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PHYSIOLOGY

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PSYCHOPHYSIOLOGICAL STATE OF AMATEUR ATHLETES REGULARLY ENGAGED IN MOUNTAIN RUNNING

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Annotation. In the performed study, the psychophysiological state was identified and its gender features were revealed in amateur athletes regularly engaged in mountain running in the conditions of the Caucasian Mineral Waters region. The study's results demonstrated a satisfactory functional state of central hemodynamics and parameters of the heart rate autonomic regulation, reduced indicators of sensorimotor reaction time and good mental capacity and endurance in male and female amateur runners aged 35-40 years. Gender differences in hemodynamic and motor performance indices in mature men and women regularly engaged in mountain running were also found. Differences in hemodynamics are manifested by greater peripheral vascular resistance and lower systolic blood pressure in women compared to men. Differences in motor skills are associated with shorter motor reaction time and its variation in men compared to women.

Keywords: amateur athletes, mountain running, long-distance running, hemodynamics, psychomotorics, reaction time, heart rate variability.

Introduction. The role of physical culture and sports as an integral part of preventing and treating diseases is growing each year [1-3]. Majority of the population is actively engaged in physical culture as part of amateur sports [4]. The studies show that physical activities have a favorable effect on delaying development of various diseases such as obesity [5], diabetes [6-7], atherosclerosis, coronary heart disease and many others [8].

There is a large number of sports and physical activities associated with mountains [9-11]. Recently, mountain running is gaining popularity. However, amateur sport and independent workouts may be followed by a high risk of violating the main principles of the training process [12], difficult environmental conditions of the middle altitude have a significant effect on the functional state of the body of those engaged, which requires a special approach [9-11]. For this reason, observation of the functional state of amateur athletes aged over 35 years is of relevance.

The study's objective – to identify the psychophysiological state and reveal its gender-based features in amateur athletes regularly engaged in mountain running.

Methods and organization. The study included amateur athletes regularly engaged in mountain running, who work out 3-6 times per week, residents in the Caucasian Mineral Waters region (Mineralnye vody, Pyatigorsk, Essentuki, Kislovodsk), age – 39.98±6.12 years.

Study of heart rate variability (HRV) и and central hemodynamics was made with the ESTECK System Complex (LD Technology, USA). The complex includes bioimpedance sensor, photoplethysmography sensors (pulse oximeter) and oscillometric sensor.

Following indices were also measured with the ESTECK System Complex: SpO_2 – blood oxygen saturation; Stiffness Index, associated with blood pressure in major arteries; Reflection Index, associated with blood pressure in small and medium arteries; PVR – peripheral vascular resistance; CO – cardiac output; CI – cardiac index.

To evaluate the influence of biologically active substances on the psychophysiological

state, we examined simple (the RT S1 test variant) and complex visual-motor reactions (the RT S4 test variant).

The reaction time study was conducted with the Vienna Test System (SCHUHFRIED GmbH, Austria). Main variables were: average reaction time, average motor reaction time. When the rest button is used, reaction time is defined as the time between the occurrence of a relevant stimulus and the moment when the finger is removed from the button. Additional variables are: reaction time dispersion – standard deviation of the reaction time after the Box-Cox transformation; motor reaction time dispersion – standard deviation of the motor reaction time after the Box-Cox transformation.

The Schulte test was conducted with the "Sports psychophysiologist" complex. This test allows estimating time characteristics of attention (selectivity, stability, switchability), mental capacity when performing activities that require attention [13].

All the participants gave an informed consent to take part in the study. The study was approved by the Biological Ethics Committee of the North Caucasian Federal Scientific and Clinical Center.

The Statistica 13.0 software was used for the statistical data processing. We calculated the standard indices of descriptive statistics (median, first and third quartiles). All data were summarized in tables. The distribution normalcy was identified with the Shapiro-Wilk test. The comparison of indices was made with the Mann-Whitney test (for analyzing data dynamics in independent groups). The statistical significance was deemed valid if $p<0,05$.

Results and discussion. The study of HRV and hemodynamic parameters has shown that almost all indices were within the physiological norm limits (table 1). There were some slightly reduced values of systolic blood pressure in women engaged in mountain running, which can be explained by sports hypotension resulting from long-term adaptation to endurance loads. The comparative index analysis between men and women demonstrated statistically significant differences in a form of higher indices of the peripheral vascular resistance ($p<0.0007$) and reduced systolic blood pressure ($p<0.001$) in women compared to men.

Table 1

Heart rate variability and central hemodynamics indices of amateur athletes regularly engaged in mountain running, Me [Q1; Q3]

Indices	Women	Men	P<	Standard
HR	77.8 [67.4; 89.1]	71.0 [62.1; 74.1]	-	60-80
HF	30.9 [23.9; 42.3]	30.7 [24.7; 38.6]	-	22-34
LF	34.6 [27.6; 40.1]	37.9 [26.4; 51.4]	-	22-46
LF/HF	0.9 [0.8; 1.5]	1.0 [0.8; 2.1]	-	0.5-2
SI	85.2 [71.3; 194.3]	85.2 [58.7; 117.5]	-	50-200
SDNN	50.8 [39.5; 64.4]	52.9 [45.9; 69.5]	-	40-80
SpO_2	97.0 [96.0; 97.0]	96.0 [95.0; 97.0]	-	95-100
Stiffness Index	7.2 [6.7; 7.5]	7.6 [7.3; 8.4]	-	7-9
Reflexion Index	30.0 [25.0; 30.0]	30.0 [25.0; 30.0]	-	30-45
Augmentation Index	1.1 [1.0; 1.1]	1.0 [1.0; 1.1]	-	0.89-1.33
PVR	1416.8 [1333.8; 1555.8]	1121.7 [1034.6; 1295.7]	0.0007	900-1500
sBP	106.0 [99.0; 123.0]	131.0 [122.0; 135.0]	0.001	110-140
dBP	75.0 [71.0; 86.0]	79.0 [70.0; 86.0]	-	75-90

Note: HF – power of high-frequency waves; LF – power of low-frequency waves; SI – stress index; SDNN – standard deviation of the NN intervals; SpO_2 – blood oxygen saturation; PVR – peripheral vascular resistance; sBP – systolic blood pressure; dBP – diastolic blood pressure; data are presented in a form of medians and quartiles; p – according to the Wilcoxon's test

The sensorimotor reaction time study revealed low values in amateur runners, which may be related to age as well as specifics of sports activity (long running). There are statistically significant gender differences as well: reduced motor time of simple and complex sensorimotor reactions in men compared to women, as well as reduced values of the motor reaction time dispersion (table 2). All participants had acceptable values of mental capacity and stability.

Table 2

Indices of sensorimotor reactions' time and mental capacity of amateur athletes regularly engaged in mountain running, Me [Q1; Q3]

Indices	Women	Men	P<
SSRT	288.0 [280.0; 307.0]	262.0 [248.0; 282.0]	-
Motor SSRT	159.0 [149.0; 196.0]	115.0 [94.0; 143.0]	0.0008
SSRT dispersion	44.0 [32.0; 46.0]	32.0 [26.0; 45.0]	-
Motor SSRT dispersion	22.0 [20.0; 29.0]	18.0 [14.0; 22.0]	0.03
CRT	425.0 [344.0; 500.0]	412.0 [345.0; 476.0]	-
Motor CRT	211.0 [155.0; 219.0]	132.0 [109.0; 149.0]	0.02
CRT dispersion	59.0 [45.0; 71.0]	64.0 [47.0; 86.0]	-
Motor CRT dispersion	30.0 [18.0; 42.0]	16.0 [14.0; 22.0]	0.03
Work efficiency	35.0 [34.2; 36.3]	37.9 [33.6; 43.7]	-
Mental capacity	1.0 [0.9;1.0]	1.0 [0.9; 1.1]	-
Mental stability	0.9 [0.9; 1.1]	1.0 [0.9; 1.1]	-

Note: SSRT – simple sensorimotor reaction time; the data are presented in a form of median and quartiles; CRT – choice reaction time; p – according to the Wilcoxon's test

Identification of connections of psychophysiological indices of HRV, reaction time and mental capacity revealed a negative correlation of the degree of choice reaction time dispersion with the HR index ($r=0.86$, $p<0.05$) and positive correlation of the degree of choice reaction time dispersion with HF ($r=0.89$, $p<0.05$), mental stability with LF ($r=0.89$, $p<0.05$). The data received reflect an increase in stability of sensorimotor reactions and mental capacity with increased tone of the sympathetic division of the autonomic nervous system.

Conclusion. The conducted study has identified the physiological state and found its gender features in amateur athletes regularly engaged in mountain running in the conditions of the Caucasian Mineral Waters region. The study's data show a satisfactory functional state of central hemodynamics and heart rate autonomic regulation, reduced indices of the sensorimotor reaction time and desirable indices of mental capacity and endurance. We have found a connection between the autonomic nervous system and mental capacity: increased stability of sensorimotor reactions and mental capacity with increased tone of the sympathetic division of the autonomic nervous system.

We have also discovered gender differences in hemodynamic and motor indices of mature mountain runners. The differences in hemodynamics are shown in higher peripheral vascular resistance and lower systolic blood pressure in women compared to men. The differences in motor skills are associated with shorter motor reaction time and its dispersion in men compared to women.

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

REFERENCES

1. Warburton D.E., Nicol C.W., Bredin S.S. Health benefits of physical activity: the evidence. *CMAJ*, 2006, vol. 174(6), pp. 801-809.
2. Mashkovskij E.V., Achkasov E.E., Bogova O.T., Vinnichuk D.O. Influence of regular exercise on morphological and functional features of cardiovascular system in active and retired elite athletes. *Sports medicine: research and practice*, 2014, no. 1, pp. 22-31. (in Russ.)
3. Ivanova G.E. Medical rehabilitation in Russia. Development prospects. *Consilium Medicum* 2013, no. 5, pp. 3-8. (in Russ.)
4. Stankevich R.A. Running as a therapy in any age. St. Petersburg: Piter, 2016. 224 p. (in Russ.)
5. Bermudez D.M., Pories W.J. New technologies for treating obesity. *Minerva Endocrinol*, 2013, vol. 38(2), pp. 165-172.
6. Galassetti P., Riddell M.C. Exercise and type 1 diabetes (T1DM). *Compr Physiol*, 2013, vol. 3(3), pp. 1309-1336.
7. Shin J.A., Lee J.H., Kim H.S., Choi Y.H., Cho J.H., Yoon K.H. Prevention of diabetes: a strategic approach for individual patients. *Diabetes Metab Res Rev*, 2012, suppl. 2, pp. 79-84.
8. Scharhag U., Lellgen G., Kindermann V. The influence of professional sports upon the heart: is it positive or negative? *Lechebnaya fizkul'tura i sportivnaya meditsina*, 2013, no. 5, pp. 26-38. (in Russ.)
9. Kabachkova A.V., Kapitanov S.N. Functionality tests of amateur athletes of mature age in middle altitude conditions. *Theory and Practice of Physical Culture*, 2020, no. 10, pp. 18-20. (in Russ.)
10. Koryagina Yu.V., Ter-Akopov G.N. Chronobiological features of sportsmen in different physical loads, training cycles and environmental conditions. *Lechebnaya fizkul'tura i sportivnaya meditsina*, 2017, no. 5 (143), pp. 29-33.
11. Ter-Akopov G.N., Koryagina Yu.V. Factors increasing reserve capabilities of athletes during acclimation to altitude. *Modern Issues of Biomedicine*, 2018, vol. 2, no. 1 (2), p. 1. (in Russ.)
12. Kapitanov S.N., Kabachkova A.V., Shil'ko V.G. Independent occupations by physical culture at men at the age from 36 till 44 years. *Tomsk State University Journal*, 2012, no. 360, pp. 148-151. (in Russ.)
13. Koryagina Yu.V., Nopin S.V. Hardware and software complex "Sports psychophysiologist". *Computer programs, databases, TIC*, 2011, no. 1, p. 308. (in Russ.)

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DOES METABOLISM DECLINE WITH AGE?

