Walking	MG	2.5±0.9	0.9±0.6	0.001
	CG	2.4±0.8	1.6±0.7	0.01
Sitting	MG	2.7±1.0	1.1±0.7	0.001
	CG	2.6±0.9	1.8±0.8	0.05
Standing	MG	3.0±1.2	1.3±0.8	0.001
	CG	2.9±1.1	2.1±0.9	0.05
Sleeping	MG	2.4±0.9	1.0±0.6	0.001
	CG	2.3±0.8	1.6±0.7	0.05
Sex life	MG	2.2±1.1	0.9±0.7	0.001
	CG	2.1±1.0	1.5±0.8	-
Social life	MG	2.6±1.0	1.1±0.8	0.001
	CG	2.5±0.9	1.8±0.8	0.05
Travelling	MG	2.8±1.2	1.2±0.9	0.001
	CG	2.7±1.1	1.9±1.0	0.05
Total	MG	26.3±8.2	10.9±5.4	0.001
	CG	25.3±7.6	17.8±6.3	0.01

Note: TPC – therapeutic physical culture; MG – main group; CG – control group

However, the degree of improvement in the functional state was significantly higher in patients in the MG compared to the CG. Thus, the total score on the questionnaire decreased in the MG by 58.6% (from 26.3±8.2 points to 10.9±5.4 points), in the CG – by 29.6% (from 25.3±7.6 points to 17.8±6.3 points). The most pronounced positive dynamics in the MG were noted in relation to pain intensity (decrease by 57.1%), walking (improvement by 64.0%) and personal care (improvement by 61.9%). In the CG, these indicators improved by 29.6%, 33.3% and 30.0%.

Conclusion. The effectiveness of the TPC program in the MG showed that its use in individuals aged 35-45 years with osteochondrosis of the lumbar spine led to a statistically significant ($p<0.05$) improvement in all the studied parameters. The range of active movements in the lumbar spine according to goniometry data improved by 40.6-64.1%, the intensity of pain syndrome according to VAS decreased by 65.1-68.1%, the indicators of functional tests improved in the range of 61.5-85.3%, the degree of impairment of life activity according to the Oswestry questionnaire decreased by 58.6%.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Bandakov M.P., Ignatova A.A. Physical rehabilitation for osteochondrosis of the lumbar spine. Psychological and pedagogical technologies physically: integration of science and practice: materials of the VI International correspondence scientific and practical conference, Kirov, May 26-27, 2016. Vyatka State University, Pedagogical Institute. Kirov: Limited Liability Company "Raduga-PRESS", 2016. pp. 13-17. (in Russ.)
2. Korovin V.V., Lunina N.V. Dynamics of lower limb muscle strength in 45-59-year-old women with lumbosacral spine extrusion at the polyclinic stage of physical rehabilitation. Therapeutic physical education and sports medicine: traditions and innovations: Proceedings of the IX All-Russian scientific and practical conference with international participation, dedicated to the Year of Science and Technology in the Russian Federation, Moscow, May 20, 2021. Miroshnikov A.B., Ermolaeva Yu.A., ed. Moscow: Russian State University of Sport "GTSOLIFK", 2021. pp. 63-67. (in Russ.)
3. Lunina N.V., Patrina S.G. Stato-dynamic indices of the functional state of the muscular corset of students of the special medical division. Physical education in the system of professional education: ideas, technologies and prospects: materials of the II All-Russian scientific and practical conference, Omsk, April 13-14, 2017. Omsk: Omsk Armored Engineering Institute, 2017. pp. 63-67. (in Russ.)
4. Mohd Isa I.L., Teoh S.L., Mohd Nor N.H., Mokhtar S.A. Discogenic Low Back Pain: Anatomy, Pathophysiology and Treatments of Intervertebral Disc Degeneration. Int J Mol Sci, 2022, vol. 24, no. 1, p. 208.
5. Biryukov A.A., Lunina N.V. Massage and therapeutic physical culture. Moscow: Publishing center "Academy", 2019. 288 p. (in Russ.)

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BIOCLIMATIC, LANDSCAPE AND RECREATIONAL POTENTIAL OF ZHELEZNOVODSK FROM THE POINT OF HEALTH PHYSICAL CULTURE

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Abstract. Aim of the study – to examine and estimate microclimate indices, landscape and recreational potential of Zheleznovodsk sanatoriums' territory. The study materials included route and climatic observation data, climate reference materials, guiding documents, building codes, international technical standards, state reports and scientific articles. The conducted analysis has shown that microclimate indices were within the normal values and have a favorable effect on a human body due to a high level of light negative air ions, territory luminance, low ion unipolarity coefficient, humidity and carbon dioxide content. Abundant flora on the territories of sanatoriums and the town provides a high level of bioclimatic, landscape and recreational potential for health physical culture.

Keywords: Zheleznovodsk, climate, microclimate indices, bioclimate, bioclimatic potential, landscape and recreational potential, health tourism, physical culture, health physical culture.

Introduction. Zheleznovodsk is one of resort towns of federal importance located in Caucasian Mineral Waters (CMW). This region is widely known for sanatorium-resort treatment and attracts tourists with its unique recreational resources [1-2]. One of the main therapeutic resources of CMW sanatoriums is favorable climate, which has been studied by ecologists for a long time [3]. On this territory, the favorable climate is created due to its geographical position – it provides sufficient solar radiation, which creates favorable air temperature due to the location of the Zheleznaya Mountain within the town, which is a natural monument of Stavropol Krai. It is covered with broad-leaved forest [4], which ensures high oxygen saturation of the neighboring areas [5]. Moreover, the mountain has a large number of mineral water springs. All this attracts a lot of tourists for sanatorium-resort treatment and health improvement. One of the most promising types of health improvement is terrain cure therapy or healthy walking.

The study of the climatic potential of sanatorium territories is relevant in relation with the decree of the Government of the Russian Federation dated 27.05.2024 No 681 "On the preparation and issuance of special medical assessment".

Aim of the study – to examine microclimate characteristics, landscape and recreational potential of the Zheleznovodsk sanatoriums' territories.

Methods and organization. The study and measurement of Zheleznovodsk sanatoriums' territories (Zheleznovodsk Clinic, N.K. Krupskaya Children Sanatorium, 30th Victory Anniversary Sanatorium, Salyut Sanatorium, Ernst Thälmann Sanatorium), which are located in different parts of the town (on the southern and south-eastern slopes of the Zheleznaya Mountain, close to the resort park and resort lake), was carried out under the agreements on preparation of special medical assessments.

The study materials included results of route and climatic observation, climate reference materials, guiding documents, SNIPs (building codes), GOSTs (international technical standards), state reports, scientific articles.

The route and climatic observation was carried out on July 16 and August 9, 2024. It included measurement of positive and negative light air ion concentration (with the mobility of $K>0.5$ $cm^2/V \cdot s$), quantities of aerosol particles of different size gradations (8 gradations in the range from 0.2 to 10 μm) in the surface atmosphere (at the respiratory level

of 1.5 m), air temperature and humidity, wind speed and direction, cloud amount and shape, ambient dose equivalent rate (ADER) of gamma radiation. We also estimated the condition of orography, flora and natural panoramas in accordance with the recommendations.

Following devices were used in the study: MAC-01 light-sized air ion counter with computer software (State Register of measuring instruments No 20429-11), Meteoscope-M with computer software, RadiaSkan-801 radiation dosimeter with computer software (State Register of measuring instruments No 69478-17), SAChM 4801-01 aerosol analyzer, a mobile version (State Register of measuring instruments No 676936-19-19), and DT-1309 light meter (6015 80 990 0, EAEU CN of FEA).

Results and discussion. Microclimate indices were measured in several locations in the territory of each sanatorium. The average value of indices for each sanatorium are presented in table 1.

Table 1

Microbioclimate indices of the Zheleznovodsk sanatoriums' territories

№	Microbioclimate indices						
	T, °C	RH, %	AP, hPA	O_2, %	CO_2, ppm (number of units/million)	∑ [(N-)+(N+)] /IUC, background	O/T, klx
30th Victory Anniversary Sanatorium	31.50	29.88	715.50	20.68	380.00	1575/0.94	25.05/6.67
Salyut	34.06	24.44	712.60	20.63	388.86	1430/1.1	24.72/6.37
Zheleznovodsk Clinic	33.50	23.50	709.00	20.70	373.00	1220/0.9	25.00/6.02
N.K. Krupskaya Children Sanatorium	34.88	21.82	706.04	20.64	364.14	1446/1.28	24.54/6.37
Ernst Thälmann Sanatorium	31.88	34.50	706.56	20.90	358.53	1342.5/0.63	18.47/9.44

Note: T, °C – air temperature; RH, % – relative humidity; AP, hPa – air pressure; O_2, % – relative oxygen content in the surface atmosphere; CO_2, ppm, number of units/million – relative carbon dioxide content in the surface atmosphere; ∑[(-) + (+)] / IUC (ion unipolarity coefficient) – air ionization background, ion/cm^3; O/T – luminance (klx), in the open (O), and under the tree crown (T)

We have registered favorable values of microclimatic indices, except for high air temperature (31.50-34.88), because the research takes place during the hottest months (July, August). The average temperature during these months in Zheleznovodsk is 21.0 and 20.6 °C respectively [6]. The lowest temperature was registered in the 30th Victory Anniversary Sanatorium's territory because of its location on the shores of the resort lake. Due to the low relative humidity, no negative effects of high temperature [7-8] were observed.

Carbon dioxide content values were also within (358.53-388.86) the norm (up to 450), the oxygen content in the surface atmosphere reaches 20.9%, which ensures a low level of atmospheric pollution of sanatorium territories by exhaust gases.

High level of air ionization (1342.5-1575) in the surface atmosphere due to the high level of landscaping of sanatorium territories and substances emitted by them, low ion unipolarity coefficient (0.63-1.28) reflect high health properties of the air in these territories. Light negative air ions provide an effective prevention and treatment of diseases of different organs and systems, such as endocrine system [9], skin (dermatitis) [10] et al.

The same plants (fig. 1) as on the Zheleznaya Mountain itself were found in the

territories of the sanatoriums, i.e oak, maple tree, common linden, blue spruce, European spruce and other ornamental shrubs. Aside from light negative air ions, they also emit phytoncides, which provide reduction of toxic gases in the atmosphere [11] and have antibacterial properties [12]. Trees and shrubs fulfil a landscape-forming function and provide aesthetic pleasure and relaxation while being outdoors in nature.

The total level of aerosol particles in the size range of 0.2 to 10 μm reached the highest values (76803 particles/l) in the 30th Victory Anniversary Sanatorium's territory (fig. 2). Such aerosol content corresponds to particularly favorable conditions.

Such high aerosol content may be associated with the sanatorium's location at an altitude of 507-516 meters above sea level close to the resort lake, which makes it difficult to ventilate the territory and ensures the accumulation of aerosol particles, including those emitted by plants (pollen). At this time sun flower and hazel, weeds such as elderberry, saltbush, wormwood and common ragweed are actively flowering [13]. For people with allergy it is recommended to limit their time outdoors and pay special attention to their well-being.