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Annotation. Low resting energy expenditure is considered a risk factor for weight gain leading to obesity. Many studies have shown that aging is associated with a decrease in basal metabolism. We examined the association between age and changes in basal metabolism in men and women, and the causes of this change. Linking these causes at the subcellular/cellular level to organs and tissues and then to body size and shape provides a comprehensive understanding of individual changes in basal metabolism in old age, which is a current topic of interest in obesity research and clinical practice.
Keywords: age, basal metabolism, obesity, body composition, thyroid, fat-free mass, body mass index.

Introduction. Many studies show that in adulthood people, who live in different countries, have lowered total energy expenditure. It is due to the lowered resting energy expenditure (REE), physical activity and, possibly, decreased thermogenesis [1]. Pontzer et al [2] revealed that total expenditure increases depending on the fat-free mass (FFM), even at various life stages. Expenditure that was corrected into FFM increases rapidly in newborn and exceed indices of an adult man by ~50% at the age of ~1 year, then gradually reduces to the adult level at the age of ~20 years, remains stable at the adult age (20-60 years) even during pregnancy, then reduces among the elderly. However, an obesity pandemic among older population [3] should have led to the increased REE due to increased number of energy tissues. Taking analysis of the problem field, data of the modern scientific literature and requests from sports physicians, physiologists and dietitians into account, we have made a study's objective.

The objective: to examine factors influencing basal metabolism reduction in the elderly.

Methods and organization. The study took place in the Russian University of Sport "GTSOLIFK" (Moscow). For the review, we searched and analyzed scientific publications. Following databases were used: PubMed, Embase, Research Gate and Cochrane Library.

Results and discussion. *Organ and tissue level.* In 1907, the English scientist Joseph Barcroft started reporting on a series of studies about catheterization aimed towards evaluation of the specific metabolic rate (*Ki*) of main organs and tissues [4]. In 1950, Drabkin and Jean [5] noted about assessment of basal oxygen consumption by the brain, heart, liver, kidneys and skeletal muscles, and by 1992, the gathered data led to the point that Elia [6] suggested *Ki* values for most main organs and tissues. Merge of these calculated values with corresponding masses of organs and tissues contributed to a measure, with the help of which one could calculate REE as a sum of REE of the main organs and tissues (table). According to this approach, REE of an organ/tissue is the product of their calculated *Ki* value and mass [7]. Despite the great progress achieved in the last century, the ability to measure REE at this level still remains limited [1]. Firstly, there is a dire need in methods allowing a quantitative assessment of *Ki* values in vivo in most organs and tissues (as a result modern physiological models include assessed *Ki* values for some main organs/tissues, but they are not recognized for such components as the digestive tract and lungs. Instead, the tissues, for which there is no *Ki* value, are frequently united into a big "residual" component, which then takes the assessed *Ki* value, although it adds a mistake in the REE evaluation).

Table

Mass specific metabolic rates (*Ki* values) of separate organs and tissues

Organ	Mass, kg		*Ki*, kcal/kg/day	Energy expenditure, kcal/day	
	Male	Female		Male	Female
Brain	1.6	1.43	240	384	343
Kidneys	0.3	0.27	440	132	119
Heart	0.33	0.28	440	145	123
Liver	1.68	1.5	200	336	300
Skeletal muscles	30.6	21.3	13	398	277
Fat tissue	19.3	29.6	4.5	87	133

A second limitation is that volumes of whole organs assessed through magnetic resonance imaging (MRI) cannot consider non-metabolic active components such as blood, connective tissue and fat, which can be contained in different amounts in the skeletal muscles, liver and other organs. This difference can affect the organ's density, as well as the value that is now considered as constant when transforming volumes measured with MRI into mass. Thirdly, the published *Ki* values may inaccurately point out regional differences in oxygen consumption, which occur in some organs/tissues, such as the brain [9]. The same thing is possibly attributed to the fat tissue, a very diverse tissue located in different parts of the whole body.

Level of the whole body. Body mass (BM) is a sum of all heat-emitting components at the level of cells and organs/tissues and a relatively small amount of a metabolically stable substance, such as hair, tendon and extracellular connective tissues. Connection between REE and body mass is a definitive sign of mammals, including man, which was formed by the Kleiber law, REE=BM*0.75 [10]. Therefore, BM is a main REE variable and predictor at the whole body level and is a key component of modern prediction equations [11]. Human body consists of 78 organs and 11 systems, which have relatively stable proportions among adults with normal BM. It is one of the reasons why men and women with reference features have the same corresponding REE values [12] and *Ki* for the whole body (i.e. REE/BM) – 24.3 and 23.6 kcal/kg/day, and why REE strongly correlates with BM in adults [7]. Essentially, all adult people are built the same, which is why BM accounts for more than two-thirds of individual differences in REE.

Excess BM and obesity are serious diseases, the incidence of which among old Europeans amounts to 60% and 20% accordingly [13] and in 50% in general around the world [14]. Obesity is characterized with excessive fat accumulation, which usually occurs during aging [15]. It mostly happens in people aged 45-70, the peak BM is registered in middle age, i.e. 50-65 years [16]. Most studies concluded that REE is significantly higher in obese people (by 360 kcal/day), average values of REE amounted from 90 kcal/day (I degree obesity compared to people without it) to 826 kcal/day (morbid obesity compared to people without it) [17]. The reason for it is that obesity is described not only with an excess of fat and muscle mass, but also with increased mass of other "accompanying" organs (liver, kidneys, heart) and tissues (skin) and related metabolic processes [18]. These data are difficult to correlate with the results found by Pontzer et al [2], since they found that total energy expenditure remains stable in adult age (20-60 years) then reduces in old age. There are two possible explanations for this. First of all, old people might have much lower REE for 1 unit of cell mass for separate organs/tissues (specific metabolic rate) than young people. Cells of organs/tissues may be different in young and old people, since histological changes, which show relative loss of these cells and expansion of extracellular compartments (e.g. connective tissue), occur in the liver and other tissues [19-20]. It is possible that adaptive changes in women take place in middle age (~47 years), while in men – in ~54 years [21].

However, working out stabilize gene expression and protein content in complexes of the electron transport chain [22], which demonstrates full preservation of active muscle cells, which can support relatively high REE in old age. Secondly, it is also well-known that relatively high REE correlated with higher levels of thyroid hormones [23], which gives a possibility to assume that reduced thyroid activity would reduce REE as well in old age.

Thyroid in old age. Main factors defining a need in energy include REE, physical processes, BM and diet frequency [24]. REE, being an important parameter of energy need, is significantly connected with thyroid hormones. Many studies revealed that the level of thyroid hormones increases in old age (>80 years) [25-28]. In terms of connection between obesity, age and thyroid hormones, a current study made by Masoumi and Pishva [29] shows that the thyroid hormone level (T3, T4 and thyroid stimulating hormone) remained within the norm in all obese people (women aged 30-50). Work by Ozcelik et al [30] demonstrated that at late stages of obesity, the increased level of thyroid hormones contributes to a raise of energy consumption by increasing resting energy need and giving the body an alternative option to "save" itself from obesity. Such case is an adaptive and preventive contribution similar to the leptin effect that correlates with an amount of fat tissue in case of obesity, inhibits diet, making an effect on the satiation center.

Conclusion. Obesity is considered as a risk factor of metabolic and chronic diseases. Reduced REE in old age may increase the risk of obesity. Analysis and accumulation of literature on this topic reflects a number of patterns. The first one implies an old person with normal BM, who leads a sedentary lifestyle. In this case REE will possibly decrease as result of losing cell fracture of organs with high *Ki*. Second pattern includes an old person with obesity, who leads a sedentary lifestyle. In this case REE will possibly increase as a result of increased mass of muscles, fat and organs with high *Ki*, as well as the increased thyroid hormone level. The third one implies an old person with normal BM, who leads an active lifestyle. In this case, a stable or increased REE is possible as a result of preserved or increased mass of skeletal muscles accordingly. This is the reason why enlightenment for the elderly on physical culture and sports is necessary, since physical activity contributes to preservation of metabolically active muscle cells that may support a relatively high REE in old age. Additional randomized research in this field is necessary.

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

REFERENCES

1. Elia M., Ritz P., Stubbs R.J. Total energy expenditure in the elderly. *Eur J Clin Nutr*, 2000, no. 54, pp. 92-103. DOI: 10.1038/sj.ejcn.1601030.

2. Pontzer H. Yamada Y., Sagayama H. Daily energy expenditure through the human life course. *Science*, 2021, no. 373(6556), pp. 808-812. DOI: 10.1126/science.abe5017.

3. Malandrino N., Bhat S.Z., Alfaraidhy M. Grewal R.S., Kalyani R.R. Obesity and Aging. *Endocrinol Metab Clin North Am*, 2023, no. 52(2), pp. 317-339. DOI: 10.1016/j.ecl.2022.10.001.

4. Barcroft J., Dixon W.E. The gaseous metabolism of the mammalian heart: Part I. *J Physiol*, 1907, no. 25;35(3), pp. 182-204. DOI: 10.1113/jphysiol.1907.sp001189.

5. Drabkin D.L., Jean R. The distribution of the chromoproteins, hemoglobin, myoglobin, and cytochrome c, in the tissues of different species, and the relationship of the total content of each chromoprotein to body mass. *J Biol Chem*, 1950, no. 182, pp. 317-334.

6. Elia M. Organ and tissue contribution to metabolic rate. In: Kinney J.M., Tucker H.N., eds. Energy Metabolism: Tissue Determinants and Cellular Corollaries. New York: Raven Press, 1992. pp. 61-79.

7. Heymsfield S.B., Smith B., Dahle J., Kennedy S, Fearnbach N, Thomas D.M., Bosy-Westphal A, Müller M.J. Resting Energy Expenditure: From Cellular to Whole-Body Level, a Mechanistic Historical Perspective. *Obesity (Silver Spring)*, 2021, no. 29(3), pp. 500-511. DOI: 10.1002/oby.23090.

8. Sinha J., Duffull S.B., Green B., Al-Sallami H.S. Evaluating the Relationship Between Lean Liver Volume and Fat-Free Mass. *Clin Pharmacokinet*, 2020, no. 59(4), pp. 475-483. DOI: 10.1007/s40262-019-00824-7.

9. Geisler C., Hübers M., Granert O., Müller M.J. Contribution of structural brain phenotypes to the variance in resting energy expenditure in healthy Caucasian subjects. *J Appl Physiol*, (1985) 2018, no. 125(2), pp. 320-327. DOI: 10.1152/japplphysiol.00690.2017.
10.Kleiber M. Body size and metabolism. H*ilgardia*, 1932, no. 6, pp. 315-351.
11.Martinho D.V., Naughton R.J., Faria A. Rebelo A., Sarmento H. Predicting resting energy expenditure among athletes: a systematic review. *Biol Sport*, 2023, no. 40(3), pp. 787-804. DOI: 10.5114/biolsport.2023.119986.
12.Jagim A.R., Camic C.L., Askow A., Luedke J., Erickson J., Kerksick C.M., Jones M.T., Oliver J.M. Sex Differences in Resting Metabolic Rate Among Athletes. *J Strength Cond Res*, 2019, no. 33(11), pp. 3008-3014. DOI: 10.1519/JSC.0000000000002813.
13.Peralta M., Ramos M., Lipert A., Martins J, Marques A. Prevalence and trends of overweight and obesity in older adults from 10 European countries from 2005 to 2013. *Scand J Public Health*, 2018, no. 46(5), pp. 522-529. DOI: 10.1177/1403494818764810.
14.Colleluori G. Villareal D.T. Weight strategy in older adults with obesity: calorie restriction or not? *Curr Opin Clin Nutr Metab Care*, 2023, no. 26(1), pp. 17-22. DOI: 10.1097/MCO.0000000000000879.
15.Liu C., Wong P.Y., Chung Y.L. Chow SK, Cheung W.H., Law S.W., Chan J.C.N., Wong R.M.Y. Deciphering the "obesity paradox" in the elderly: A systematic review and meta-analysis of sarcopenic obesity. *Obes Rev*, 2023, no. 24(2), pp. e13534. DOI: 10.1111/obr.13534.
16.Eglseer D., Traxler M., Embacher S. Reiter L, Schoufour J.D., Weijs P.J.M., Voortman T., Boirie Y., Cruz-Jentoft A., Bauer S.; SO-NUTS consortium.. Nutrition and Exercise Interventions to Improve Body Composition for Persons with Overweight or Obesity Near Retirement Age: A Systematic Review and Network Meta-Analysis of Randomized Controlled Trials. *Adv Nutr*, 2023, no. 14(3), pp. 516-538. DOI: 10.1016/j.advnut.2023.04.001.
17.Carneiro I.P., Elliott S.A., Siervo M. Padwal R, Bertoli S, Battezzati A., Prado C.M. Is Obesity Associated with Altered Energy Expenditure? *Adv Nutr*, 2016, no. 7(3), pp. 476-487. DOI: 10.3945/an.115.008755.
18.Hwaung P., Bosy-Westphal A., Muller M.J. Geisler C, Heo M, Thomas D.M., Kennedy S., Heymsfield S.B. Obesity Tissue: Composition, Energy Expenditure, and Energy Content in Adult Humans. *Obesity (Silver Spring)*, 2019, no. 27(9), pp. 1472-1481. DOI: 10.1002/oby.22557.
19.Gallagher D., Allen A., Wang Z., Heymsfield S.B., Krasnow N. Smaller organ tissue mass in the elderly fails to explain lower resting metabolic rate. *Ann N Y Acad Sci*, 2000, no. 904, pp. 449-455. DOI: 10.1111/j.1749-6632.2000.tb06499.x.
20.Wang Z., Heshka S., Heymsfield S.B., Shen W, Gallagher D. A cellular-level approach to predicting resting energy expenditure across the adult years. *Am J Clin Nutr*, 2005, no. 81(4), pp. 799-806. DOI: 10.1093/ajcn/81.4.799.
21.Siervo M., Oggioni C., Lara J., Celis-Morales C, Mathers J.C., Battezzati A., Leone A., Tagliabue A., Spadafranca A., Bertoli S. Age-related changes in resting energy expenditure in normal weight, overweight and obese men and women. *Maturitas*, 2015, no. 80(4), pp. 406-413. DOI: 10.1016/j.maturitas.2014.12.023.
22.Joanisse S., Ashcroft S., Wilkinson D.J., Pollock R.D., O'Brien K.A., Phillips B.E., Smith K., Lazarus N.R., Harridge S.D.R., Atherton P.J., Philp A. High Levels of Physical Activity in Later Life Are Associated With Enhanced Markers of Mitochondrial Metabolism. *J Gerontol A Biol Sci Med Sci*, 2020, no. 75(8), pp. 1481-1487. DOI: 10.1093/gerona/glaa005.
23.Hu S., Zhang X., Stamatiou M., Hambly C, Huang Y., Ma J., Li Y., Speakman J.R. Higher than predicted resting energy expenditure and lower physical activity in healthy underweight Chinese adults. *Cell Metab*, 2022, no. 34(10), pp. 1413-1415. DOI: 10.1016/j.cmet.2022.05.012.
24.Plucker A., Thomas D.M., Broskey N., Martin C.K., Schoeller D., Shook R., Heymsfield S.B., Levine J.A., Redman L.A. Adult energy requirements predicted from doubly labeled water. *Int J Obes (Lond)*, 2018, no. 42(8), pp. 1515-1523. DOI: 10.1038/s41366-018-0168-0.
25.Boucai L. Surks M.I. Reference limits of serum TSH and free T4 are significantly influenced by race and age in an urban outpatient medical practice. *Clin Endocrinol (Oxf)*, 2009, no. 70(5), pp. 788-793. DOI: 10.1111/j.1365-2265.2008.03390.x.
26.Boucai L. Hollowell J.G., Surks M.I. An approach for development of age-, gender-, and ethnicity-specific thyrotropin reference limits. *Thyroid*, 2011, no. 21(1), pp. 5-11. DOI: 10.1089/thy.2010.0092.
27.Ehrenkranz J., Bach P.R., Snow G.L., Schneider A., Lee J.L., Ilstrup S., Bennett S.T., Benvenga S. Circadian and Circannual Rhythms in Thyroid Hormones: Determining the TSH and Free T4

Reference Intervals Based Upon Time of Day, Age, and Sex. *Thyroid*, 2015, no. 25(8), pp. 954-961. DOI: 10.1089/thy.2014.0589.
28.Martínez Brito D., Botrè F., Romanelli F., de la Torre X. Thyroid metabolism and supplementation: A review framed in sports environment. *Drug Test Anal*, 2022, no. 14(7), pp. 1176-1186. DOI: 10.1002/dta.3257.
29.Masoumi Z.T., Pishva H. Does diet and activity lead to difference in resting energy expenditure in obese women? *BMC Womens Health*, 2023, no. 23(1), p. 335. DOI 10.1186/s12905-023-02480-3.
30.Ozcelik F., Dastan A., Pence H., Ciraci M. Adaptive contribution of thyroid hormones in obesity. *International Journal of Negative Results*, 2019, no. 9;1(2), pp. 1-1. DOI: 10.14302/issn.2641-9181.ijnr-18-2530.

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DEVELOPMENT AND SCIENTIFIC JUSTIFICATION OF THE THERAPEUTIC AND RECREATIONAL, LANDSCAPE AND CLIMATIC POTENTIAL OF THE "TROPA KEDROVAYA" TERRAIN CURE PATH IN YUZHNO-SAKHALINSK

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Annotation. Scientifically justified, therapeutic and recreational, landscape and climatic potential of the "Tropa Kedrovaya" terrain cure path in Yuzhno-Sakhalinsk was identified. The initial data included results of comprehensive monitoring (bioclimatic, landscape, ecological) of the "Tropa Kedrovaya" terrain cure path, reference materials of long-term (meteorological, heliophysical, ecological) observations on the weather station of Yuzhno-Sakhalinsk. The conducted study has identified landscape and recreational potential of the path located in the "Gornyj Vozdukh" Sports and Tourism Complex according to the modular technology accepted in balneology, the value (2.16 points out of 3) shows its compliance with the highest rank (the first) and characterizes it as favorable. Value of the microbioclimatic potential K(BKP) amounted to 2.24 points out of 3, which corresponds to the gentle effect of microbioclimate on the human body. The route of the "Tropa Kedrovaya" path may be used for health tourism, its landscape and climatic resources – for climate therapy.

Keywords: landscape and climatic potential, terrain cure, ecology, bioclimate, health tourism, recreation, Sakhalin.

Introduction. Effectiveness of health tourism depends on a presence and variability of natural healing resources (landscapes and biological climate), their qualitative and quantitative characteristics and a possibility of comprehensive application in landscape therapy, climate therapy, sport and eco-tourism.

Currently in Russia, due to the shortage of foreign tourist flows, a study and development of new prospective locations with high landscape, climatic and balneological potential to create new resorts, health locations, sports and health centers is of special value [1-2].

From this point of view, an idea to examine the natural landscape and climatic potential of the mountain area in Yuzhno-Sakhalinsk for the development of summer health tourism and recreation gains relevance [3]. The studies have shown [4] that the effectiveness of resort treatment and health tourism depends in many ways on the rank, features of health functions of different bioclimatic modules, a possibility to apply them in many ways for therapeutic purposes, the presence and degree of severity of pathogenic and environmental factors of the surrounding environment, collectively identifying the health potential of the natural environment, which determined the purpose of the study.

The "Gornyj Vozdukh" Sports and Tourism Complex, located in Yuzhno-Sakhalinsk on the Bolshevik (601 m above sea level) and Krasnaya (779 m above sea level) mountains, is the best ski resort of the Far East, winner of the "Leaders of the sports industry" award in the nomination of the "Best ski resort in Russia". In this regard, it is relevant to develop an infrastructure in this territory also for various summer types of recreational activity, in particular – recreational routes of the terrain cure paths.

The purpose of this study was to develop and scientifically substantiate therapeutic and recreational, landscape and climatic potential of

the "Tropa Kedrovaya" terrain cure path in Yuzhno-Sakhalinsk.

The work was carried out according to the contract No 43-23 dated February 22, 2023 with the "Gornyj Vozdukh" Sports and Tourism Complex to perform a study work titled "Estimation of the landscape and climatic potential of the recreational routes located in the "Gornyj Vozdukh" Complex of the Sakhalinsk Oblast".

Methods and organization. The research materials included the results of comprehensive monitoring (bioclimatic, landscape, ecological) of the "Tropa Kedrovaya" terrain cure path; reference materials of long-term (meteorological, heliophysical, ecological) observations on the weather station of Yuzhno-Sakhalinsk and guiding documents, SNiPs, GOSTs, state reports and scientific articles.

The study also included route observation (bioclimatic, landscape, ecological) of the "Tropa Kedrovaya" terrain cure path, comprehensive methods and estimation models of climate and landscapes for balneological and health tourism reasons [5-11], math and analytic techniques of evaluating the landscape and climatic potential (LCP).

The observation procedure of the "Tropa Kedrovaya" path was carried out from June 13 to 24, 2023. The procedure included measurements of positively and negatively charged light air ions (with mobility of K>0,5 $cm^2/(V•s)$), the number of aerosol particles of various dimensional gradations (8 gradations in the range of 0.2 to 10 μm) in the surface atmosphere at the height of human breathing of 1.5 m, identification of air temperature and humidity, ambient dose equivalent rate (ADER) of gamma radiation, estimation of orography, flora, and natural panoramas [10].

The LCP evaluation was carried out with a comprehensive method of modular analysis of the balneological significance of landscape elements (geography, flora, water bodies, their landscape and aesthetic quality), bioclimate (meteorological, radiation, circulation, ionization), ecological state of the natural environment with the identification of categories of their suitability for the health tourism purposes according to the standards accepted in balneology [10].

The following devices were used: MAC-01 light-sized air ion counter (State Register of measuring instruments No 20429-11), RadiaSkan-801 radiation dosimeter (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), DT-1309 light meter, IKV-8 air quality monitor (State Register of measuring instruments No 71394-18), Polar V800 heart rate monitor.

Results and discussion. According to the observational data, five sample areas (SA) / terrain cure stations were identified on the path for the aforementioned comprehensive observations, according to the materials of which we have developed suggestions on their rational application in health tourism. Length of the "Tropa Kedrovaya" path is 3450 m, height difference – 524 m, maximum surface grade of the route – 24°. The route's configuration is presented with the corresponding SA coordinates in the table 1, graphically – on the figure 1, where the SA locations with different landscape and climatic conditions are indicated.

The path starts in the Valley of Tourists on the north-western slope of Krasnaya in the area of the lower cable car station and stretches up the slope.

The landscape and climatic potential of the "Tropa Kedrovaya" path is based on orographic features of mountains', water bodies' locations, as well as the local flora.

Microbioclimatic features on the territory of the terrain cure path are presented in table 2, which indicates the absence of a sharp variability of hygrothermal indices.