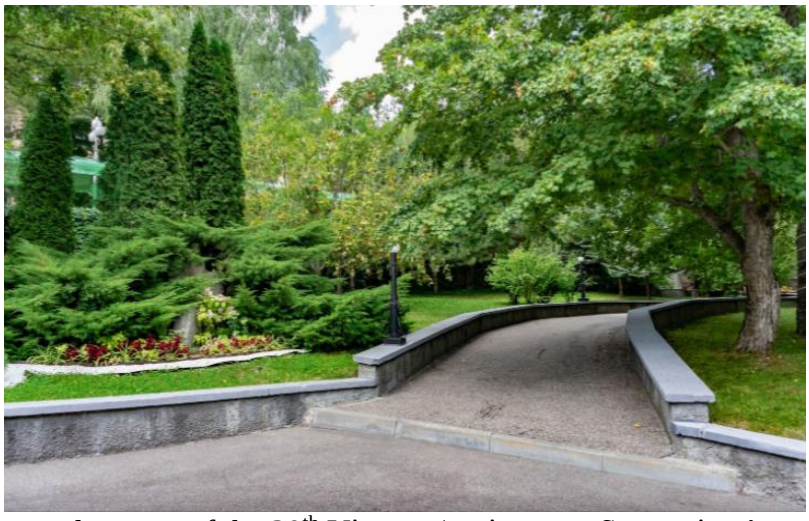

Fig. 1. Landscaping of the 30th Victory Anniversary Sanatorium's territory

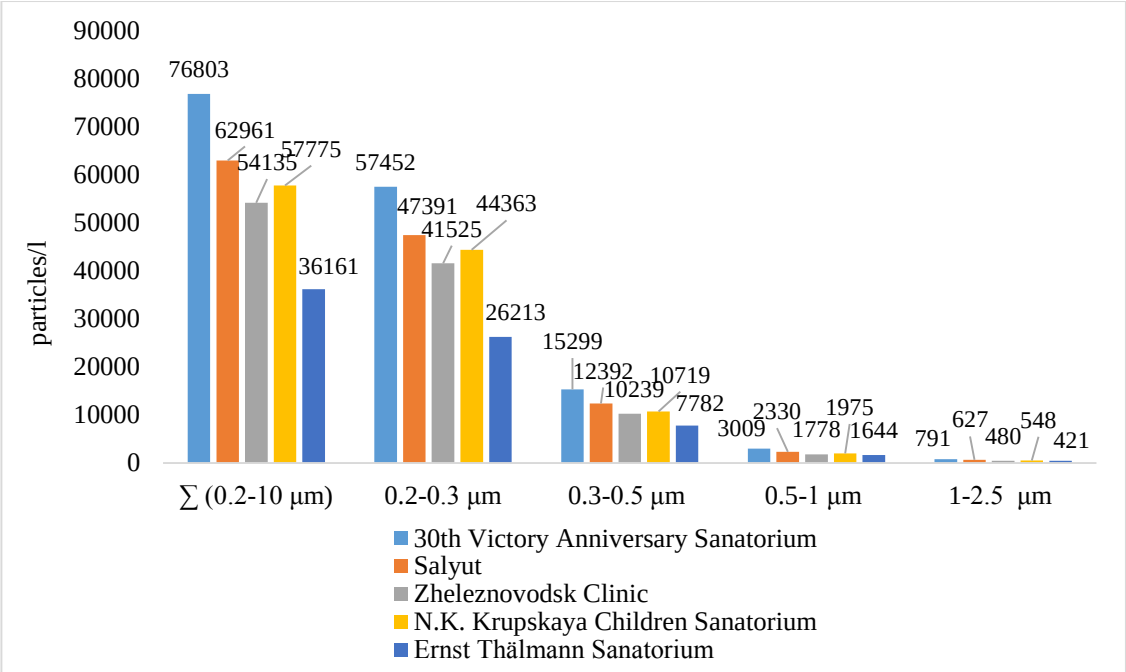

Fig. 2. Aerosol pollution in the territories of Zheleznovodsk sanatoriums

The biologically significant aerosol level for a human body in the range of 0.5 to 1 μm was within the normal values (up to 3000 particles/l) in almost all the sanatoriums. The 30th Victory Anniversary Sanatorium was an exception, where the average pollution level in the range of 0.5 to 1 μm was slightly higher than the standard – 3009 particles/l (fig. 3). The lowest aerosol content in such range was registered in the Ernst Thälmann Sanatorium due to its location at an altitude of 629-656 m above the sea level.

The radiation and ecology study of the territories has revealed that the ambient dose equivalent rate of gamma radiation was normal (up to 0.5 μSv/h) in all territories (0.11-0.19 μSv/h), which reflects absence of radiation pollution in Zheleznovodsk (fig. 4).

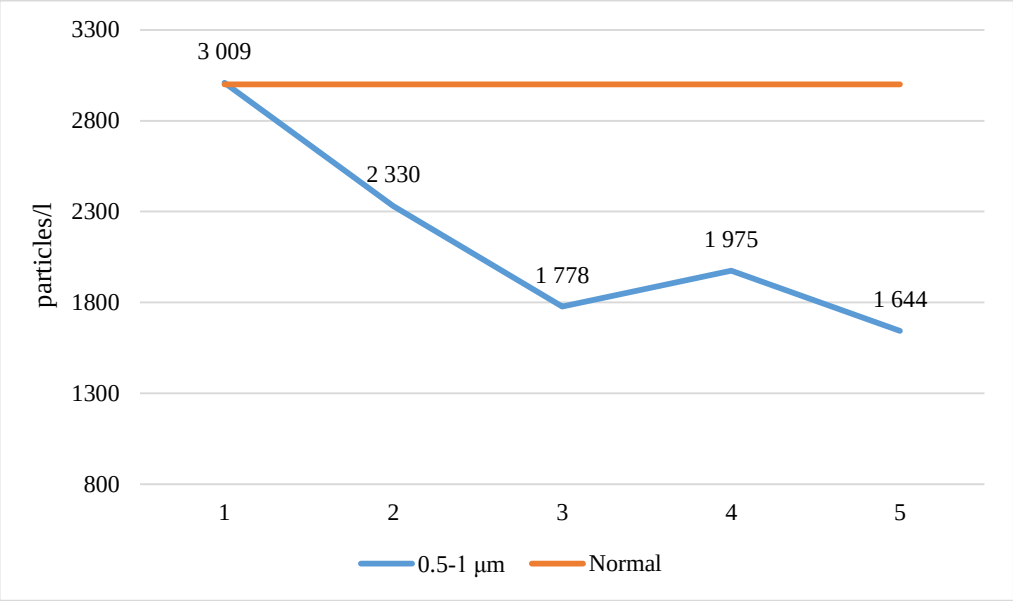

Fig 3. Surface atmosphere pollution by aerosol particles in the size range from 0.5 to 1 μm in the territories of Zheleznovodsk sanatoriums

Note: 1 – 30th Victory Anniversary Sanatorium; 2 – Salyut; 3 – Zheleznovodsk Clinic; 4 – N.K. Krupskaya Children Sanatorium; 5 – Ernst Thälmann Sanatorium

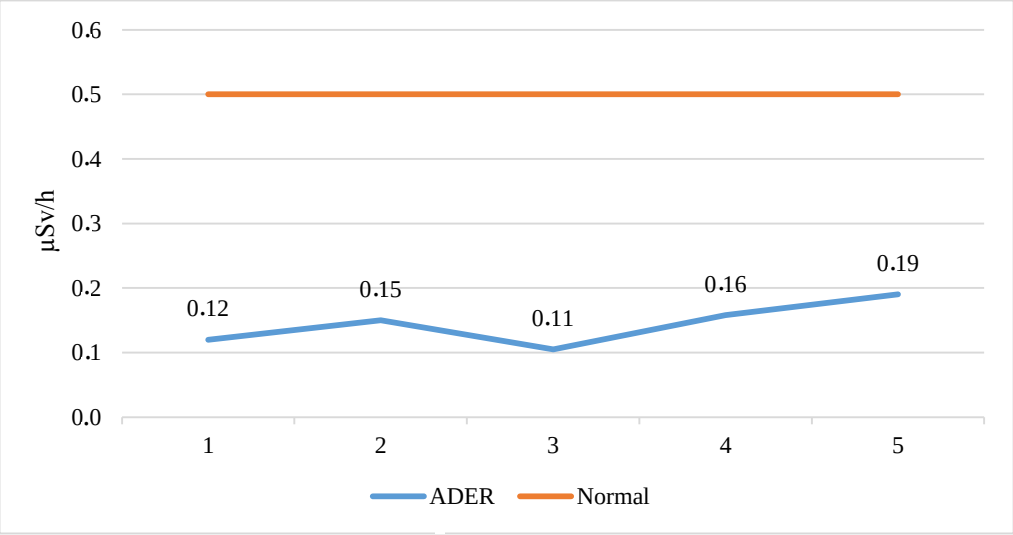

Fig. 4. Radiation pollution level in Zheleznovodsk

Note: ADER – ambient dose equivalent rate; 1 – 30th Victory Anniversary Sanatorium; 2 – Salyut; 3 – Zheleznovodsk Clinic; 4 – N.K. Krupskaya Children Sanatorium; 5 – Ernst Thälmann Sanatorium

Conclusion. The microclimate characteristics in the territories of the Zheleznovodsk sanatoriums are within the normal values, they provide favorable conditions [14] for climate therapy, such as sun therapy, air therapy, health physical culture, i.e. terrain cure therapy. For people with allergy it is recommended to take into account the blooming calendar when planning climate therapy. The saturation of the surface atmosphere with oxygen, high landscaping level in the territory make it possible to carry out health activities, such as terrain cure therapy and health tourism. Patients undergoing sanatorium-resort treatment are recommended to walk on the territories of sanatoriums and terrain cure paths located in the park. Such activity provides a reduction of the nervous system excitability and improve metabolism. To preserve the therapeutic properties of the climate and the high landscape and recreational potential of the territories, it is necessary to conduct periodic environmental monitoring.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Babyakin A.F., Efimenko N.V., Glukhov A.N., Grinzaid Yu.M., Danilov S.R., Kajsinova A.S., Korchazhkina N.B., Povolotskaya N.P., Polozkov I.M., Chalaya E.N. Balneology of Caucasian Mineral Waters. Vol. 1. Ujba V.V., ed. Pyatigorsk: LLC "Izdatel'skij dom", 2009. 333 p. ISBN: 5-86351-033-8. (in Russ.)
2. Babyakin A.F., Efimenko N.V., Amiyants V.Yu., Andrienko N.G., Blinkova L.N., Velikanov D.I., Glukhov A.N., Grinzaid Yu.M., Zherlitsina L.I., Kajsinova A.S. et al. Balneology of Caucasian Mineral Waters. Vol. 2. Ujba V.V., ed. Pyatigorsk: Pyatigorsk State Research Institute of Balneology, 2011. 368 p. ISBN: 5-86351-033-8. (in Russ.)
3. Povolotskaya N.P., Slepykh V.V., Efimenko N.V., Zherlitsina L.I., Senik I.A., Urvatcheva E.E., Kirilenko A.A., Kortunova Z.V. Dynamics of recreational landscapes in the resorts of the Caucasian Mineral Waters. *Resort Medicine*, 2014, vol. 3, pp. 9-20. (in Russ.)
4. Zhekeznaya mountain. Ministry of Natural Resources and Environment of the Stavropol Krai. Available at: https://mpr26.ru/oopt/pamyatniki-prirody/gora-zheleznaya/ (accessed 14.08.2024) (in Russ.)
5. Dorozhkina E.A. Effect of plants on building microclimate and human body. *Symbol of science*, 2015, no. 4, pp. 228-231. (in Russ.)
6. Handbook on USSR climate. Issue 13, part II. Air and soil temperature. Leningrad: Gidrometeoizdat, 1966. 430 p. (in Russ.)
7. Povolotskaya N.P. Weather classification and assessment of the thermal state of a person during climate treatment and recreation in Caucasian Mineral Waters. Issues of Medical Climatology and Climate Therapy of Patients on Resorts. Pyatigorsk: Pyatigorsk Research Institute of Balneology and Physiotherapy, 1975. pp. 16-23. (in Russ.)
8. Smirnov A.A. Effect of high temperature and air humidity on the rate of human body overheating. *Hygiene and Sanitation*, 1961, no. 10, pp. 20-23. (in Russ.)
9. Meshcheryakov A.Yu. Evaluation of negative air ion effect on a person in man-made environments. *Vestnik nauchnykh konferentsij*, 2017, no. 2-1. pp. 98-102. (in Russ.)
10. Dikova O.V. Negative air ions in the treatment of dermatitis. *Journal of New Medical Technologies*, 2009, vol. 16, no. 1, pp. 71-74. (in Russ.)
11. Litvinova L.I. Role of volatile plant phytoncides in atmosphere cleansing from some toxic emissions from industries and motor vehicles. *Hygiene and Sanitation*, 1982, no. 4, pp. 15-18. (in Russ.)
12. Chubatova S.A. Phytoncides: history and application prospects. *Bacteriology*, 2020, vol. 5, no. 3, pp. 60-67. (in Russ.)
13. North Caucasus blooming calendar. Available at: https://nozefrinalergy.ru/tpost/r1jrmdvc71-kalendar-tsveteniya-severnogo-kavkaza (accessed 14.08.2024) (in Russ.)
14. Mikhajlenko V.I., Mikhajlenko A.V., Povolotskaya N.P. et al. Natural resource potential of the territory and nature management: regional aspects: learning guide. Mikhajlenko V.I., ed. Pyatigorsk: North Caucasus State Technical University, RIA-KMV, 2007. 320 p. (in Russ.)

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EFFECT OF OCCLUSION TRAINING ON ELECTROCELLOGRAM PARAMETERS IN FEMALE AESTHETIC GYMNASTS: A RANDOMIZED CONTROLLED TRIAL

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Abstract. Maintaining the integrity of muscle cell membranes at the proper level is crucial for successful performance. The aim of the study is to develop and experimentally substantiate the technique of occlusion training application to increase the phase angle of female athletes engaged in aesthetic gymnastics. Twenty level female athletes participated in the study. Electrocellogram was performed using bioelectrical impedance analysis. In the experimental group a special elastic cuff for occlusion training and a portable device for ultrasonic diagnostics were used. After 180 days of intervention, the phase angle increased by 0.19° ($p>0.05$) in the experimental group and by 0.48° ($p<0.01$) in the control group. The difference between groups was 0.29°, and it was not statistically significant ($p<0.05$). 180 days of regular blood flow restriction training did not impair cell stability and integrity assessed using phase angle.
Keywords: aesthetic gymnastics, electrocellogram, phase angle, occlusion training, blood flow restriction training.

Introduction Aesthetic gymnastics is a complex sport requiring high muscle strength, strength endurance, flexibility, balance, aerobic and anaerobic metabolism [1]. In this regard, there is clear evidence that the demands on muscle cell integrity both during training and especially during competition are higher than previously thought. Therefore, maintaining the integrity of muscle cell membranes at a proper level in aesthetic gymnastics is crucial for a successful performance.

The bioelectrical impedance analysis (BIA) of body composition was suggested as cheap, portative and efficient method for estimating body composition of athletes [2]. The electrical impedance is defined by a vector ratio between resistance, which is represented by hydration, and reactive resistance associated with cell membrane integrity. The angle created by both vectors is a phase angle (PhA) [3], the value of which reflects cellular health [4]. PhA is an indicator of stability, integrity and nutritive status of cell membranes [5]. The intact cell membranes are important for a proper cellular function, i.e. for intercellular communication and intracellular signal transfer. It also relates to the quality of neuromuscular communication or the ability of the neural system to control motor activity, which explains the increase in PhA after training [6]. This method can be comprehended in the same way as other "electrogram" methods, which record the electrical activity of organs such as the brain and the heart by measuring changes in electrical processes. This new term is called "cell electrogram" or "electrocellogram" [7]. PhA is used in clinical practice [8] and sports as a possible indicator of health, physical performance and muscle strength [9-10]. A recent systematic study of Cirillo et al [11] revealed positive correlation between PhA and countermovement jump, wrist strength and lower limb strength in athletes. Since skeletal muscle is the largest conductive tissue in the body, PhA is strongly correlated with body muscle mass [12].

Blood flow restriction training (BFR) includes exercise with low mechanical load or intensity using a device capable to limit blood flow to the trained limb [13]. Such training method has demonstrated results similar to high-intensity training in terms of increasing strength and muscle mass [14]. This is the reason why during BFR training became popular in sports. However, research shows that

working muscles acidify more during BFR training than during traditional training [15]. Cell swelling, acidosis and oxidation degrade membrane properties and lead to membrane permeability [16]. Changes in cell membrane fluidity play a key role in regulation of structural, functional and dynamic properties of membranes. Therefore, potential of implementing BFR for muscle cell of aesthetic gymnasts remains to be explored. According to the analysis of the problem situation, data of modern scientific literature and requests of sports physiologists, biologists, coaches and athletes, the following aim was formulated.

Aim of the study – to develop and experimentally prove the effectiveness of occlusion training for improving the phase angle of aesthetic gymnasts.

Methods and organization. The study took place in the Department of Sports Medicine, Russian University of Sport, Moscow and lasted for 180 days [17]. The study included 20 elite aesthetic gymnasts, level of sportsmanship – 15 Masters of Sport and 5 Candidates for Master of Sport. They were randomized into two groups using the random number table (fig.): the experimental group trained with BFR (8 Masters of Sport and 2 Candidates for Master of Sport, n=10), the control group trained according to a traditional method (7 Masters of Sport and 3 Candidates for Master of Sport, n=10). All the participants gave voluntary informed consent to participate in the study in accordance with the 2020 Ethical Standards for Research in Sports and Physical Activity [18] (Extract from Minutes No 2, meeting of the GTSOLIFK Ethics Committee dated 12.09.23). The program, protocols and methods of the RCT were developed based on modern concepts and regulations of evidence-based medicine, which were applied in accordance with the aim of the study. All gymnasts had a comprehensive examination before and at the end of the study, including: interview, examination and body composition analysis. Electrocellogram was registered on the Medass ABC-02 device (Russia).

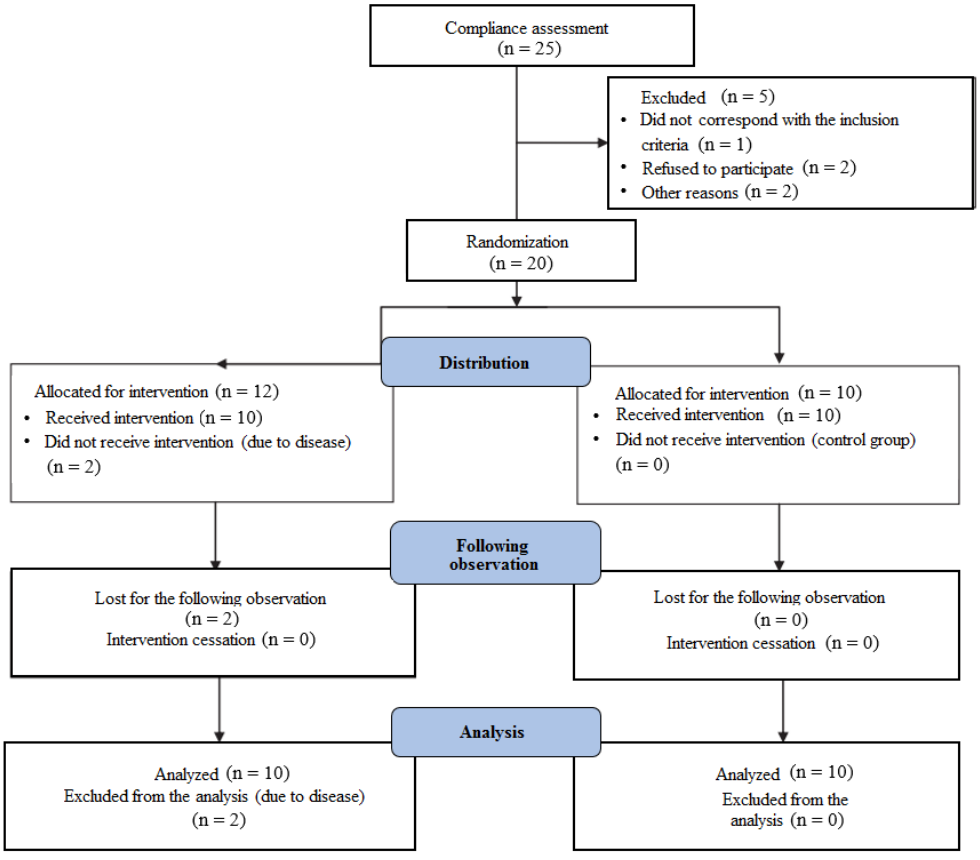

Fig. The CONSORT flowchart

Pressure of specific occlusion training bands was registered with the Logiq V2 portative device for ultrasound diagnosis (General Electric, USA). A 50% blood flow occlusion was recorded in accordance with a twofold increase in linear blood flow velocity in the artery below the applied band compared to the velocity without it. The band has numerical divisions, and after ultrasound diagnosis a table was created for the experimental group, in which the numbers of turns for tightening the band were marked in order to see the necessary degree of BFR during training. According to the available literature data, we also developed a following protocol for special gymnast training. We used a series of familiar 17 exercises performed with one's own body mass for 8 repetitions each, these exercises include dynamic movements, holding static postures, and jumps. The protocol lasted 15 minutes, with 15-30 second rest between exercises. This protocol was performed in the experimental group after the main training with the bands on the upper and lower limbs, taking into account necessary occlusion pressure (40-80%), frequency of occlusion training sessions – 3 times a week. The special training protocol included following exercises:

1) hip flexion while sitting on the floor;
2) hip hyperextension while lying on the stomach;
3) sitting up from lying position, 4 movement variations;
4) hip hyperextension with abduction while lying on the stomach, 2 movement variations;
5) double alternating crunches while lying on the floor;
6) cross arm flexion and leg hyperextension while lying on the stomach;
7) one-arm push-ups while lying on the side;
8) cross hip flexion and adduction while lying on the back;
9) high-amplitude hip flexion while lying on the back;
10) hip abduction while lying on the side;
11) squat hip hyperextension;
12) forearm plank for one minute;
13) burpees without push-ups, with jumps;
14) double jumps with side splits;
15) bouncing on one leg;
16) high knees running in place;
17) squats while standing on toes.

The statistical analysis was done with the STATISTICA 10 software package (StatSoft, USA). The statistical differences in the groups were calculated with the Wilcoxon's signed rank test, between the groups – with the Mann-Whitney's test. The differences deemed statistically significant at $p<0.01$. Differences between groups were identified for each participant within the study groups separately, and medians, upper and lower quartiles were then calculated.

Results and discussion. Biological tissues are complex heterogenic environments consisting of cells with different intracellular characteristics and signaling systems, which are coded by genes in cell core and activated when external signals are received from foreign cells or non-cell components in human tissues [19]. Interaction between intracellular components (for examples, the structure and functions of organelles, hydration level) and extracellular matrices creating structural and biochemical cell support is a basis for the development and function of body tissues, organs and systems in more complicated cases. Although dynamic cellular processes are constantly at work providing a biological balance between tissue and organ functions, mechanical and non-mechanical processes may lead to disruption or alteration in these functions. And though exposure of the cell to extreme stress in a form of high-intensity or prolonged exercise represents the most significant mechanical factor affecting cellular health and tissue function, there are other parameters of more physical, chemical and biological origin to consider. Since such changes have a direct impact on cell structure and physiological functions, acting as an indirect indicator of total health, a better understanding of cell properties for cellular health monitoring purposes was the aim of the study.

According to Campa et al [20], the participants were included into the 50^{th} percentile of standard PhA for female gymnasts. After 180

days of intervention (table), PhA in the experimental group increased by 0.19° (p>0.05), in the control group – by 0.48° (p<0.01). The difference between the groups reached 0.29° being statistically insignificant (p<0.05).

Table

Phase angle parameters in female athletes

Experimental group				
Parameter		0 days	180 days	Δ
PhA, °	Me	6.02	6.18	0.19
	Q1; Q3	[5.86; 6.06]	[5.84; 6.41]	[-0.22; 0.35]
Control group				
Parameter		0 days	180 days	Δ
PhA, °	Me	5.97	6.49	0.48
	Q1; Q3	[5.41; 6.13]	[6.26; 6.61]	[0.42; 0.65]*

Note: Me – Median; Q1; Q3 – Quartile 1 and Quartile 3; Δ – changes in parameters within the group (0-180 days); PhA – phase angle; * – statistically significant changes in the group over the course of 180 days, p<0.01

The cell membrane integrity is of great interest when examining efficiency of BFR-based interventions. The data received show that regular acidification of muscle cells caused by BFR does not degrade stability and integrity of cell membranes of gymnasts [21]. Researchers show that regular interval BFR training improves the ability to regulate pH during dynamic exercise, mainly by improving muscle lactate-dependent H+ transport function and blood H+ buffering capacity. It is possible that such adaptive mechanisms improve structures and functions of cells in the working muscles.