Table 1

Reconnaissance sketch of the “Tropa Kedrovaya” terrain cure path

SA No	Location description	Northern latitude, °	Eastern latitude, °	Height above sea level, m	Physiological expenditure, kcal*
SA-1	The path’s beginning in the Valley of Tourists	46.942327	142.805960	232	0
SA-2	Turn on the serpentine	46.945945	142.811007	309	133
SA-3	Location on the	46.944093	142.816590	464	448
SA-4	Gabions and springs	46.941714	142.827744	630	781
SA-5	Upper cable car station	46.934848	142.831790	756	1022

Note: SA – sample area/terrain cure station; * – the calculation of energy consumption was identified while walking at an average speed of 2.4 km/h according to the pulse of a man aged 45 years, 85 kg

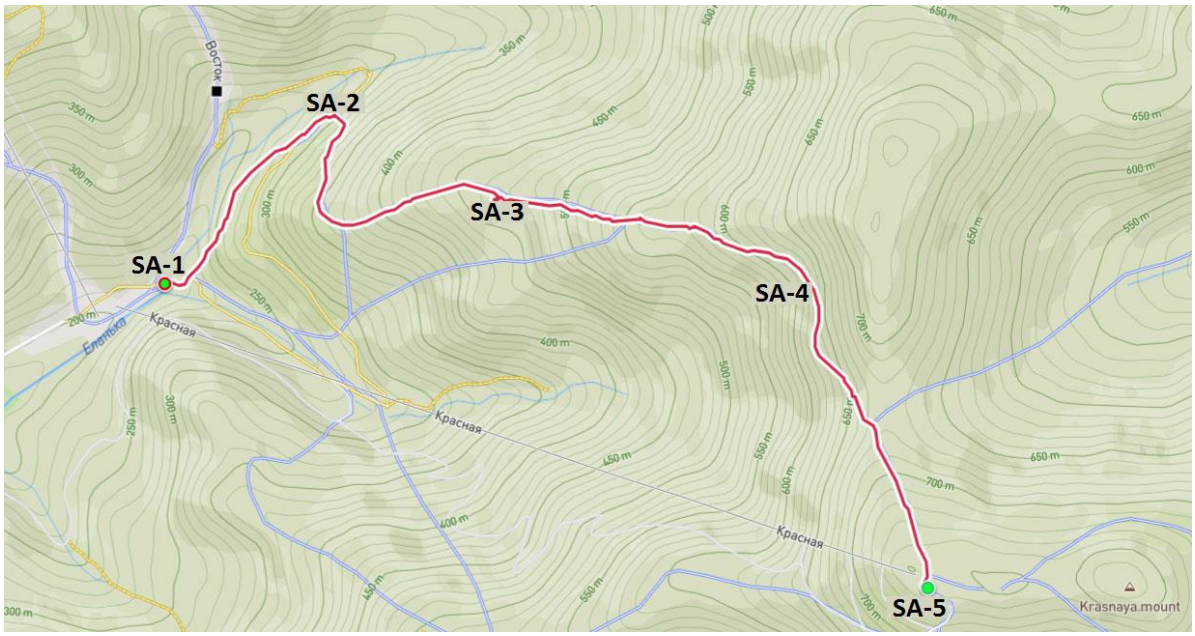

Fig. 1. The sample areas’ scheme of “Tropa Kedrovaya” terrain cure path

Note: SA – sample area/terrain cure station

Table 2

Values of the microbioclimatic modules on the “Tropa Kedrovaya” terrain cure path

SA No	Microbioclimate indices						
	T, °C	RH, %	AP, hPa	O_2, %	CO_2, ppm	∑ [(N-)+(N+)] /IUC, background	O/T, klx
SA-1	20.0	63.5	981	20.7	430	850/0.7	23.7/5.7
SA-2	16.4	64.6	973	20.8	419	1610/0.66	23.7/12
SA-3	24.1	52.6	956	21.2	415	1380/0.75	23.7/5.2
SA-4	23.7	41.2	937	21.1	385	1440/0.67	23.5/ns
SA-5	21.7	44.9	923	21.0	390	1260/1	23.4/ns

Note: SA – sample area/terrain cure station; T, °C – air temperature; RH, % – relative humidity; O_2, % – relative oxygen content in the air; CO_2, ppm – carbon dioxide content, units/million in the air; AP, hPa – air pressure; ∑[(-) + (+)] / IUC – air ionization background on the SA, ion/cm^3; O/T – illuminance (klx), in the open (O), and under the tree crown (T); IUC – ion unipolarity coefficient; ns – no shadow

One of the main health functions of microbioclimate of the path's territory is a high level of air ionization of the surface atmosphere (∑ 850-1610 ion/cm^3) with a low IUC (0.66-1), which demonstrates enhanced health properties of the surface atmosphere.

During the study, relative oxygen content on the path amounted to 20.7-21.2% relative to the standard values of 21%. Carbon dioxide content was 385-430 ppm (particles/million). This indicator was below the permissible level of 450 ppm for an open area, which characterized the air throughout the entire length of the path as clean and fresh (fig. 2).

Another important index reflecting cleanness of the air is the level of aerosol particles of the surface atmosphere in the range of 0.2 to 10 µm. The values of this index varied from 10605 (near SA-4 in the area of the upper cable car station) to 108088 (in the Valley of Tourists at the lower cable car station) particles/l. The lowest values (5724 particles/l) were recorded at the top of Krasnaya at an altitude of 780 m above sea level, 200 meters from the upper cable car station (fig. 3).

The level of biologically significant aerosol in a particle range from 0.5 to 1 µm did not exceed the norm on the most part of the "Tropa Kedrovaya" path. The excess was recorded in the Valley of Tourists in the area of the lower cable car station, where the main part of the territory is covered with gravel and allocated for ski slopes. The lowest value of ultrafine aerosol (485 particles/l) was recorded in the area of SA-5 at the top of Krasnaya, near the upper cable car station (fig. 4).

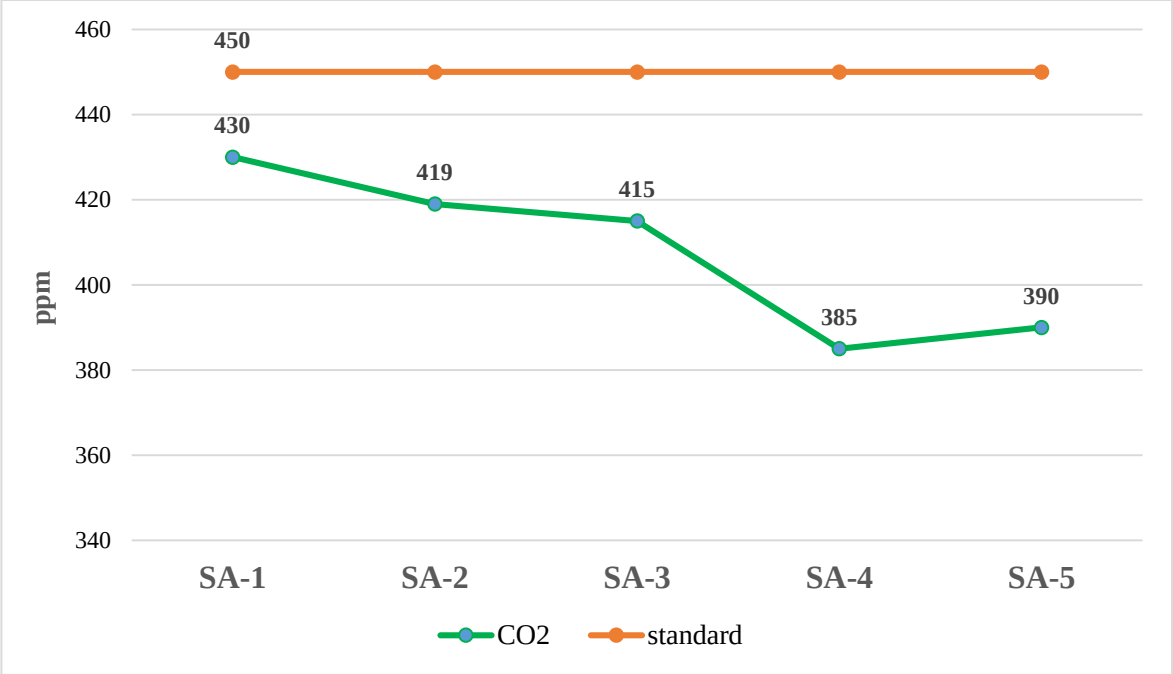

Fig. 2. Relevant CO_2 content in the air on the "Tropa Kedrovaya" path
Note: SA – sample area/terrain cure station

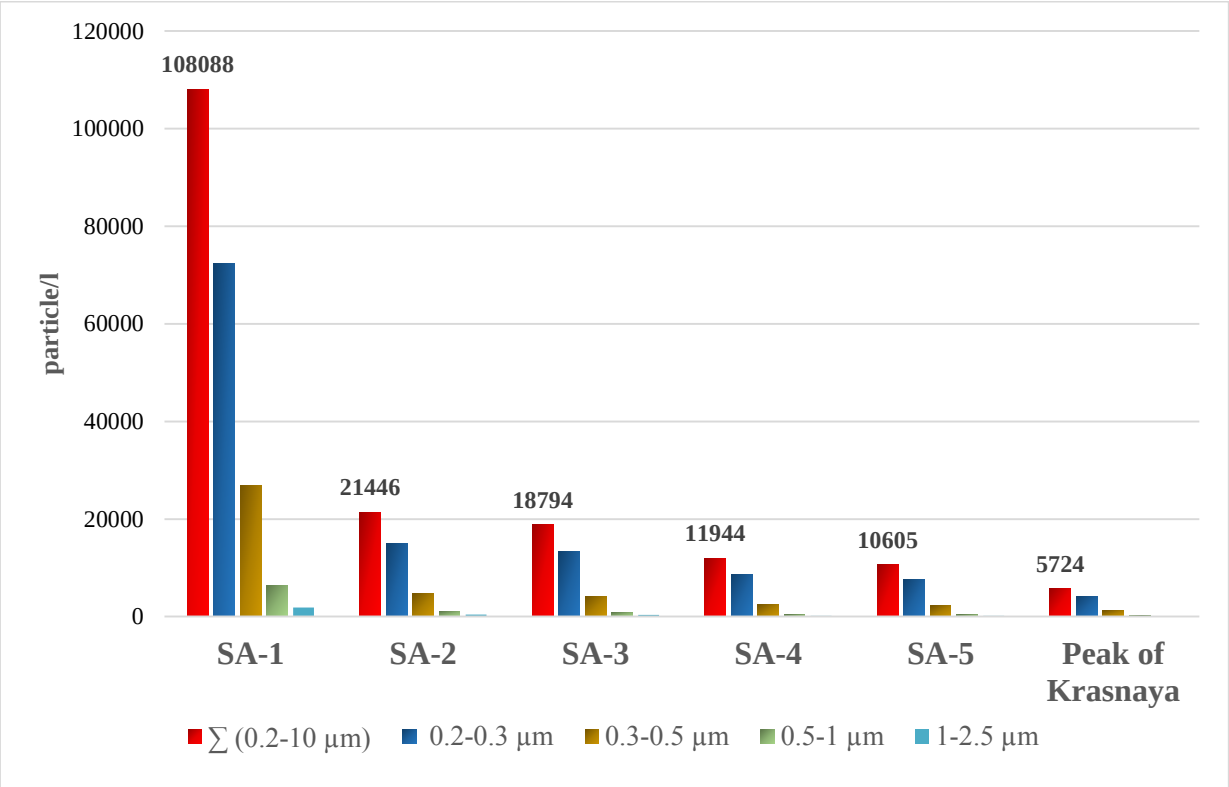

Fig. 3. Aerosol pollution of the surface atmosphere with particles of different sizes on the "Tropa Kedrovaya" terrain cure path