Conclusion. The biophysical response of a human body to electric currant is widely known as a barometer for fluid distribution and cell function. Among different BIA indices used for estimating body composition, PhA was repeatedly considered as a functional marker of muscle cellular health. Although programs of BFR training have demonstrated their efficiency in improving PhA with varying degrees of change depending on other BIA indices, there is still a limited number of studies explaining biological mechanisms underlying these changes. Cell membranes are crucial for cellular health, since they divide intercellular and extracellular environment, create a barrier controlling the movement of substances inside and outside of cells (e.g. nutritious substances and metabolism products) and provide a platform for intercellular signaling [6]. Cell membrane integrity reflects an ability to resist damage and ability of the membrane to recover. It may be estimated according by the penetration of impermeable molecules into the cell and by changes in the extracellular membrane [22]. Many researchers pointed out an increased acidosis of the working muscles as a result of BFR training, which raised concerns on cell membrane integrity in the long run. Our data show, that 180 days of regular BFR training do not degrade indices of cell stability and integrity assessed with PhA. Additional RCTs are required in this field.

Study limitations. The study had some limitations, including a relatively low number of participants. In addition, in order to estimate damage and recovery of cell membrane we used a single electrocellogram indicator, i.e. phase angle. We also did not take into account the ovarian menstrual cycle phases of the study participants, as well as, consequently, the effect of the cycle phase on phase angle indices.

Ethical Standards. All studies were conducted in accordance with the principles of biomedical ethics formulated in the Helsinki Declaration of 1964 and its subsequent updates and approved by the local bioethical committee of RUS “GTSOLIFK” on 12.09.2023 Protocol No 2.

Informed Consent. Each participant of the study provided voluntary written informed consent, signed by them after explaining to them the potential risks and benefits and the nature of the upcoming study.

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Conflict of interest. The authors declare that they have no apparent or potential conflicts of interest related to the publication of this article.

REFERENCES

1. Armada Martínez C., Cavas-García F., Díaz-Suárez A., Martínez-Moreno A. Psychological Profile and Competitive Performance in Group Aesthetic Gymnastics. *Front Sports Act Living*, 2021, no. 3, pp. 625944. DOI: 10.3389/fspor.2021.625944.

2. Campa F., Gobbo L.A., Stagi S., Cyrino L.T., Toselli S., Marini E., Coratella G. Bioelectrical impedance analysis versus reference methods in the assessment of body composition in athletes. *Eur J Appl Physiol*, 2022, no. 122 (3), pp. 561-589. DOI: 10.1007/s00421-021-04879-y.

3. Vásquez M.A., Alonso J.C., de la Maza B.P., Arnáiza E.G., Sastrea D.G., Coboa D.G.A., Fondoa A.M.U., Gonzáleza M.A., del Carmen Dameto Ponsa M., Ballesteros Pomar M.D. Ángulo de fase: diferencias entre desnutrición relacionada con la enfermedad, obesidad y población sana. *Endocrinología, Diabetes y Nutrición*, 2024, no. 22. DOI: 10.1016/j.endinu.2024.07.004.

4. Lukaski H.C., Kyle U.G., Kondrup J. Assessment of adult malnutrition and prognosis with bioelectrical impedance analysis: phase angle and impedance ratio. *Curr Opin Clin Nutr Metab Care*, 2017, no. 20(5), pp. 330-339. DOI: 10.1097/MCO.0000000000000387.

5. Cattem M., Orsso C.E., Gonzalez M.C., Koury J.C. One-Year Changes in Bioelectrical Impedance Data in Adolescent Athletes. *Nutrients*, 2024, no. 16(5), pp. 701. DOI: 10.3390/nu16050701.

6. Short T., Yamada P. Exploring the Mechanistic Trail Connecting Cellular Function, Health, and Athletic Performance With Phase Angle: A Review on the Physiology of Phase Angle and Exercise-Based Interventions. *Topics in Exercise Science and Kinesiology*, 2024, no. 5(1), p. 7.

7. Bellido D., García-García C., Talluri A., Lukaski H.C., García-Almeida J.M. Future lines of research on phase angle: Strengths and limitations. *Rev Endocr Metab Disord*, 2023, no. 24(3), pp. 563-583. DOI: 10.1007/s11154-023-09803-7.

8. Custódio Martins P., de Lima T.R., Silva A.M., Santos Silva D.A. Association of phase angle with muscle strength and aerobic fitness in different populations: A systematic review. *Nutrition*, 2022, no. 93, p. 111489. DOI: 10.1016/j.nut.2021.111489.

9. Marini E., Campa F., Buffa R. Stagi S, Matias C.N., Toselli S., Sardinha L.B., Silva A.M. Phase angle and bioelectrical impedance vector analysis in the evaluation of body composition in athletes. *Clin Nutr*, 2020, no. 39(2), pp. 447-454. DOI: 10.1016/j.clnu.2019.02.016.

10. Silvino V.A., Barros K.R.B., Brito F.M., Magalhaes F.M.D., Carioca A.A.F., Phase angle as an indicator of body composition and physical performance in handball players. *BMC Sports Sci Med Rehabil*, 2024, no. 16(1), p. 114. DOI: 10.1186/s13102-024-00899-1.

11.Cirillo E., Pompeo A., Cirillo F.T., Vilaça-Alves J., Costa P., Ramirez-Campillo R., Dourado A.C., Afonso J., Casanova F. Relationship between Bioelectrical Impedance Phase Angle and Upper and Lower Limb Muscle Strength in Athletes from Several Sports: A Systematic Review with Meta-Analysis. *Sports (Basel)*, 2023, no. 11(5), p. 107. DOI: 10.3390/sports11050107.

12.Martins P.C., Alves Junior C.A.S., Silva A.M., Silva D. Phase angle and bodycomposition: A scoping review. *Clin Nutr ESPEN*, 2023, no. 56, pp. 237-250. DOI: 10.1016/j.clnesp.2023.05.015.

13.de Queiros V.S., Rolnick N., Kamiş O., Formiga M.F., Rocha R.F.C., Alves J.C.M, Vieira J.G., Vianna J.M., Wilk M., Fostiak K., Cabral B.G. dA.T., Dantas P.M.S. Body position and cuff size influence lower limb arterial occlusion pressure and its predictors: implications for standardizing the pressure applied in training with blood flow restriction. *Front Physiol*, 2024, no. 15, p. 1446963. DOI: 10.3389/fphys.2024.1446963.

14.Kamiş O., Gürses V.V., Şendur H.N., Altunsoy M., Pekel H.A., Yıldırım E, Aydos L. With Blood Flow Restriction Versus High-Load Resistance Exercise on Hamstring Muscle Adaptations in Recreationally Trained Men. *J Strength Cond Res*, 2024, no. 7. DOI: 10.1519/JSC.0000000000004870.

15.Fukuta H. Effect of One Session of Muscle Blood Flow Restriction Training Versus Normal

Training on Blood Lactate Level. *Prog Rehabil Med*, 2024, no. 9, p. 20240017. DOI: 10.2490/prm.20240017.
16.Dias C., Nylandsted J. Plasma membrane integrity in health and disease: significance and therapeutic potential. *Cell Discov*. 2021, no. 7(1), p.4. DOI: 10.1038/s41421-020-00233-2.
17.Cuschieri S. The CONSORT statement. *Saudi J Anaesth*, 2019, no. 13(Suppl 1), pp. S27-S30. DOI: 10.4103/sja.SJA_559_18.
18.Harriss, D. J. MacSween A., Atkinson G. Ethical Standards in Sport and Exercise Science Research: 2020 Update. *Int J Sports Med*, 2019, no. 40(13), pp.813-817. DOI: 10.1055/a-1015-3123.
19.Sardinha L., Rosa G.B. Phase angle, muscle tissue, and resistance training. *Rev Endocr Metab Disord*, 2023, no. 24(3), pp. 393-414. DOI: 10.1007/s11154-023-09791-8.
20. Campa F., Thomas D. M., Watts K., Clark N., Baller D., Morin T., Toselli S., Koury J.C., Melchiorri G., Andreoli A., Mascherini G., Petri C., Sardinha L.B., Silva A.M. Reference Percentiles for Bioelectrical Phase Angle in Athletes. *Biology (Basel)*, 2022, no. 11(2), p. 264. DOI: 10.3390/biology11020264.
21.Christiansen D., Eibye K., Hostrup M., Bangsbo J. The effect of blood-flow-restricted interval training on lactate and H+ dynamics during dynamic exercise in man. *Acta Physiol (Oxf)*, 2021, no. 231(3), p. e13580. DOI: 10.1111/apha.13580.
22.Ammendolia, D.A., Bement W.M., Brumell J.H. Plasma membrane integrity: implications for health and disease. *BMC Biol*, 2021, no. 19(1), p. 71. DOI: 10.1186/s12915-021-00972-y.

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FUNCTIONAL STATUS OF THE LOWER LIMBS AFTER PERIPHERAL MAGNETIC STIMULATION OF THE LUMBAR AND SACRAL SPINE OF ATHLETES OF DIFFERENT SPORTS

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Abstract. Aim of the study – to conduct a comparative study of the use of high-intensity repetitive peripheral magnetic stimulation of the lumbar region on the functional status of the lower limbs of female athletes engaged in martial arts and cyclic sports. The study included 9 elite female athletes, 5 of whom were engaged in martial arts, and 4 of whom were engaged in cyclic sports. Repetitive peripheral magnetic stimulation was performed on the BTL-600 Super Inductive system, the stimulation area – the lumbar and sacral spine. The application of magnetic stimulation to the lumbar and sacral spine caused unidirectional changes in the parameters of the neuromuscular system of the lower limbs: reduction of M-response latency and duration, although the M-response surface was also reduced. Rheovasography of the lower limbs in the "tibia" and "foot" segments showed a significant improvement of all hemodynamic parameters. Greater changes in the functional status and hemodynamics of the lower limbs were observed in martial artists compared to cyclic sports athletes. The tested method of high-intensity magnetic stimulation may be recommended for athletes when recovering after an intensive training day during the preparatory period of sports training.
Keywords: magnetic stimulation, magnet therapy, recovery, female athletes, musculoskeletal system, neuromuscular system.

Introduction. One of the main directions of biomedical support of elite sport in the Russian Federation is the development of new technology for recovery, rehabilitation and physical performance improvement [1]. At present, magnetic stimulation is a highly efficient treatment method, widely used when treating and rehabilitating patients with pathologies of the central and peripheral nervous system, musculoskeletal system, urological diseases [2-4]. In the course of recent years, more studies on the transcranial and peripheral effect of repeated magnetic field on the functional state of organs and systems of athletes are being published [5-7]. However, the literature data analysis showed an absence of properly set parameters of intensity, mode and number of stimuli when applying peripheral magnetic stimulation for athlete recovery [8-9], as well as features of its application for athletes of different sports.

Therefore, aim of this study – to examine the use of repeated peripheral magnetic stimulation of the lumbar region on the functional status of the lower limbs of female athletes engaged in martial arts and cyclic sports.

Methods and organization. The study involved 9 elite female athletes, 5 of whom were engaged in martial arts (taekwondo), age – 20 (19; 23) years, and 4 of whom were engaged in cyclic sports (underwater sport, triathlon, water polo), age – 21 (19; 30) years.

The study was conducted in Kislovodsk (the Yug Sport center) in the conditions of training camps, during the preparatory period of the training process. During the study, the athletes performed several intense workouts each day. All participants gave an informed consent to participate in the study according to the WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects (2013), as well as a permit for processing

personal data. The study was approved by the Local Ethics Committee on Biomedical Research Expertise, North-Caucasian Federal Research-Clinical Center of Federal Medical and Biological Agency, protocol No 2 dated 30.06.2023.

Repeated peripheral magnetic stimulation was performed on the BTL-6000 Super Inductive System, the Elite variant (BTL Industries Ltd., United Kingdom). The procedure was performed in the supine position, with the centre of the applicator placed at a minimum distance from the skin. Stimulation area – the lumbar and sacral spine. During stimulation, we used the pre-installed (1001) "Myorelaxation" protocol, sequence mode consisting of 7 sections with specified types of amplitude modulation (constant-constant-trapezoidal-trapezoidal-constant-sinusoidal-constant) and frequency modulation of 1 to 150 Hz. The stimulus intensity was chosen individually until the motor response threshold was reached (20 (±5) %). One procedure lasted 10 minutes, amount of sessions – 5.

To study changes in the functional status of the neuromuscular system, we used stimulation electroneuromyography (ENMG) on a 4-channel Neuro-MVP complex (Neurosoft, Ivanovo). We examined registration of motor responses (M-responses) from the m. Extensor digitorum brevis innervated by the n. Peroneus and the m. Abductor hallucis innervated by the n. Tibialis. Hemodynamics of the lower limb vessels was studied on a rheograph (the Valenta rheorgaph, Neo Company LLC, Saint Petersburg) according to the RVG method (rheovasography).

The statistical data processing was carried out in Statisica 13.0. The data are presented as median, 1st and 3rd quartiles. The changes in parameters before, after the 1st session and after the whole course was analyzed using the Wilcoxon signed-rank test.

Results and discussion. Application of the 1st session and the course of peripheral magnetic stimulation of different female athletes has revealed the following peculiarities. In female martial artists, the terminal latency on the right (before – 3.7 (3.6;4.2) ms, after – 3.4 (3.1;3.4) ms, $p<0.05$) (fig. 1) and on the left (before – 3.5 (3.3;4.2) ms, after – 3.3 (3.3;3.4) ms, $p<0.05$) decreased already after the 1st session in the "tarsus" stimulation point (n. Peroneus stimulation), as well as the residual latency on the right (before – 2.41 (2.12;2.63) ms, after – 2.08 (1.88;2.27) ms, $p<0.05$). The terminal latency also decreased (n. Tibialis stimulation) in the "medial malleolus" point on the right (before – 4.9 (4.6;5.4) ms, after – 4.5 (3.3;4.5) ms, $p<0.04$) (fig. 2) and the "popliteal fossa" point on the right (before – 13 (12.3;13.1) ms, after – 11.6 (11;11.6) ms, $p<0.05$).

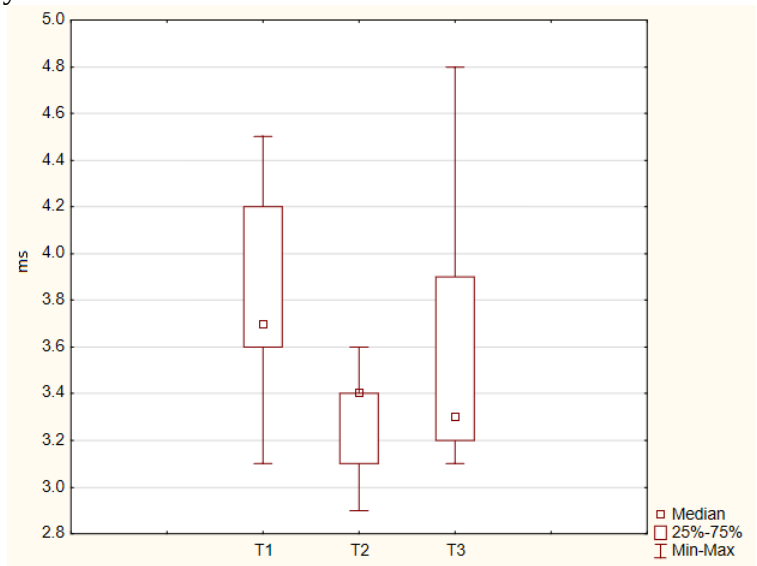

Fig. 1. Terminal latency in the "tarsus" stimulation point on the right with n. Peroneus stimulation in female martial artists before (T1), after the 1st session (T2) and after the magnetic stimulation course (T3)

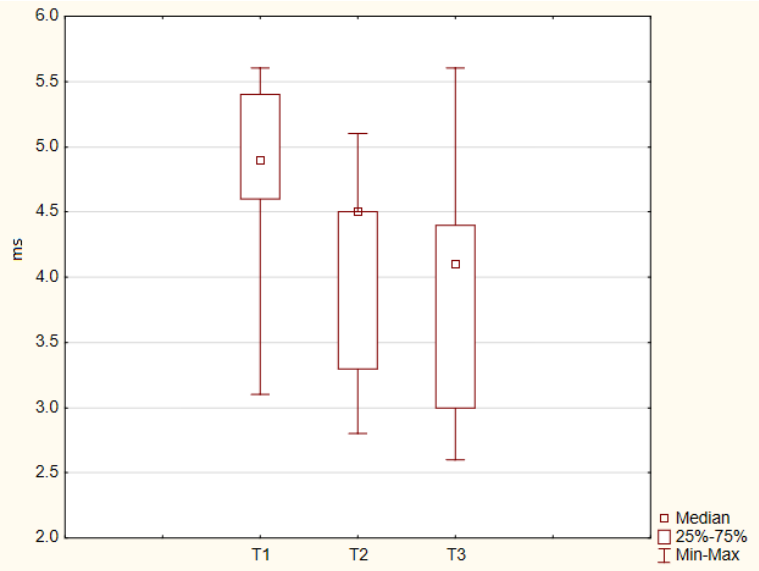

Fig. 2. Terminal latency in the "medial malleolus" stimulation point on the right with n. Tibialis stimulation in female martial artists before (T1), after the 1st session (T2) and after the magnetic stimulation course (T3)

After the magnetic stimulation course with n. Peroneus stimulation, the nerve conduction velocity decreased in the "popliteal fossa" stimulation point on the right (before – 56 (55.3;57.1) m/s, after the course – 50 (49.5;53.5) m/s, $p<0.04$) and on the left (before – 57.7 (56.8;60) m/s, after the course – 51.7 (49.5;56.2) m/s, $p<0.04$).

After the 1st magnetic stimulation session with n. Peroneus stimulation, the M-response area reduced in the "tarsus" point on the right (before – 23.65 (13.9;32.55) mV×ms, after – 16.6 (9.6;23.8) mV×ms, $p<0.05$) (fig. 3), in the "head of fibula" point on the right (before – 22.85 (14;31.05) mV×ms, after – 16.45 (8.8;25.15) mV×ms, $p<0.05$) and in the "popliteal fossa" point on the right (before – 23.4 (14.8;36.95) mV×ms, after – 19.25 (9.9;29.15) mV×ms, $p<0.05$) in female cyclic sports athletes.

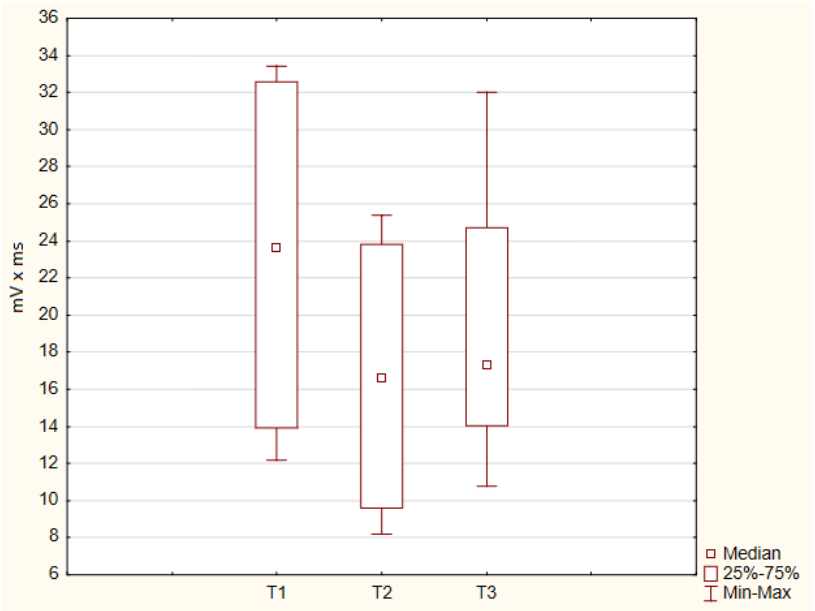

Fig. 3. M-response in the "tarsus" stimulation point on the right with n. Peroneus stimulation in female cyclic sports athletes before (T1), after the 1st session (T2) and after the magnetic stimulation course (T3)

After the magnetic stimulation course with n. Peroneus stimulation, the terminal latency decreased in the "head of fibula" point on the right (before – 10.7 (10.2;11.8) ms, after – 10 (9.75;10.55) ms, $p<0.05$). In the "popliteal fossa" point on the right, the M-response duration also decreased (before – 8.265 (6.89;8.975) ms, after – 7.85 (6.6;8.55) ms, $p<0.05$). When the n. Tibialis was stimulated, the M-response duration decreased as well in the "medial malleolus" point on the right (before – 6.46 (5.725;7.36) ms, after – 5.41 (4.9;6.01) ms, $p<0.05$).

Also, after the magnetic stimulation course with n. Peroneus stimulation, the terminal (before – 4 (3.5;4.7) ms, after – 3.6 (3.25;3.95) ms, $p<0.05$) and residual latency (before – 2.345 (1.935;2.645) ms, after – 2,345 (1.935;2.645) ms, $p<0.05$) decreased in the "tarsus" stimulation point on the left.

Analysis of changes in the peripheral blood flow of the lower limbs of women engaged in martial arts before, after the 1st session and after the magnetic stimulation course has revealed an increased rheographic index in the "left foot" segment (before – 0.57 (0.55;0.69) c.u., after the 1st session – 0,92 (0.81;1.09) c.u., after the course – 1.17 (0.69;1.4) c.u., $p<0.04$). In the "right foot" segment, after the 1st session, there was a statistically significant increase in the time of the maximum systolic filling of the vessels (before – 0.122 (0.1;0.126) s, after – 0,158 (0.141;0.17) s, $p<0.04$) and elastic modulus (vascular tone indicator) (before – 10 (10;13) %, after – 15 (12;23) %, $p<0.04$). After the 1st session, the rheographic wave propagation time (before – 0.24 (0.24;0.27) s, after – 0.26 (0.25;0.28) s, $p<0.04$) and the rime of slow filling of the vessels (before – 0,092 (0.079;0.095) s, after – 0.109 (0.104;0.122) s, $p<0.04$) decreased in the "left tibia" segment. After the course, the venous outflow significantly increased in the "left tibia" segment (before – 13 (12;29) %, after – 25 (22;47) %, $p<0.05$).

In cyclic sports athletes only statistically significant changes in the increase of the time of slow filling of the vessels were revealed in the "right foot" segment after the 1st magnetic stimulation session (before – 0.089 (0.074; 0.103) s, after – 0.117 (0.1;0.155) s, $p<0.05$).

Conclusion. Therefore, repeated peripheral magnetic stimulation on the lumbar and sacral spine has caused unidirectional changes of the neuromuscular system of the lower limbs: reduction of M-response latency and duration, although the M-response area was also reduced. Rheovasography of the lower limbs in the "tibia" and "foot" segments revealed a significant improvement of all hemodynamic parameters. Greater changes in the functional state and hemodynamics of the lower limbs were observed in martial artists. The revealed changes show that high-intensity repeated peripheral magnetic stimulation of the lumbar and sacral spine causes relaxation (reduced activity) of the neuromuscular system of the lower limbs and improvement of hemodynamics, which contributes to accelerated processes of urgent recovery after intense sports activity. The tested method of applying the high-intensity magnetic stimulation may be recommended for athletes to recover after an intensive training day during the preparatory period of sports training.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Ter-Akopov G.N. Medical and biological support of the highest achievement sports: status and topical issues (article one). *Resort medicine*, 2023, no. 2, pp. 139-146. (in Russ.)

2. Pomytkin A.N., Lebedeva I.S., Tikhonov D.V., Kaleda V.G. Rhythmic transcranial magnetic stimulation in the treatment of resistant depression in schizophrenia. *S.S. Korsakov Journal of Neurology and Psychiatry*, 2021, vol. 121, no. 5-2, pp. 99-105. (in Russ.)

3. Novikova E.S., Rozanov I.D. Low-dose radiotherapy for chronic pain syndrome in specific and nonspecific musculoskeletal system diseases. *Medical alphabet*, 2019, vol. 1, no. 2, pp. 58-58. (in Russ.)