Note: SA – sample area/terrain cure station

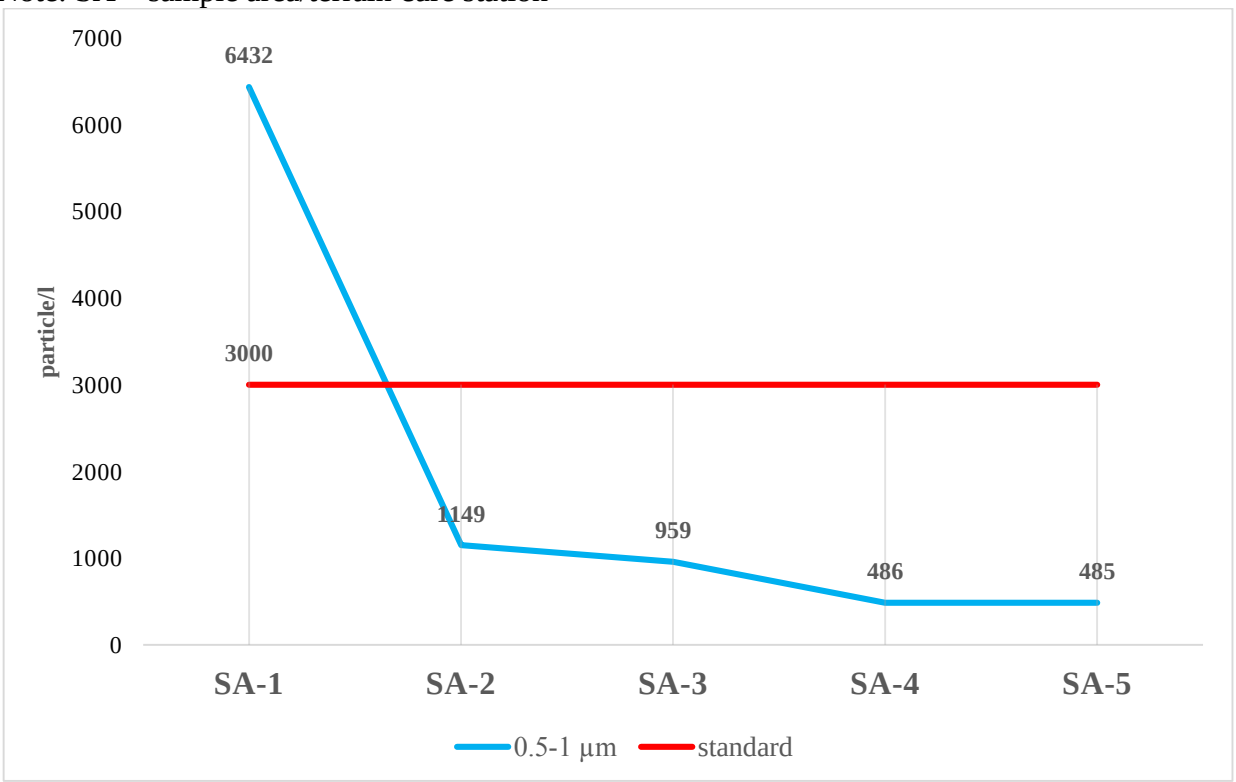

Fig. 4. Aerosol pollution of the surface atmosphere with 0.5-1 µm particles on the "Tropa Kedrovaya" terrain cure path

Note: SA – sample area/terrain cure station

One of the main resort and tourist significant elements of the path's landscape is the abundant fauna (fig. 5), presented by following coniferous trees: Sakhalin fir, Jezo spruce, larch, Siberian dwarf pine that is occasionally encountered on the path; broad-leaved trees, such as Erman's birch, Manchurian alder, mountain ash, willow, elder-tree etc. [12-14].

The path's territory as a whole has a favorable complex of plant communities that have therapeutic, environment-forming functions with the nutritional and medicinal gifts of nature [15].

Another important function of the forest on the terrain cure path is a presence of volatile organic compounds (VOC) in the surface atmosphere that possess therapeutic and health properties. VOC have a positive effect on the blood circulating system. For example, when inhaling volatile phytoncides of coniferous trees, the resistance of erythrocytes to a lack of oxygen increases, which almost doubles their life span. Volatile phytoncides also influence physical and chemical composition of air. They contribute to an increase of negative ion concentration in the air and reduce concentration of positive ones. Phytoncides ionize air oxygen, stimulating its biological activity. Moreover, they improve the efficiency and economy of the cell's energy, contribute to the settling of dust particles. Landscape resources of the plants in this natural zone reflect great prospect of developing natural air and phytotherapy in case of the proper arrangement of paths and design of the territory [16].

Elements of the landscape and recreational potential of the area with an estimation of their resort and tourist significance on the "Tropa Kedrovaya" terrain cure path (according to 25 modules) are presented in table 3.

Fig. 5. View on the "Tropa Kedrovaya" terrain cure path

Table 3

Balneological assessment of landscape modules on the “Tropa Kedrovaya” terrain cure path

No	Landscape parameters	Characteristics	Category of suitability for resort and recreational use	Score, points
1. Location’s orography modules				
1	Orography	Steep slope (less than 24º) in a low-mountain area	Relatively favorable	1
2	Exposure of slopes, rumba	The slope of Krasnaya and other picturesque slopes of neighboring mountains	Very favorable	3
3	Height above sea level, m	232 to 756	Favorable	2
4	The path’s slope, °	Average – 7.8°, maximum – 24°	Favorable	2
5	Distance from the part to the nearest public asphalt road, m	~370	Favorable	2
6	The variation degree of the natural underlying surface	On the main part of the path, the underlying surface is artificial soil	Favorable	2
			Total score (12/6)	**2.0**
2. Location’s fauna modules				
1	Forest stand	Mixed coniferous and broad-leaved trees, mainly coniferous trees of the II-III class (occasionally fallen trees)	Very favorable	3
2	Crop density	On separate timbered areas – 0.6-0.8	Very favorable	3
3	Bonitet, class	All tree bonities were registered in coniferous and deciduous forests, II-III class	Favorable	2
4	Density of undergrowth, composition	Dense forest, visibility ~100 m	Favorable	2
5	Ratio of shadow and open spaces on the path’s routes, %	20:80	Favorable	2
6	Proportion of green areas, %	More than 60	Very favorable	3
7	Clutteriness	No fallen trees	Very favorable	3
			Total score (18/7)	**2.6**
3. Attractive views of natural panoramas				
1	Contrast of borders between landscape elements	High variability of landscape elements and flora, especially in open areas	Very favorable	3,0
2	The colorfulness of mountain panoramas	Pronounced	Very favorable	3,0

Table 3 (continued)

3	The degree of diversity of the approximate (0-500 m) attractive mountain panoramas	High	Very favorable	3,0
			Total score (9/3)	**3.0**
4. Modules of soil quality and the underlying terrain surface				
1	Soil types	Mountain brown-taiga nonpodzolized and weakly podzolized matted soils, mountain-forest brown soils with a small thickness of the humic horizon; in some places they are characterized by the development of gleization, increased acidity	Favorable	2
2	Soil humidity	On most of the path – dry	Relatively favorable	1
3	Swamp percentage, %	~1	Very favorable	3
4	Landslides	1-3%	Relatively favorable	1
5	Seismicity	8-9	Relatively favorable	1
6	Karst	None	Very favorable	3
7	The number of one-time visitors on the path's territory, people/ha	0-1	Very favorable	3
8	Degree of preservation of the underlying surface	The soil periodically shifts on the surface	Relatively favorable	1
			Total score (15/8)	**1.88**
5. Heat and moisture availability of vegetation cover				
1	G.T. Selyaninov hydrothermal coefficient (HTC)	1,3 – slightly arid	Favorable	2
Comprehensive LCP assessment		$=\sum K_1+\ldots\ldots+K_{25}/25=\sum 54/25=2.16$		Favorable
Landscape rank		1		High

The microbioclimatic potential of the "Tropa Kedrovaya" terrain cure path occurs under effect of the main climate forming factors: atmospheric circulation, solar radiation, environmental features of the territory.

Following favorable microbioclimatic features of the territory were found: relatively gentle hygrothermic mode, high purity of the surface atmosphere, the presence of preventive, biologically active ultraviolet solar radiation (with a wavelength of 290-315 nm), an increased level of natural air ionization, a long period with favorable outdoor conditions – 239 days a year (table 4).

Table 4

Microbioclimatic potential of the “Tropa Kedrovaya” terrain cure path

No	Microbioclimatic modules	Value	Category of the medical and climatic conditions	Score, points
1. Microbioclimatic modules (K_1/n = 35/16 = 2.19 points)				
1	The number of days in a year with comfort, a weak subcomfort for outdoor walks (for sick and weakened people)	76	Sparingly training	2
2	Summer period (EET>15 c.d.), days	44	Training	1
3	Cold period (EET<0 c.d.), days	154	Especially favorable for winter sports	3
4	The number of days in a year with favorable outdoor weather for summer and winter recreation (if ET>-10 c.d. and the weather pathogenic factors are absent)	239	Sparing	3
5	Frost-free period, days	126 (102 to 160)	Sparingly training	2
6	The number of days in a year with a stable snow cover, days per year	150 (129 to 189)	Especially favorable for winter sports	3
7	The number of days in a year with a hot supercomfort day (RET >22 c.d.)	10	Especially favorable	3
8	Average monthly air temperature in January, °C	-13.7	Sparing	3
9	Average monthly air temperature in July, °C	16.8	Sparing	2
10	Average annual air temperature, °C	2.2	Training	1
11	Absolute maximum of air temperature, °C	+34	Sparingly training	2
12	Absolute minimum of air temperature, °C	-36	Training	1
13	Snowstorm, days per year	32	Sparingly training	2
14	Rain days per year ≥ 1 mm for a year	101	Sparingly training	2
15	Days with thunderstorm per year	7	Sparing	3
16	Days with mist per year	62	Sparingly training	2
2. Sun radiation modules (K_2/n = 21/9 = 2.33 points)				
1	Hours of sunshine per year	1870-1933	Sparingly training	2
2	Sunny day average duration, hours	6.1	Sparingly training	2
3	Amount of solar per year, kWh/m^2	1248.8	Sparingly training	2

Table 4 (continued)

4	The gradation of the biological effect of solar radiation according to the magnitude of the UVI (ultra violet index) and the degree of potential danger of the damaging effects of UV solar radiation in winter at noon, c.u.	0.5-1	Sparing	3
5	Hours of sunshine in July	156	Sparing	3
6	Hours of sunshine in December	122	Sparingly training	2
7	Number of sunless days per year	59	Sparingly training	2
8	Number of sunless days in July	7	Sparingly training	2
9	Number of sunless days in January	6	Sparingly training	3
3. Circulation modules (K_3/n =10/5 = 2.0 points)				
1	Number of cyclones per year	50	Sparingly training	2
2	Wind force: the number of days per year with a wind speed of 15 m/s or more	20	Training	1
3	Average wind speed in summer, m/s	3,2	Sparing	3
4	Average wind speed in winter, m/s	3,5	Sparing	3
5	Maximum wind gust, m/s	40 (18-40)	Training	1
4. Air humidity modules (K_4/n = 11/5 = 2.2 points)				
1	Repetition rate of relative humidity values below 30%, days per year	7	Sparing	3
2	Repetition rate of relative humidity values at noon above 80%, days per year	97	Sparingly training	2
3	Average monthly relative air humidity at 1 PM in July, %	79	Sparingly training	2
4	Average monthly relative air humidity at 1 PM in January, %	77	Sparingly training	2
5	Repetition rate of weather with the “sultriness” phenomena in summer, %	3%	Sparingly training	2
5. Air ionization modules (K_1/n = 6/2 = 3.0 points) – unique conditions				
1	Level of negatively charged light oxygen ions (N^-), ion/cm^3 (according to the summer data)	850-1610	Sparing	3
2	Ion unipolarity coefficient (IUC)	0.66-1.0	Sparing	3
Results:				
$K(BKP)=\sum K_1+\ldots\ldots+K_{37}=83/37$ = 2.24 points				

Note: EET – equivalent-effective temperature; ET – effective temperature; RET – radiation-effective temperature

Therefore, the microbioclimatic potential index (K(BKP)) scored 2.24 points out of 3, which conditionally corresponds with a sparing microbioclimatic effect on a human body and favorable conditions for health tourism, as well as increased potential possibilities of the examined location for climate therapy arrangement (air cure and solar treatment, prevention of UV

insufficiency, staying outdoors for a long time, natural air, ion and phytotherapy).

Conclusion. Natural objects and conditions, climate properties of the "Tropa Kedrovaya" terrain cure path may be used for sport tourism, disease prevention and recreation organization.

Landscape and climatic resources of the Susunai ridge slopes and its separate parts (Krasnaya) may degrade and need protection.

In order to fully implement the potential of these natural resources for the purposes of health improvement of the population, it is necessary to justify their use in the field of resort medicine, recreational tourism and sports.

After the comprehensive monitoring procedure and creation of the bioclimatic profile of the "Tropa Kedrovaya" terrain cure path, we have prepared a list of improving measures: installation of signs that will help tourists navigate along the route, with a distance from the beginning to the end of the path; mesh floors to protect visitors and the path from falling stones and soil; creation of separate comfortable recreation areas on the path with hammocks, benches and other infrastructure, including trash bins.