4. Pushkar' D.Yu., Kulikov A.G., Kasyan G.R., Kupriyanov Yu.A., Romikh V.V., Zakharchenko

A.V., Voronina D.D., Yarustovskaya O.V., Zajtseva T.N. Extracorporeal magnetic stimulation of the pelvic floor neuromuscular system in urological practice. *Russian Journal of the Physical Therapy, Balneotherapy and Rehabilitation,* 2019, vol. 18, no. 4, pp. 264-276. (in Russ.)
5. Kasumova A.A., Krasnikova V.V., Pospelova M.L., Fionik O.V., Alekseeva T.M., Samochernykh K.A. Possibilities of using the transcranial magnetic stimulation method in the treatment of chronic pain syndromes. *Modern problems of science and education,* 2021, no. 2, pp. 195-195. (in Russ.)
6. Kutashov V.A., Ulyanova O.V. Application of transcranal magnetic stimulation within complex treatment of patients with ischemic stroke in the late recovery period from medical rehabilitation positions. *Herald of physiotherapy and health resort therapy,* 2018, vol. 24, no. 3, pp. 73-80. (in Russ.)
7. Koryagina Yu.V., Abutalimova S.M., Kushnareva Yu.V., Nopin S.V., Mitin I.N. Peripheral magnetic stimulation of the torso muscles of athletes during intensive training activity. *Modern Issues of Biomedicine,* 2024, vol. 8, no. 3. DOI: 10.24412/2588-0500-2024_08_03_28. (in Russ.)
8. Astafyeva D.S., Vlasov Ya.V., Strelnik A.I., Chigareva O.V., Markina E.A., Shishkovskaya T.I., Smirnova D.A., Gayduk A.Ya. Repetitive transcranial magnetic stimulation use in neuropathic pain with comorbid depression: a review of efficient treatment protocols' parameters. *Neuromuscular Diseases,* 2023, vol. 13, no. 2, pp. 20-30. (in Russ.)
9. Bakulin I.S., Pojdasheva A.G., Lagoda D.Yu., Evdokimov K.M., Sabirova A.Kh., Suponeva N.A., Piradov M.A. Safety and tolerability of different protocols of high-frequency rhythmic transcranial magnetic stimulation. *Ulyanovsk Medico-biological Journal,* 2019, no. 1, pp. 26-37. (in Russ.)

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APPLICATION OF VARIOUS FITNESS TECHNOLOGIES IN PHYSICAL EDUCATION AND SPORTS ACTIVITIES OF FEMALE STUDENTS OF MEDICAL UNIVERSITY

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Abstract. Objective of the study: to evaluate the indices of physical fitness and the morpho-functional status of female students during strength fitness and body conditioning classes. To achieve this goal, this survey used anthropometric measurements, functional tests and tests to determine the speed and strength abilities of girls. In the work carried out, the indices of the morphofunctional status and physical fitness of female students during body-conditioning and strength training classes are assessed. A tendency towards an increase in body mass index and weight, the breathing test on inhale and a decrease in the heart rate recovery time after exercise in female students engaged in predominantly strength-oriented training was revealed. As a result of strength training classes during the autumn semester, female students had a higher level of speed-strength abilities, strength endurance and maximum strength in relation to the indicators of the body conditioning group.

Keywords: functional status, strength fitness, body conditioning, anthropometry, female students.

Introduction. In the current period of fitness industry development and trend for a sports lifestyle, people of different ages would like to start working out in a gym. In addition to traditional physical culture and sports, young girls and women choose new types of training, for example ABL (abdominal – buttocks – legs) and ABS (abdominal – back – spine) workout; Cycling (group cardio workout on exercise bicycles); Yoga (system of gymnastic and strength exercises for maintaining proper weight); Pilates (sets of exercises in a slow tempo for strengthening joints and muscles, posture correction, improving sleep) et al. Application of new types of training in a university significantly improves effectiveness of pedagogical influence. A number of studies demonstrated positive changes among female students in indices of different motor qualities, morphofunctional status, body composition [1-3]. Data from the specialized literature shows that, on average, shoulder girdle muscle strength is 40-70% weaker, and lower limb muscle strength is 25-30% weaker in women compared to men [4]. Physical development (PD) is considered as a set of morphological functions in close connection with physical performance of a person accompanied with age-related individual characteristics, i.e. as a comprehensive anthropometric, biomedical and social interdisciplinary complex. Body mass, body length, body mass index (BMI) are the generally accepted parameters of PD, which in turn are supplemented by dynamometry, spirometry and ergometry, contributing to a more accurate update of experimentally obtained data for practical application in a wide range of specialist fields [5].

Objective of the study: estimate indices of physical fitness and the morphofunctional status of female students during strength fitness and body conditioning classes.

Study tasks:

1) to conduct anthropometric measurements and functional tests;

2) to assess the level of development of agility, strength endurance and maximum strength of test subjects;

3) to carry out a comparative analysis of the results obtained.

Methods and organization. The study took place in the Department of Physical Culture and Sports, Yaroslavl State Medical University during the first semester of the year 2022-2023. It included 97 1-3 year female students from different faculties. All the test subjects signed an informed consent for participation in the study. They were then divided into 2 groups: group I included students of the main department (n=82), regularly engaged in body conditioning (BC) during physical education classes in accordance with the academic curriculum without additional activity (sports clubs, national teams of the university). Group II included students of the sports department (n=15), who were engaged in strength fitness classes three times a week. Duration of classes in both groups was 1.5 academic quarters with load percentage of 80%. Classes for the group I were aimed towards a development of agility and speed-strength qualities, general physical fitness. A significant part of time (not less than 50%) of each class included running. Group II mainly used exercises for strength development (with weight resistance, dumbbells, stuffed balls, barbells, exercise machines). Cardio exercises were used mainly in the preparatory part (constituting 15-30% of the total duration).

For the comparative evaluation of speed-strength abilities of the students we used the following tests: dynamometry (back and wrist), squats, 100-meter run and push-ups. To evaluate the functional status, we measured height, weight, heart rate (HR), vital capacity of the lungs (VC) and used the respiration test on inhale and the functional test of 20 squats for 30 s ($t_{recovery}$). Taking into account the data received experimentally, we calculated BMI and relative strength. The statistical data analysis was carried out in Statistica 6.1. (StatSoft, Inc., 2004). We calculated mean values (M) and standard deviation (±σ) of the set parameters. The normality of distribution was identified with the Shapiro-Wilk test. Significance of differences was calculated by Student's T-test.

Results and discussion. The analysis of the data obtained has revealed identical parameters of age, height and HR in the observed groups (table 1). At the same time, we have found significant differences in the results of motor tests (table 2).

Table 1

Morphofunctional status of the girls (n=97), M±σ

Indicator	Group I (n=82)	Group II (n=15)	P
Age, years	19.4±1.2	19.8±1.2	-
Height, cm	165.3±5.9	165.1±4.7	-
Weight, kg	56.4±7.9	60.1±10.6	-
BMI, kg/m^2,	20.6±2.5	21.9±3.5	-
HR, beats/min	83.2±10.6	86.3±17.3	-
VC, ml^3	3727.8±536.2	3262.5±442.7	<0.005
Respiration test on inhale, s	47.6±12.9	52.8±17.7	-
$t_{recovery}$, s	91.6±33.1	87.3±14.4	-

Note: BMI – body mass index; HR – heart rate; VC – vital capacity of the lungs

Table 2

Speed-strength and strength fitness of the girls, M±σ

Indicator	Group I (n=82)	Group II (n=15)	P
100-meter run, s	18.6±1.6	16.9±1.7	<0.001
Squats, squats/min	57.1±6.8	62.5±10.3	<0.01
Push-ups	12.2±5.9	10.0±5.3	-
Back strength, kg	48.695±15.5	58.3±13.1	<0.03
Wrist strength, kg	26.2±3.9	25.9±4.6	-
Relative strength, r.u.	0.86±0.3	0.97±0.2	-

Results of testing agility, strength endurance and maximum strength of group II students significantly exceeded the same parameters of group I. The latter corresponds with the data on the positive effect of strength training on physical fitness of girls [6-9]. Our study shows that speed abilities of group II ("strength fitness") were 10% higher compared to group I. Muscle work during sprinting requires maximum effort in the shortest time, therefore the level of development of explosive strength of the lower limb muscles (calf, quadriceps, gluteal muscles) and trunk muscles (intercostal muscles, biceps, etc.) is the main indicator of speed and strength [10]. In the study, we registered the highest (by 9.5%) strength endurance indices of leg flexor and extensor muscles in the group II according to the squat test. We have also found higher (by 19.7%) value of back strength in the group II compared to group I, as well as a tendency for increasing relative strength. The statistical processing of the push-up test has not revealed statistically significant differences between the groups. In addition, average values of the push-up test results in group I (Ready for Work and Defense (GTO), stage VI), corresponded to the silver badge and to the bronze one in group II. Therefore, it is advisable to include additional set of exercises for the shoulder girdle and chest muscles for further physical development of the female students in both groups.

The comparative analysis of the morpho-functional status parameters of the test subjects revealed a tendency for increasing body mass, BMI, values of the respiration test on inhale and decreasing HR recovery time after activity in group II compared to group I. The latter corresponds with studies on the effect of different types of training (including those based on strength) on the improvement of the functional status of the respiratory and cardiovascular systems of students [11-12]. VC of girls in group I was 12.5% higher than in group II ($p<0.005$). Presumably, this phenomenon was associated with the external respiration activation of female students as a result of long-term adaptation after greater running activity in group I.

Conslusion:

1) As a result of strength fitness classes during the first semester, the female students engaged in strength fitness have a higher level of speed-strength abilities, strength endurance and maximum strength compared to the indices of body conditioning group. At the same time, it will be reasonable for the strength fitness group to include 5-8 exercises aimed at improving strength endurance and strengthening the shoulder girdle muscles.

2) Functional fitness and anthropometric characteristics in both groups were within the physiological norm. We have found a tendency for increasing results in the respiration test, BMI and body mass and decreasing HR recovery time after activity of students engaged in strength fitness. Additionally, we have recorded statistically higher VC in group I students.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Vorontsov N.D., Volodin A.V., Solomakhina T.R. Comparative evaluation of the effect of types of fitness on physical condition of female students. *Azimuth of Scientific Research: Pedagogy and Psychology*, 2018, vol. 7, no. 3 (24), pp. 75-77. (in Russ.)

2. Gubantseva I.B., Egorov V.N., Pluzhnikova L.A. Designing of fitness technologies in the educational space of the university. *Izvestiya Tula State University*, 2017, no 2, Available at: https://cyberleninka.ru/article/n/proektirovanie-fitnes-tehnologiy-v-obrazovatelnom-prostranstve-vuza (accessed 06.08.2024).

3. Fedorova O.N., Smirnova Yu.V., Eliseeva T.P. The effectiveness of fitness classes to women of mature age. *Modern problems of science and education*, 2020. no. 6, p. 19. Available at: https://science-education.ru/ru/article/view?id=30272 (accessed 06.08.2024). (in Russ.)

4. Khor'kova, A.S. Morphological and some physiological features of the development of the female body and its adaptation to physical stress. *Yugra State University Bulletin*, 2016, vol. 12, no. 1, pp. 204-208. DOI: 10.17816/byusu2016121204-208 (in Russ.)