In order to use landscape and climatic resources of the "Tropa Kedrovaya" path accordingly, following activities are recommended for tourists:

- slow walking along the terrain cure path with solar insolation of exposed parts of the body (5-10 minutes) in order to prevent UV insufficiency;

- solar treatment in recreational areas on the route: usually with a small (hygienically recommended) solar insolation dose (1/8-1/4 of a biodose);

- recuperation at rest in the shade of coniferous and broad-leaved plants for 5-10 minutes (natural air, ion and phytotherapy);

- long-term recuperation at rest or sleep in the shade of coniferous and broad-leaved plants;

In the period of the year with temperature above 10 °C walk training sessions should take place 2-3 times every week for 1 month, then 1-2 times a week for 1 month, then the above mentioned steps are repeated. If the body has a good ability to withstand physical loads, it can be increased (e.g. change the sparing mode to the sparingly training mode). During the period of the year with negative air temperatures, it is advisable to switch to winter types of physical training (e.g. skiing);

- sports training with the use of mountain terrain cure path;

- landscape relaxation with the psycho-emotional impact of the natural beauty of mountain panoramas.

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REFERENCES

1. Federal law No. 26 dated 23.02.1995. "About natural healing resources, health areas and resorts". (in Russ.)

2. GOST 17.8.1.02-88. Interstate standard. Nature protection. Landscapes. Classification. Nature protection. Earth. Collection of GOSTs. Moscow: Izdatel'stvo standartov, 2002. (in Russ.)

3. Koryagina Yu.V., Povolotskaya N.P., Nopin S.V., Ter-Akopov G.N., Popov A.N. Landscape and climatic potential of the health route of the "Detskaya tropa" terrain cure walking path in Yuzhno-Sakhalinsk. *Modern Issues of Biomedicine*, 2022, vol. 6, no. 3. DOI: 10.51871/2588-0500_2022_06_03_31. (in Russ.)

4. Efimenko N.V., Zherlitsina L.I., Povolotskaya N.P. et al. Systematic approach to the use of heliogeophysical factors in preparation of medical weather forecasts for federal resorts of Caucasian Mineral Waters. XIII International Crimea Conference "Cosmos and biosphere". Simferopol: ARIAL, 2019. pp. 64-67. (in Russ.)

5. Efimenko N.V., Povolotskaya N.P., Kajsinova A.S. et al. Method of resort assessment of forest landscapes of mountain territories for the purposes of climate and landscape therapy in resort treatment of the contingent to be serviced by the FMBA of Russia: manual for physicians. Approved by the Deputy Head of the FMBA V.B. Khavkina 17.12.2015. Registration number: 82-15. Pyatigorsk: Pyatigorsk State Research Institute of Balneology of the FMBA of Russia, 2015. 26 p. (in Russ.)

6. Povolotskaya N.P. Weather classification and assessment of thermal comfort during climate therapy and recreation in the CMW. Issues of medical

climatology and climate therapy of patients in resorts. Pyatigorsk: Pyatigorsk State Research Institute of Balneology and Physiology, 1975. pp. 16-23. (in Russ.)
7. Balneology of the Caucasian Mineral Waters: scientific work. Under the editorship of V.V. Ujba. Pyatigorsk: Pyatigorsk State Research Institute of Balneology of the FMBA of Russia, 2011. 368 p. (in Russ.)
8. Mikhajlenko V.I., Mikhajlenko A.V., Povolotskaya N.P. et al. Natural resource potential of territory and environmental management: regional aspects. Learning guide. Pyatigorsk: SevKav-GTU, RIA-KMV, 2007. 320 p. (in Russ.)
9. Granberg I.G., Povolotskaya N.P., Golitsyn G.S. et al. Medical weather forecasting system in federal resorts of the Caucasian Mineral Waters: methodological guidelines. Pyatigorsk: Pyatigorsk State Research Institute of Balneology of the FMBA of Russia, Obukhov Institute of Atmospheric Physics of the Russian Academy of Sciences, 2009. 23 p. (in Russ.)
10.Povolotskaya N.P., Slepykh V.V., Zherlitsina L.I. et al. Method for assessing landscape and climatic potential of resorts and health locations: methodological guidelines of the FMBA of Russia No. 13. Pyatigorsk: FMBA of Russia, FSBI "North-Caucasian Federal Research-Clinical Center of Federal Medical and Biological Agency", 2021. 39 p. (in Russ.)
11.Health of the Russia's population: environmental influence in conditions of climate change. Collective monograph, under the editorship of A.I. Grigor'ev. Moscow: Nauka, 2014. pp. 355-370. (in Russ.)
12. Report on the state and environmental protection of the Sakhalin Oblast in 2020. Ministry of Ecology of the Sakhalin Oblast. Yuzhno-Sakhalinsk: LLC "Eikon", 2021. 179 p. (in Russ.)
13.State Report "On the state of sanitary and epidemiological welfare of the population of Sakhalin Oblast in 2021". Yuzhno-Sakhalinsk: Sakhalin Oblast Department of Rospotrebnadzor, 2022. 198 p. (in Russ.)
14.State Report "On the state of protection of the population and territories of the Russian Federation from emergency situations natural and man-made nature in 2020". Moscow: Ministry of Emergency Situations of Russia, 2021. 264 p. (in Russ.)
15. Nikolaev V.A. Landscape science. Moscow: Moscow State University, 2000. 94 p. (in Russ.)
16. Handbook on physical geography of the Sakhalin Oblast. Yuzhno-Sakhalinsk: Sakhalin Book Publishing House, 2003. 112 p. (in Russ.)

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THE EFFICIENCY OF APPLYING THE EXERCISE THERAPY FOR THE ELDERLY WITH GRADE 1 COXARTHROSIS

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Annotation. The article demonstrates the results of applying exercise therapy for the elderly with grade 1 coxarthrosis. The effectiveness of the exercise therapy is represented by an increased range of motion in the affected joint according to goniometry, a decrease in joint dysfunction according to the Trendelenburg Test, and a reduced pain intensity in the affected lower limb according to the visual analogue scale. The data obtained can be implemented in the development of physical rehabilitation programs for grade 1 coxarthrosis and in the work of experts in adaptive physical culture with the examined contingent.
Keywords: grade 1 coxarthrosis, hip joint, exercise therapy.

Introduction. Coxarthrosis is a heterogenic group of diseases of various origin with similar biological, morphological, clinical signs and outcome, based on the lesion of all the joint's components: cartilage, subchondral bone, synovial membrane, ligaments, capsule and periarticular muscles [1].

The musculoskeletal system diseases in adults rank second in the category of temporary incapacity to work and third among causes of disability and death. According to literature references, in recent years not only increasing incidence of the hip joint pathology was noted, but also the disease occurs in younger ages, and in more complicated forms as well [2].

In case of more complicated forms, pain, impaired support function and reduced movement amplitude in the hip joint lead to an inability to work or its limitation, make self-care difficult, making quality of life worse and turning such patients into the disabled in 38-71% of cases [3].

This disease is characterized with a wide variety of clinical signs, accompanying symptoms, severity of motor disorders, compensation degrees, reasons that caused the diseases, which create complications for preserving skills needed in life [4].

The purpose of our study – to evaluate the efficiency of applying exercise therapy for the elderly with grade 1 coxarthrosis.

Methods and organization. The study took place in the Central Hospital of the Federal Customs Service in Moscow, from November 2022 to February 2023.

The study involved 9 people, including 4 men and 5 women aged 63 to 74 years with grade 1 coxarthrosis.

Goniometry was carried out to assess movement amplitude in the affected lower limb, as well as mobility in the hip joint. Extension, tension and retraction amplitude were also examined, the results were calculated in °.

The Trendelenburg test was used for identifying dysfunction of the hip joint in the affected limb. The pain intensity was assessed with the visual analogue scale. The obtained results were processed with statistical methods: we calculated the arithmetic mean and standard deviation. The significance of changes in the examined indices in parametric methods was evaluated with the Student's T-test (if $p \leq 0.05$), when applying non-parametric methods – with the Wilcoxon signed-rank test (if $p \geq 0.05$).

To correct motor disorders, the elderly passed an exercise therapy course, which was divided into 3 periods: sparing period – 3 weeks, sparing and practice period – 4 weeks and practice period – 6 weeks, including means and forms are described in the table 1.

Table 1

Content of the exercise therapy course for the elderly with the grade 1 coxarthrosis

Means and forms of the exercise therapy	Sparing period (3 weeks)	Sparing and practice period (4 weeks)	Practice period (6 weeks)
Morning hygienic gymnastics (MHG)	+	+	+
Therapeutic gymnastics (TG)	+	+	+
Therapeutic massage	+	+	+
Physiotherapy	+	+	-
Mechanotherapy	-	+	-
Controlled walking	-	+	+
Hydrokinesiotherapy	-	-	+
Independent classes	-	-	+

The sparing period took three weeks. Main methods and forms: MHG included calisthenics for all muscle groups, breathing static and dynamic exercises. MHG were done daily for 5-7 minutes. TG were done 3 times a week for 20-25 minutes and included exercises for strengthening muscles of the lower limbs and joints, exercises for increasing mobility in the hip joints, exercises on massage mats, exercises on a force plate, exercises with objects and gymnastic apparatus. Full extension in the hip joint was not allowed. The massage sessions took place after TG. The anterior and posterior surfaces of the thigh and the hip joint were massaged (stroking and rubbing). The shockwave therapy was used on the hip joint and surrounding muscles. The course consisted of 5-7 sessions for 10-15 minutes.

The sparing and practice period took 4 weeks. Main methods and forms: MHG sessions daily, 5-7 minutes each. The TG took 3 times a week for 30-35 minutes. We also added exercises for coordination, active exercises for the distal regions of the lower limbs, isometric stress exercises for the gluteal muscles, exercises for the hip joint flexion and extension. During the therapeutic massage course, the thigh and lumbar muscles were massaged (stroking, rubbing and kneading). The magnet therapy was used on the hip joint, surrounding tissues and the lumbar spine in a form of bicycle ergometer sessions. They took 2 times a week for 10-12 minutes. The speed was 5-7 km/h. These sessions were conducted instead of TG sessions. The controlled walking sessions were carried out 4 times a week with a speed of 40-60 steps per minute and a distance of 1-1.5 km. It was recommended to conduct these sessions outdoors or on a training device (running machine).

The practice period took 6 weeks. Main methods and forms: MHG sessions daily for 10 minutes. TG took 4 times a week for 40-45 minutes, we also added exercises for strengthening muscles of the lower limbs and joints, exercises for increasing mobility of the hip joint, stretching exercises, exercises for relaxing spasmic muscles. During the therapeutic massage course all techniques were used.

Impact was made on the hip joint, surrounding tissues and the lumbar spine. Hydrokinesiotherapy sessions took 2 times a week for 40-45 minutes, including calisthenic exercises on the edge of the pool, breathing exercises, exercises with objects, exercises with imitation of swimming styles (front and back crawl, breast-stroke). Controlled walking sessions were carried out 4 times a week with a speed of 80-100 steps per minute. Distance – 2 km. Independent classes took place daily, 3 times a day for 15-20 minutes. These classes included exercises from TG sets.

Results and discussion. The goniometry study of joint mobility was carried out before and after the exercise therapy course, the received data is presented in table 2.

Table 2

Goniometry results of the affected lower limb during the course of rehabilitation measures among the elderly with grade 1 coxarthrosis

Test type	Results, °		Difference in a.u.	Difference in %	Student's T-test (T_{crit}=2.12)	P≤
	before	after				
	$X_{mean}±σ$	$X_{mean}±σ$				
Flexion	141.2±1.3	122.6±1.4	18.6	13.2	9.74	0.05
Extension	173.2±2.1	161.6±1.8	11.6	6.7	4.19	0.05
Retraction	21.7±1.5	26.5±1.4	4.8	18.1	2.34	0.05

After the course, dynamics of goniometry indices in the hip joint in flexion amounted to 13,2%, changing from 141.2±1.3° to 122.6±1.4°, in extension – from 173.2±2.1° to 161.6±1.8° with dynamics of 6.7%, in deviation – from 21.7±1.5° to 26.5±1.4° with dynamics of 18.1% (p≤0.05).

The goniometry data reflect increased joint mobility of the lower limb, which, in our opinion was supported by the use of specific TG exercises (correction of the main defect, stretching exercises, relaxation exercises), therapeutic massage and mechanotherapy.

Dynamics of the hip joint dysfunction indices after the course, assessed with the Trendelenburg test, are presented in table 3.

The hip joint's dysfunction degree, evaluated with the Trendelenburg test, has significantly reduced – the test's results changed by 28.2% (p≤0,05), from 21.4±1.2 to 29.8±0.8 s.

Table 3

Dynamics of the hip joint dysfunction indices after the course among the elderly with grade 1 coxarthrosis

Test	Results, s		Difference in a.u.	Difference in %	Student's T-test (T_{crit}=2.12)	P≤
	before	after				
	$X_{mean}±σ$	$X_{mean}±σ$				
Trendelenburg test	21.4±1.2	29.8±0.8	8.4	28.2	7.1	0.05

Table 4

Dynamics of pain intensity of the hip joint after the course among the elderly with grade 1 coxarthrosis

Index	Results, points		Difference in a.u.	Difference in %	Wilcoxon signed-rank test (T_{crit} =8)	P≥
	before	after				
	$X_{mean}±σ$	$X_{mean}±σ$				
Visual analogue scale (n=9)	7.7±0.9	2.1±1.2	5.6	72.7	0	0.05

Dynamics of pain intensity of the hip joint after the course, assessed with the visual analogue scale, is presented in table 4

The pain intensity degree, assessed with the visual analogue scale, has significantly reduced by 72.7% (p≥0.05), from 7.7±0.9 to 2.1±1.2 points.

Conclusion. As a result of the rehabilitation course with the exercise therapy measures, the movement amplitude has increased, dysfunction and intensity of paint in the hip joint have reduced, which indicates the efficiency of applying the exercise therapy measures for the elderly with grade 1 coxarthrosis.

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REFERENCES

1. National Collaborating Center for Chronic Conditions (NCCCC). Osteoarthritis: national clinical guideline for care and management in adults. London: Royal College of Physicians, 2008.
2. Stasevich N.Yu., Sarkisov K.A., Smyslov I.N., Uchaikin Yu.N. Hip joint osteoarthritis as a medical and social health problem. *Klinicheskij opyt dvadtsatki*, 2015, no. 2 (26), pp. 48-51. (in Russ.)
3. Ivanova G.E., Mel'nikova E.V., Belkin A.A., Belyaev A.F., Bodrova R.A., Bujlova T.V., Mal'tseva M.N., Mishina I.E., Prokopenko S.V., Sarana A.M. et al. How to organize medical rehabilitation? *Bulletin of Rehabilitation Medicine*, 2018, no. 2(84), pp. 2-12. (in Russ.)
4. Russian Scientific Research Institute of Traumatology and Orthopedics named after R.R. Vreden. Organizing rehabilitation treatment of victims with injuries of the musculoskeletal system and their consequences. Methodological guidelines. Saint Petersburg, 2018. 29 p. (in Russ.)

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MORPHOFUNCTIONAL FEATURES OF 30-40 YEARS OLD MEN WITH OBESITY AT THE INITIAL STAGE OF HEALTH AND FITNESS CLASSES IN THE FITNESS CENTER

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Annotation. The article reflects the morphofunctional characteristics of 30-40 years old men with obesity at the initial stage of health and fitness classes in a fitness center. An increase in body mass index was revealed, corresponding to class II obesity, as well as a satisfactory state of the cardiovascular system (according to the Ruffier index) and the respiratory system (according to the respiration tests on inhale and exhale), the values of which indicate a high risk of transition to the unsatisfactory function. The results obtained indicate the high importance of studying the morphofunctional characteristics of those involved in health and fitness classes at the initial stage for the subsequent selection and control of physical activity in the studied population.

Keywords: morphofunctional characteristics, men, obesity, cardiovascular system, respiratory system, health and fitness activities, fitness center.

Introduction. Socioeconomic and other factors alongside with scientific and technological advances have suddenly limited everyday activity of the population [1], having an unfavorable effect on health [1-2]. Health of mature men is exposed to risks of the deteriorated function of cardiovascular, nervous, respiratory and other systems [3] of isolated or accompanying nature, often combined with excess body mass. Obesity is considered as a multifactor disease, the main point of which is a long-term imbalance between energy intake and expenditure [4]. Most of the male population solve this issue by working out in a fitness center, frequently – by not controlling physical loads, not estimating the initial body function, which can cause an unfavorable effect on the state of health of those engaged.

The study's purpose – to examine morphofunctional features of 30-40 years old men with obesity at the initial stage of health and fitness classes in a fitness club.

Methods and organization. The study took place in the BIOSFERA CLUB fitness&spa center (Moscow). The research included men (n=18) aged 30-40 years with diagnosed class I obesity without any concomitant cardiorespiratory pathology.

Following indices were included in the anthropometric measurements: body mass (kg) и fat component percentage (%) were identified with floor scales (Noerden SENSORI, China); girth dimensions (cm) of waist and hips were identified with a tape measure; we also calculated the body mass index (BMI) = body mass (kg) / height^2 (m) = kg/m^2. Functional state of the cardiovascular system was examined with the Ruffier test with an accompanying calculation of the corresponding index (points); the respiratory system's function was estimated with the respiratory tests on inhale and exhale. The statistical result processing was made with the Statistica 13 analysis software package: we calculated mean arithmetic values and standard deviation of the received indices and compared to standard values.

Results and discussion. The anthropometric indices of the studied group confirm the previously proven diagnosis – class I obesity (table).

Average values of body mass (144,36±10,25 kg) reflect its excess with the

existing pronounced signs of male type obesity the with the prevalence of waist girth (140.25±9.18 cm) over the hip girth (110.17± 8.44 cm), the fat component percentage is 27.91±0.94%, which together creates a high risk of diastasis of the rectus abdominis muscles [5].

Table

Description of anthropometric indices of 30-40 years old men with class I obesity, $\bar{X}\pm\sigma$

Indices	Test results
Waist girth, cm	140.25±9.18
Hip girth, cm	110.17±8.44
Body mass index, kg/m^2	46.81±1.17
Fat component, %	27.91±0.94

Moreover, the body mass index (BMI=46.81±1.17 kg/m^2) corresponds with class II obesity, which is different from the initial diagnosis – class I obesity. There can be several reasons for this: a significant time period between the diagnosis and the beginning of health and fitness classes in the center, psychological stress, improper diet, non-compliance with recommendations on the daily routine, etc.

To assess the cardiovascular system's function in conditions of dosed loads we conducted the Ruffier test, results of which (14,59±0,47 points) show low working capacity and satisfactory cardiac efficiency. Results of the respiratory tests on inhale (30.07±0.37 s) and exhale (25,41±0,59 s) reflect a satisfactory state of the respiratory system, closely bordering with the unsatisfactory function.

Conclusion. Research of the morphofunctional features of 30-40 years old men with obesity has shown a difference between the proven diagnosis and the morphofunctional state of the studied group at the initial stage of health and fitness classes in the center. We have identified the increased body mass index exceeding the range of values corresponding with class I obesity; indices of the cardiorespiratory system function correspond with values reflecting a satisfactory state with a high risk of transition to the unsatisfactory function. The obtained data reflect a high importance of studying morphofunctional features of those involved at the initial stage of health and fitness classes for a consecutive selection and control of physical activity for the examined group.

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REFERENCES

1. Zhannazarova G.K., Talipova R.N. Scientific and technological progress – positive and negative sides. *Young Scientist*, 2016, no. 21.1 (125.1), pp 16-19. (in Russ.)

2. Church T.S., Thomas D.M., Tudor-Locke C., Katzmarzyk P.T., Earnest C.P., Rodarte R.Q., Martin C.K., Blair S.N., Bouchard C. Trends over 5 decades in the U.S. occupation-related physical activity and their associations with obesity. *PLoS One*, 2011, no. 6(5), p. 19657. DOI: 10.1371/journal.pone.0019657.

3. Golovanov S.A. Comprehensive correction of men's health in conditions of aerobic physical

4. activity: an author's abstract. Moscow, 2016. 22 p. (in Russ.)

5. Kadouh H.C., Acosta A. Current paradigms in the etiology of obesity. *Techniques in Gastrointestinal Endoscopy*, 2017, no. 19(1), pp. 2-11. DOI: 10.1016/j.tgie.2016.12.001

6. Severtseva M.V., Lunina N.V. Physical rehabilitation in the correction of diastasis in women in the late postpartum period: a literature review. *Russian Journal of Sports Science: Medicine, Physiology, Training*, 2023, vol. 2, no. 1. DOI: 10.51871/2782-6570_2023_02_01_6.

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IMPROVING THE LOWER LIMBS' FUNCTION IN SPASTIC DIPLEGIA IN PRESCHOOL CHILDREN BY MEANS OF PHYSICAL REHABILITATION

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Annotation. At present, there are many methods of using physical rehabilitation means for patients with cerebral palsy, but the reliable effectiveness of many of them has not been confirmed. The complex use of means and forms of physical rehabilitation will increase mobility in the joints of the lower limbs, reduce their spasticity and improve the balance function in children with cerebral palsy. The aim of the work is to improve the function of the lower limbs, balance and reduce muscle spasticity in preschool children with cerebral palsy. As a result, the range of motion in all joints of the lower limbs increased, spasticity reduced and the balance function improved, which indicates their effectiveness in preschool children with spastic diplegia. Efficiency is confirmed by the positive dynamics of indicators of goniometry of the hip, knee and ankle joints, muscle spasticity of the lower limbs and balance function.

Keywords: cerebral palsy, physical rehabilitation, hydrokinesiotherapy, therapeutic gymnastics, mechanotherapy, massage, cycling, skiing.

Introduction. Cerebral palsy (CP) makes a group of neurological disorders that lead to disorders of motor activity, spatial body positions, as well as to contracture development. These disorders may occur as a result of developmental delay or brain damage in the early ontogeny [1]. High CP incidence among children lead to the point that this disease takes the first place among the reasons leading to disability [2].

Therapeutic gymnastics (TG) is the main way of physical rehabilitation of children with CP. It is necessary to commence TG classes as early as possible to prevent irreversible consequences such as contractures, deformities of the upper and lower limbs, disturbed balance and coordination functions, occurrence of improper motor stereotypes. Inclusion of the Gross training device, hydrokinesiotherapy, therapeutic massage, cycling and skiing has a positive effect on physical state of children with CP [3].

Currently, there is a lot of physical rehabilitation methods for CP patients, but many of them were not proven as reliably effective. There is an assumption that a comprehensive application of such methods will contribute to the increase of mobility in the joints of the lower limbs, reduction of spasticity and improvement of balance function in children with CP.

The study's objective – to improve the lower limbs' function, balance and reduce muscle spasticity in preschool children with spastic CP.

Methods and organization. The study took place in the "Three sisters" rehabilitation center located in the Moscow region for 4 months from September to December 2022. Inclusion criteria: age – children aged 4-6 years; diagnosis – cerebral palsy with spastic diplegia, period – residual. The study included 6 preschool children, 3 boys and 3 girls. Functional characteristics of the lower limbs, in particular – mobility in the hip, knee, ankle joints – were identified with the goniometry method in the following initial positions – lying on the back and lying on the stomach. The muscle spasticity indices were identified with the Modified Ashworth Scale (MAS). The balance function was assessed with the Berg scale.

Math-and-stats methods were used to process the obtained results: we identified mean values of the indices and standard deviation. The significance level of differences for parametric indices was calculated with the Student's t-test ($p \geq 0.05$), for non-parametric indices – the Wilcoxon signed-rank test ($p \leq 0.05$).

Results and discussion. The comparative analysis of the goniometry indices of the lower limb's joints before and after the course demonstrate a significant improvement of the studied indices (table).