5. Gaivoronskij I.V., Semenov A.A., Chrishtop V.V. Anthropometric assessment of the physical

development of young adults. *Modern problems of science and education*, 2022, no. 6-2, p. 11. Available at: https://science-education.ru/ru/article/view?id=32235 (accessed 06.08.2024) (in Russ.)
6. Gudimov S.V., Osetrov I.A., Pleshchev I.E., Koznov A.V. Somatotypical, functional and strength characteristics of girls at different stages of recreational fitness training. *Russian Journal of Sports Science: Medicine, Physiology, Training*, 2024, vol. 3, no. 1. DOI: 10.24412/2782-6570-2024_03_01_7. (in Russ.)
7. Gudimov S.V., Osetrov I.A., Zhuravlev S.A. Development of students' strength abilities by means of athletic gymnastics. The Olympic Idea Today: proceedings of the sixth All-Russian Scientific Conference with international participation. Rostov-on-Don: SFU, 2016. pp. 204-209. (in Russ.)
8. Mishchenko N.Yu. Correction of the body of girls aged 16-18 years tools of power fitness (on the example of classes in the gym and fitness room). *Scientific Notes of the P.F. Lesgaft University*, 2021, no. 11 (201), pp. 300-310. (in Russ.)
9. Nikolaev P.P., Shikhovtsov Yu.V., Nikolaeva I.V., Surkova D.R. Force training effects on university students' physical status. *Scientific Notes of the P.F. Lesgaft University*, 2018, no. 2 (156), pp. 151-156. (in Russ.)
10.Maslovskij E.A., Semenov V.G., Zakrevskij V.I. The arm-swing style of sprinting in the context of sensory-motor awareness of movement. Innovative Technologies in the Training of Elite Athletes in the Olympic Reserve Schools: a collection of scientific papers of the V International Scientific and Practical Conference. Smolensk, 2014. pp. 312-313. (in Russ.)
11.Anikienko Zh.G. Features of influence of fitness products on the physical readiness, physical development and functional condition of the girls. *Scientific Notes of the P.F. Lesgaft University*, 2012, no. 10 (92), pp. 10-16. (in Russ.)
12.Gudimov S.V., Klimova G.F., Koznov A.V., Krolikov Yu.V. Physical fitness of medical university students depending on the type of physical and sports activity. *Proceedings of the Rostov State University of Railway Engineering*, 2023, no. 2, pp. 56-61. (in Russ.)

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THE CONCEPT OF FORMING PERSONAL MOTOR CULTURE IN SOCIAL AND PROFESSIONAL COMMUNITIES OF THE REPUBLIC OF BELARUS

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Annotation. The article presents theoretical analysis, synthesis and substantiation of conceptual provisions for the formation of personal motor culture in the ontogenesis of a modern person in the conditions of a rural biogeosociocenosis. The aim of the study: development and theoretical substantiation of the scientific concept of the formation of personal motor culture in social and professional communities of rural areas of the Republic of Belarus. The concept of the formation of personal motor culture in a rural community is substantiated, which is a civilizational and historical phenomenon of social, cultural and environmental modification and modernization of an individual's motor aspect in accordance with a specific biogeosociocenosis (the combination of the influence of natural, social, educational, industrial, professional and everyday conditions of the surrounding environment).

Keywords: personal motor culture, biogeosociocenosis, social and professional communities, general educational institutions in rural areas.

Introduction. Any manifestation and development of biological life in nature is not possible without movement of the seen (performed by a living organism) and the unseen (occurring in a living organism).

In the civilizational aspect we always associate the term “culture” with human population, noting that the creation of any cultural values is possible only by a human [1-3]. Such statement may be justified in regards to the most types of both social and personal culture. However, it is different in terms of physical culture. If we consider a human body from a cultural and anthropological point of view as one of the universal cultural values occurred in the process of its self-creation, and man himself as the pinnacle of creation, it will be obvious that the roots of this issue come to phylogenesis of the Earth’s fauna [4-5]. It was through the biological evolution of species that the cultural elevation of a man over the animal world happened, first as Homo habilis and then as Homo sapiens [1, 6, 7].

Aim of the study – to analyze, synthesize and justify conceptual provisions for the formation of personal motor culture in the ontogenesis of a modern person in the conditions of a rural biogeosociocenosis.

Methods and organization. An analysis of scientific and methodological literature on the issue was conducted. A total of 41 research materials were analyzed in the study.

Results and discussion. Homo habilis is associated with the origin of the early “oldowan” culture, marked by a creation of primitive stone tools and transition from carnivory to omnivory. Homo sapiens is related to the “aurignacian” culture represented by the well-developed intelligible speech, clothing creation and wearing and food thermal processing [3]. In both cases, along with the development of the object culture, we see the increasing development of motor culture that allows to translate mental images into material objects and language constructions (human speech), accompanying and improving the quality of a man’s life activity [6-7].

Such phenomenon of a progressive development of everyday motor culture of a man intensely carried on until the formation of industrial society, during which there was a period of relative stagnation. The post-industrial period was indicated with regression of everyday motor culture for the majority of the human population in the countries that currently call themselves developed [3, 7]. In the era of

scientific and technical revolution and global information technology development in the world community, the motor culture improvement in different fields of life activity has become the task of complex and high-precision machines and mechanisms [7]. This, in turn, with food prosperity in the background (but not the nutrition culture), contributed to "deculturation" of motor culture and, consequently, "deculturation" of corporality of an individual and human population as a whole – the two main components of a personal physical culture [6-8].

Therefore, the creation by the modern states of social and pedagogical conditions that help each individual to become aware of their own place in the social and historical period of motor and corporeal "deculturation" and, most importantly, to start the pursuit for and fulfill a substitute for motor and cultural alternative to the lost everyday life-supporting motor activity is the main goal of the social and pedagogical paradigm (realization of personal educational potentialities in an open society) and the first conceptual position of our scientific concept of forming personal motor culture in the modern society.

Considering the term "physical culture" (from the Greek "φύσις" – nature) from the point of semantics as natural culture or culture of nature, it is necessary to note that its commonly used form is directly connected with human beings, although there is no direct indication of this in the word combination itself [7, 9]. No one uses the term in relation to other species of the Earth's fauna (or flora). Nevertheless, they, like human, have the same cultural and biological values [10]. Therefore, the term should be considered as directly related to the human being, as well as to both natural and universal value (human body as an object of biological evolution and self-creation). The implication is that the "pinnacle of creation" is made not only due to their own self-creative activity, but also due to the processes of biological evolution, i.e. mechanisms of all-round adaptation (man adaptation to the environment) and "anti-adaptation" (adaptation of the environment to man), respectively increasing or decreasing the level of their personal motor and cultural self-organization [7]. In the course of the last century, in most areas of human culture, the process of anti-adaptation, which still consists of the same motor activity, aimed at the comfort of physical labor, involved everything, which was detrimental to the motor and cultural development of an individual and human population in whole [11-12].

Such view on things allows us to dive deeply into the essence of origin of physical culture as the culture of human nature represented by the body culture and the culture of motor activity. The latter one lies in the basis of all other types of personal culture (ecological, aesthetic, labor, household, gastronomic et al).

Since the main value of human self-creation and the instrument of embodiment of most material (perceived by the senses) human culture is the human hand [10, 13, 14], and its tool is motor activity [12, 15, 16], that allows to turn the conceived (thought) into a physical body (a household object, or an object for spatial or plastic art: sculpture, graphics, painting and architecture) or an informational body (a verbal object of temporary performing art, which occurs only here and now: dance and music), it is the level of this motor activity's culture that determines the quality of embodiment of mental objects, from primitive and talentless to talented and exceptional. The quality of objectifying thoughts in cultural values is estimated with the senses – "specialized peripheral, anatomical and physiological system that due to its receptors contributes to the acquisition and initial analysis of information that comes from the outside world and other organs of the body, i.e. external environment" [17-18]. Therefore, the culture of motor activity (or, in other words, motor culture) is both a tool for creation and the product of culture of not only one individual, but also the world human culture in whole. This statement is a second conceptual position of the scientific concept of personal motor culture formation, which allows us to see a person as not only "the measure of all things", but also as their creator (including themselves) through

self-realization via their own motor culture in specific natural and environmental conditions. The objectification of a human's thoughts in regards to themselves (embodiment of motor activity and corporeal images) is a process of motor and somatic self-creation (a purposeful totality of all live activity's motor actions) and the results of their own physical culture. From the priorities of each individual the physical culture of the local community, population and species of a whole is formed.

In modern historiography it is accepted to consider that the active development of human culture began with the creation of the first cities [19], when the rules of co-existence required a new arrangement of settlement and life support infrastructure, and before that there were only its rudiments [20]. Nevertheless, considering the human motor culture development from the moment of its creation and use of the first tools of labor up to the present time, it is possible to speak about its origins as motor algorithms of individuals in the natural environment and as cultural heritage of the human population [21]. The same lies in the historical foundation of motor culture manifested through the perfection of games and dances showing the ways of hunting, farming, housekeeping, caring for the younger generation, home and property defense and other from generation to generation [20]. Such activities are present nowadays in a form of outdoor games. They help children to learn these motor algorithms to prepare them for adult life activity in a particular social and demographic community.

Thus, we can associate the origin of the personal motor culture with small tribal communities in close proximity to nature, in the modern world – biogeosociocenosis of rural areas. This is the reason why the modern rural community in different countries is on one way or another a carrier of "motor cultural relics" of the human population to a greater extent compared with the urban community, and the motor culture of the rural community is of primary importance compared with that of the urban community. Such statement is our third conceptual position of the scientific concept of forming personal motor culture, allowing us to consider the rural community as a carrier of original motor and cultural heritage, which has deep cultural and historical roots.

When studying the historical development of social and economic infrastructure of rural areas over the last century, it is important to note its rapid development in the Republic of Belarus over the last 20 years, which allows us to speak about the practical "erasure" of the boundary between the village and the city in terms of providing the benefits of civilization [22]. When giving a social and historical estimation of the educational system of the rural community, it should be also noted that the rural school has been the main (and often the only) cultural and educational center in the rural community [23-24]. It has been repeatedly proven by life itself, and shutting up a village school condemns the village itself to death [25-39].

The effective organization of modern infrastructure (educational, cultural, trade, consumer and communal services, communications, post office et al) in rural areas is concentrated in settlements of a new type – "agricultural towns" [40-41]. Provision of comfortable housing in agricultural towns contributes to solving the problem of centralizing production and labor resources, social and cultural provision for the majority of the rural population [25, 28, 41]. This circumstance allows us to assume the probability of effective realization of potential opportunities of rural residents through the creation of favorable pedagogical conditions for the formation of the educational space in rural schools for all its subjects an a field of motor culture as the basis of health formation of the rural population as a whole. This statement is our fourth conceptual position of the scientific conception on forming personal motor culture in the rural community.

In the light of the information provided above, the concept of forming personal motor culture in professional and social communities of the rural area has logical and theoretical basis that allows us to construct scientific and practice-oriented educational activity through search for effective approaches to provide favorable pedagogical conditions of everyday

motor life of the rural population, contributing to a sufficient level of self-creation and health formation of its representatives in postnatal ontogenesis with the involvement of great natural potential of rural biogeosociocenosis.

Therefore, relevance may be attributed to our proposed understanding of the concept of forming personal motor culture in the rural community, represented by the theoretical and methodological justification of a new scientific direction in the physical culture theory, defined by the categorical and conceptual system of the "personal motor culture" phenomenon, relevant for social (rural residents) and professional (professional and corporate communities of rural areas) communities on a three-level basis from the philosophical (dialectical, cultural and historical), general scientific (general scientific and pedagogical) and specific scientific (didactic, social and pedagogical) points of view.

The categorical and conceptual system of such direction includes a set of accompanying definition clusters of "personal motor culture", based on the scientific and theoretical justification of the introduction of reference motor algorithms in the everyday life activity of the rural community, contributing to health formation of the human body as a universal value. The antagonist in this situation is the term "motor personal anti-culture" which is defined as a set of irrational motor algorhythms that do not possess universal value, clog the motor sphere and lead to the destruction of human body and health, as well as the reduction of the social status of an individual in society.

The concept of forming personal motor culture in the rural community is a civilizational and historical phenomenon of social, cultural and environmental modification and modernization of the motor sphere of an individual in a particular biogeosociocenosis (a comprehensive influence of natural, social, educational, production, professional and living conditions of the surrounding space). Consideration of this concept is proposed on a two-level social and pedagogical basis:

- the first level involves the evolutionary and civilizational "spontaneous modification of personal motor culture based on corporeal adaptation to the "background" everyday motor activity. In this case, the realization of the ontogenetic aspect of a personality occurs through family and social pedagogy, as well as motor experience of a particular community, in which the individual lives. Consequently, the number of personal motor culture modifications will correspond with a number of communities in which it provides its life activity. The first level serves as a foundation for the second one;

- the second level includes a pedagogically controlled modernization of personal motor culture based on correction of modes and ways of everyday "background" motor activity by introducing reference motor algorhythms (poses, locomotions, imitations and manipulations), as well as stimulating creative self-realization of motor potentials in different fields of motor art and sport. Thus, the leading role in human ontogenesis is played by pedagogically guided mechanisms of biological adaptation. This allows to more successfully realize the health-forming and creative components of social and cultural potential of the rural community within ontogenesis of a particular individual by means of social and developmental pedagogy.

Conclusion. As a result of the theoretical analysis and synthesis, based on practical experience in the study of the development of public education in rural areas in general and physical culture in particular, we can identify the main theses of the concept of forming personal motor culture in rural society:

1. To fully replace the lost natural life-supporting everyday motor activity, the modern rural community needs to create favorable pedagogical conditions of the educational space of rural schools acceptable by the predominant majority of its subjects in the field of motor culture both directly in the educational institution and in the place of residence of the latter.

2. After creating favorable pedagogical conditions of the rural schools' educational spaces, the next stage in the realization of conceptual provisions should be the development and implementation of pedagogical technologies for the formation of personal motor culture, which could be based on the preservation and

application of "motor cultural relics" (as motor cultural heritage of mankind) for health-formation of the rural population via personal self-realization through their own motor culture in particular natural and environmental conditions.

3. The foundation of the pedagogical technology of forming personal motor culture in rural community should include criteria of the everyday motor culture education: from the position of motor diversity consistency (pose, locomotion, manipulation and imitation), from the position of activity duration (optimization and rationalization) and from the position of activity discreteness (timely change in activity as the basis of the regime of everyday labor and rest), as well as the position of the activity's quality – a system of comprehensive pedagogical assessment of motor and cognitive maturity, based on empiric indicators for objective identification of the level of motor and cultural proficiency. The aforementioned criteria may be realized via pedagogical diagnosis and estimation of a human motor sphere, individualization of motor activity formation and their motor and cultural proficiency.

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REFERENCES

1. Stolyarov V.I. Dialectics as the logic and methodology of science. Moscow: Politizdat, 1975. 247 p. (in Russ.)
2. Chumakov A.N. Cultural-civilizational research: their role and value in the global world. *Vestnik Moskovskogo Universiteta. Seria 27. Globalistika i geopolitika*, 2018, no. 1. Available at: https://cyberleninka.ru/article/n/kulturno-tsivilizatsionnye-issledovaniya-ih-rol-i-tsennost-v-globalnom-mire (accessed 21.02.2023). (in Russ.)
3. Panov E.N. Man – creator and destroyer: evolution of behavior and social organization. Moscow: Publishing house "YASK", 2017. 634 p. (in Russ.)
4. Kuramshin Yu.F., Grigor'ev V.I., Latysheva N.E., Dvejrina O.A., Aksenov V.P., Vydrin V.M., Moiseev N.M., Titorova O.N., Marishchuk V.L., Romanenko N.V., Shitikova G.F., Popov V.I., Grigor'ev V.I. Theory and methodology of physical culture: a textbook for universities. Kuramshina Yu.F., ed. Moscow: Sovetskij Sport, 2004. 463 p. (in Russ.)
5. Bal'sevich V.K. Essays on developmental human kinesiology: a textbook. Moscow: Sovetskij sport, 2009. 220 p. Available at: https://e.lanbook.com/book/10833 (accessed 08.07.2023). (in Russ.)
6. Stolyarov V.I. Modern theory of the physical education (problems, solutions, the innovative conception). *Science and sport: current trends*, 2016, no. 1. Available at: https://cyberleninka.ru/article/n/sovremennaya-teoriya-fizicheskogo-vospitaniya-problemy-puti-resheniya-innovatsionnaya-kontseptsiya (accessed 29.02.2023). (in Russ.)
7. Stolyarov V.I. Innovative concept of modernizing the theory and practice of physical education. Litres, 2017. 1036 p. (in Russ.)
8. Snezhitskij P.V. Motor culture: genesis, state, problems: a monograph. Grodno: Grodno State Agrarian University, 2022. 299 p. (in Russ.)
9. Matveev L.P., Polyanskij V.P. Application of physical culture: conceptual principles and their concretization in contemporary conditions. *Theory and Practice of Physical Culture*, 1996, no. 7, pp. 42-43. (in Russ.)
10. Larina T.A. Anthropology. Genetic aspects of evolution. *Journal of Mining Institute*, 2010, no. 7 Available at: https://cyberleninka.ru/article/n/antropologiya-geneticheskie-aspekty-evolyutsii (accessed 09.08.2021) (in Russ.)
11. Stolyarov V.I. Philosophy of physical culture and sports activities and human corporality (history, current state, author's concept): a monograph. Moscow: Rusains, 2017. 264 p. (in Russ.)
12. Korenberg V.B. Notes on the culture of movements. Gymnastics. 2nd issue. Moscow: Fizicheskaya Kul'tura I Sport. 2010. pp. 14-18. (in Russ.)
13. Anthropology of professions: collection of scientific articles. Romanov P.V., Yarskaya-Smirnova E.R., ed. Saratov: Center for Social Politics and Gender Studies; Nauchnaya kniga, 2005. 464 p. Available at: https://books.google.by/books?hlru&lr=&id=KzQrkFU50pMC&oi=fnd&pg=PA7&dq=P.+V.+Romanov&ots=4i0RDSGG5x&sig=FWt80aT4QDh02NrJ65sTzX07ZE&redir_esc=y#v=onepage&q=P.%20V.%20Romanov&f=false (accessed 27.12.2021). (in Russ.)
14. Snezhitsky P., Romanova E., Bolotin A. Results of testing an improved methodology for assessing the dynamic performance of rural population in Belarus. *Journal of Physical Education and Sport ® (JPES*), 2024, vol. 24, no. 1, pp. 29-35.

15. Korenberg V.B. On some basic notions of our sphere. *Theory and Practice of Physical Culture*, 2007, no. 2, pp. 11-12. (in Russ.)
16. Kurys' V.N. Evstigneeva M.I. Content and correlation of the terms "physical culture of personality" and "bodily and physical culture". *Scientific notes of P.F. Lesgaft University*, no. 11 (95), 2013, pp. 79-87. (in Russ.)
17. Sirotkina, I.E. Motor culture as an object of science. *Etnograficheskoe obozrenie*, 2018, no. 6, pp. 23-27. (in Russ.)
18. Sirotkina I.E. Sources for a non-existent discipline: on what source study basis to create the history of motor culture? History of science and technology: origins, monuments, legacy. Materials of the International Scientific Conference. Available at: https://www.academia.edu (accessed 12.01.2021). (in Russ.)
19. Shnyukov V.V. Universal human values as a subject of philosophical understanding. *University News. North-Caucasian Region. Social Sciences*, 2005, no. 3. Available at: https://cyberleninka.ru/article/n/obschechelovecheskie-tsennosti-kak-predmet-filosofskogo-osmysleniya (accessed 05.08.2021). (in Russ.)
20. Grigor'evich V.V. General history of physical education and sports: study guide. Moscow: Sovetskij sport, 2008. 286 p. (in Russ.)
21. Lyuban T.N. History and contemporary state of pedagogical anthropology in Russia. *Vestnik Pravoslavnogo Sviato-Tikhonovskogo gumanitarnogo universiteta. Seria 4: Pedagogika. Psikhologia*, 2011, no. 20. Available at: https://cyberleninka.ru/article/n/istoriya-i-sovremennost-pedagogicheskoy-antropologii-v-rossii (accessed 06.07.2020) (in Russ.)
22. Fomenkova S.F. Agricultural towns of Belarus: present state and future prospects. *Herald of the MACI*, 2018, no. 3 Available at: https://cyberleninka.ru/article/n/agrogorodki-belarusi-sovremennost-i-perspektivy (accessed 05.11.2019) (in Russ.)
23. Gusev D.A., Lebedeva O.V. Interaction between school and university in the education of rural school students. *Nachalnaya shkola*, 2022, no. 9, pp. 59-61. DOI: 10.51906/0027-7371_2022_9_59. EDN MGTGEQ. (in Russ.)
24. Kuz'min Yu.A., Medvedeva L.F. System-structural analysis of numerical composition dynamics of agricultural population of the Belarus Republic. *Educational Bulletin "Consciousness"*, 2017, no. 12. Available at: https://cyberleninka.ru/article/n/sistemno-strukturnyy-analiz-dinamiki-chislennosti-selskogo-naseleniya-respubliki-belarus (accessed 08.07.2022). (in Russ.)
25. Pakush L.V. Mirenkova I.V. Conceptual foundations of employment formation in rural areas. Collection of scientific papers "Problems of Economics". Ministry of Agriculture and Food of the Republic of Belarus. Gorki: Belarussian State Agricultural Academy, 2021, no. 2 (33), pp. 105-114. (in Russ.)
26. Gorbushov A.A. Sociocultural approach in assessing effectiveness of rural schools. *Yaroslavl pedagogical bulletin*, 2022, no. 3 (126), pp. 8-16. (in Russ.)
27. Tarasenko L.V. Rural school in modern Russian society: sociocultural analysis. *Vestnik TGPI*, 2008, no. 2, pp. 231-232. (in Russ.)
28. Fadeeva I.M., Kuryshova L.N., Kalatsina O.S. Demographic challenge to rural schools. *Vestnik of Moscow State Linguistic University. Social Sciences*, 2019, no. 4 (837), pp. 184-201. (in Russ.)
29. Tsirul'nikov A.M. Strategies and models of rural school development. *Bulletin of the Russian Humanitarian Scientific Foundation*, 2000, no. 1, pp. 170-183. (in Russ.)
30. Mendibaev N. The village as an anthroposocial integrity in a transforming society. Bishkek, 2014. 364 p. (in Russ.)
31. Palyukh B.V., Semenov N.A., Vetrov A.N., Borisov A.L. Information and analytical system "Planning the structure of a network of small rural schools". *Software and systems*, 2002, no. 2, pp. 42-45. (in Russ.)
32. Pchela I.V. The economic conditions of teachers of rural schools in the Primorsky region in 1900-1914. *Ojkumena. Regional researchers* 2019, no. 2, pp. 55-61. (in Russ.)
33. Semenova G.I. Health protection technologies in a small rural school. *Tomsk State Pedagogical University Bulletin*, 2010, no. 1 (91), pp. 66-69. (in Russ.)
34. Solovchenkov S.A. Rural school and its role in maintaining social and formed the role of education. *Privolzhskij nauchnyj vestnik*, 2011, no. 4 (4), pp. 116-119. (in Russ.)
35. Borovik V.G. Preservation of ungraded schools, or good wishes of the Russian Ministry of Education. *Public education*, 2020, no. 1, pp. 56-60. (in Russ.)
36. Gorbushov A.A. "At the crossroads: rural schools in Russia facing a choice of development paths": monograph. Ekaterinburg: Publishing house of the Ural University, 2016. 124 p. (in Russ.)
37. Gur'yanova M.P. Russian rural school as a socio and cultural phenomenon. *Pedagogika*, 1999, no. 7. Available at: https://portalus.ru/modules/shkola/

rus_readme.php?subaction=showfull&id=1191423109&archive=&start_from=&ucat=& (accessed 12.12.2020) (in Russ.)
38. Gur'yanova M.P. Rural school as a basic institution for the formation of the vitality of a developing personality. Human vitality: individual, professional and social aspects. Makhnach A.V., Dikaya L.G., ed. Moscow: Institute of Psychology of the Russian Academy of Sciences, 2016. pp. 193-210. (in Russ.)
39. Domashev A.N. Rural school as one of the factors in schoolchildren socialization. *Sociology in the modern world: science, education, creativity*, 2017, no. 9-1, pp. 99-103. (in Russ.)
40. Artyukhin M.I., Pushkevich S.A. Demographic crisis and the ways to overcome it in the conditions of modern Belarus. *Sotsiologicheskij al'manakh,* 2017, no. 8. Available at: https://cyberleninka.ru/article/n/demograficheskiy-krizis-i-puti-ego-preodoleniya-v-usloviyah-sovremennoy-belarusi (accessed 05.07.2020). (in Russ.)
41. Blokhin, V.N. Socio-economic changes in rural communities of the Belarusian-Russian border region. Gorki: BGSHA, 2020. 178 p. (in Russ.)

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