Table

Comparative results of the goniometry indices in the hip, knee and ankle joints (°) in children with cerebral palsy

Goniometry, °	Groups		Difference		P≤
	Before rehabilitation (n=6)	After rehabilitation (n=6)			
	M±б	M±б	abs.u.	%	
Hip joint flexion	119.2±1.3	122.5±1.8	3.3	2.77	0.05
Hip joint extension	9.5±0.5	12.4±0.7	2.9	30.5	0.05
Hip joint adduction	19.9±1.8	22.9±1.8	3.0	15.08	0.05
Hip joint abduction	29.7±1.2	31.5±1.4	1.8	6.06	0.05
Hip joint external rotation	39.5±1.1	42.2±1.4	2.7	6.84	0.05
Hip joint internal rotation	29.8±2.5	33.9±2.5	4.1	13.8	0.05
Knee joint flexion	119.55±2.1	122.88±1.9	3.33	2.8	0.05
Ankle joint dorsiflexion	19.8±1.6	23.3±1.5	3.5	17.68	0.05
Ankle joint plantar flexion	33.5±0.7	42.5±1.0	9.0	26.87	0.05

The main tasks of physical rehabilitation of preschool children with CP were: development and improvement of proper motor skills, mobility in the limbs' joints, improvement of the balance indices and reduction of muscle spasticity in the lower limbs.

The course of physical rehabilitation measures with therapeutic gymnastics, mechanotherapy, hydrokinesiotherapy, therapeutic massage, cycling and skiing was divided into 3 periods of 4 months: introductory (1 month), main (2 months) and final (1 month), directed towards solving the tasks described above. The first period included adaptation of a child's body to physical loads, learning proper motor skills and motor stereotypies. The main period consisted of an active work with means and methods of physical rehabilitation to solve the set tasks. In the final period, the results were consolidated and improved.

The physical rehabilitation measures were aimed towards enhancing mobility of the lower limbs' joints, developing coordinated motor movements, improving balance, correcting accompanying disorders and deformities of the musculoskeletal system (incorrect position of the feet, posture disorders, scoliosis, hip dysplasia, etc.), overall strengthening, improving health and adaptation to increasing loads.

All these goals were achieved by adding calisthenic exercises (CE) (20% of total volume of physical exercise (TVPE)) for medium and large muscle groups, breathing exercises (BE) (10% of TVPE), special exercises (SE) (70% of TVPE): exercises for improving mobility in the joints and preventing contractures, resistance exercises (with an instructor and various equipment), exercises to learn how to kneel, walk on the knees, elements of a step and physiological walk skills without an additional support. All the exercises were performed slowly, actively and passively with the help and under control of an instructor. The children were learning to independently perform exercises for home sessions with their parents. The "RIFTON" bicycle that fixates body and limbs

in a correct position was used for cycling. Riding on that bicycle contributed to an increase of muscle strength, being a training for the vestibular system and for the development of spatial awareness, correct posture support, increasing mobility and flexibility. SE were used to learn following skills: an ability to get on and off the bike, performing alternate pedaling, riding on the bike independently. After cycling, relaxing and stretching exercises were applied. Therapeutic massage was included in the course, during all periods, performed daily for 15-20 minutes, 15 to 30 procedures in total. Before gymnastics and cycling, segmental and full-body massage was applied, after – linear and point massage. The therapeutic leg massage was done slowly, deeply, with emphasis on the calf muscles, calf flexors, with deeper work of tendons and places of their attachment to bones, alternating with passive, stretching spastic muscles, movements in the hip, knee and ankle joints. Toning massage was also done for the antagonists of spastic muscles. The stressed muscles relaxed more easily when the antagonist muscles were stressed. During the main period, the therapeutic gymnastics sessions also included SE on the "BOSU" ball for improving balance, for developing endurance, strength exercises for enhancing the lower limb muscles and fixing the feet support function. Exercises on the Gross training device: CE – exercises with a stick, a ball; BE – dynamic exercises; SE – for learning and reinforcing following skills: walking on a rehab ramp (including walking down backwards); walking through obstacles; walking up and downstairs; walking on an uneven surface while preserving balance. The pool classes were conducted with an instructor and included exercises for all muscle groups, special exercises for learning how to move in water, relaxing exercises, exercises for improving joint mobility, imitating swimming movements that contributed to increase muscle strength of the lower limbs and reduced load on the joints. The following exercises were added in walking sessions: walking forward, backwards, sideways, cross-step, sidestep, high knee walks. The water level was slightly above the knee. Special exercises: strength exercises for the lower limbs' muscles; resistance exercises for the lower limbs; "swimming under a pool float" exercises, with movement on the bottom of the pool. In order to perform such exercises, the water level was waist-high or chest-high. Elements of outdoor games were also added. The classes were held once a week, for 45-50 minutes, 10-15 exercises. The water temperature in the pool was 32-33 °C. The last period included skiing slowly with the instructor, with air temperature not lower than -10 °C, twice a week, 500 meters. The children were taught how to stand and walk on skis, proper technique of performing alternating movements with arms and legs, independent skiing. The relaxing exercises took place after skiing.

Before the course, the average index of balance according to the Berg scale scored 30.3±4.03 points, which reflects an average risk of falling, and after the course this index has improved by 29.4% and scored 39.2±4.96 points, which corresponds to a lower risk of falling and enhanced orthostatic stability.

According to the Ashworth scale, the average index of muscle spasticity scored 2.16±0.75 points before the course, which indicates a pronounced increase in muscle tone. After the course the index reduced by 46.3% and scored 1.16±0.75 points, which shows decreased spasticity in the lower limbs.

Conclusion. As a result of applying physical rehabilitation measures, the movement amplitude has increased in all joints of the lower limbs, spasticity has reduced and balance has improved, which demonstrated their effectiveness among preschool children with spastic diplegia.

The hip joint goniometry indices have improved: flexion – by 2.77%, from 119.2 to 122.5°; extension – by 30,5%, from 9.5 to 12.4°; adduction – by 15.08%, from 19.9 to 22.9°; abduction – by 6.06%, from 29.7 to 31.5°; external rotation – by 6.84%, from 39.5 to 42.2°; internal rotation – by 13.8%, from 29.8 to 33.9°. The knee joint goniometry has improved as well: flexion – by 2.8%, from 119.55 to 122.88°. The ankle joint goniometry has changed: dorsiflexion – by 17.68%, from 19.8 to 23.3°; plantar flexion – by 26.87%, from 33.5

to 42.5°. The muscle spasticity indices, according to the Modified Ashworth Scale, have improved by 46.3%, from 2.16 to 1.16 points. The balance indices have improved as well according to the Berg scale by 29.4%, from 30.3 to 39.2 points.

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REFERENCES

1. Dul'nev, V.V. Zueva G.A., Kulova O.Yu. Features of the cerebral palsy's epidemiology in children of the Tver region. *Bulletin of Medical Internet Conferences*, 2017, no. 7 (7), pp. 2-4. (in Russ.)
2. Studenikin V.M., Tursunkhuzhaeva S.Sh. Cerebral palsy and neurodietics. *Zhizn' s DTSP. Problemy i reshenia*, 2010, no. 4, pp. 28-30. (in Russ.)
3. Studenikin V.M., Shelkovskij V.I., Balkanskaya S.V. Cerebral palsy: current treatment approaches. *Lvrach.ru*, 2007, no. 5, pp. 80-82. (in Russ.)
4. Umnov V.V. Cerebral palsy. Effective ways to combat motor disorders. Saint Petersburg: Desyatka, 2013. 236 p. (in Russ.)
5. Semenova E.V., Klochkova E.V. Rehabilitation of children with cerebral palsy: an overview of current approaches to assist rehabilitation centers. Moscow: Lepta Kniga, 2018. 584 p. (in Russ.)
6. Novikova N.V., Fedoskina E.M. Features of physical rehabilitation in pediatric cerebral palsy. Smolensk, 2008. p. 61. (in Russ.)

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CORRECTION OF KYPHOTIC POSTURE DISORDER IN PRIMARY SCHOOL CHILDREN BY MEANS OF PHYSICAL REHABILITATION IN THE CONDITIONS OF FITNESS CENTER

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Annotation. The article reflects the results of the correction of kyphotic posture disorder in primary school children in a fitness center by means of physical rehabilitation. The results significantly improved ($p<0.5$) in terms of static endurance of the neck muscles by 65.8%, the abdominal muscles – by 69.8%, the back muscles – by 60.1%, spinal mobility improved by 60%, visual posture diagnosis – by 165.4%, the number of points scored increased from 2.6±1 to 6.9±0.9 points ($p<0.5$). The revealed positive dynamics of the studied indices reflect a pronounced corrective effect of the application of physical rehabilitation means implemented in a fitness center for primary school children with kyphotic posture disorders.
Keywords: posture disorders, posture correction, children, primary school age, physical rehabilitation, fitness center.

Introduction. Kyphotic posture disorder in primary school age is one of the main disorders of the musculoskeletal system, formation of which has a great number of factors [1-2]. The pathological process has a trend for progression, having a negative effect on almost all systems of a growing body [3], worsening health [4], school performance and adaptation. Systematic application of various means, forms and methods of physical culture and recreational nature convincingly proves the effectiveness of their use for various disorders of the musculoskeletal system regardless of the age of the participants [3, 5]. Moreover, the need of long-term correction of present disorders in case of a limited set of special corrective means causes monotony and lowered motivation for regular workout. It is especially relevant for primary school age, in which game activity plays an important role in the development of a growing body, when higher cortical structures regulating motivational and volitional behavior are still unformed. Conditions of modern fitness centers allow to expand a field of application of recovery measures for a comprehensive impact on a body, supporting interest of those involved to a long-term recovery process, combining a personal approach and modern arrangement of corrective measures, taking into account present disorders.

The objective – to evaluate effectiveness of using physical rehabilitation measures for primary school children with kyphotic posture disorder in a fitness center.

Methods and organization. The study took place in the Medical Department of the Kimberly Fitness and Recreation Center (Moscow) during October 2022 – March 2023. It included 10 primary school children with posture disorders, who visit the center.

Strength endurance of the stabilizing muscles that elongate the spine was identified with motor tests [6] according to the anatomical location of the following muscle groups: neck, back, abdominal muscles while holding them contracted for a while in a lying position. The spinal mobility (flexibility) was assessed with a "trunk tilt towards" motor test while standing, arms down with fixation of the distance (in cm) from the fingertips to the support on which the test subject was standing. Assessment of the visual posture diagnosis (VPD) was done comprehensively according to a sum of points received after a series of tests: anthropometric measurement of symmetry of location of body members forming cervical and scapular regions

(right, left); calculation of the ankle-brachial index; identification of the correctness of the posture of the sagittal plane by the number of points where the back touches the vertical support. The best result was 8 points, showing that the posture is maximally correct. The statistical data processing was made with the Statistica 13 software package, we calculated mean arithmetic values and standard deviation of received indices, significance of differences was evaluated with the Wilcoxon signed-rank test ($p>0.05$). Distribution normalcy of the examined data was identified with the Kolgomorov-Smirnov test.

Results and discussion. In the preliminary testing of the studied group, we have identified lowered values of examined parameters (table): weak strength endurance of the stabilizing muscles, poorly formed posture.

Following physical rehabilitation measures were applied in the fitness center for the correction of revealed disorders of the musculoskeletal system: therapeutic gymnastics (TG) classes 4 times a week for 40 minutes; therapeutic massage of the back, pectoral and abdominal muscles 3 times a week for 40 minutes; therapeutic swimming 3 times a week for 40 minutes; hydrokinesiotherapy 3 times a week for 30 minutes; gymnastics with a ball 3 times a week for 45 minutes. Among physiotherapeutic measures, the following ones were used: paraffin ozokerite applications on the thoracic spine, 7 treatments every other day, 20 min; pearl baths, 7 treatments every other day, 15 min, water temperature – 35°; mineral baths, 7 treatments every other day, 15 min, water temperature – 35°; peloid therapy, applications on the thoracic spine, 8 treatments every other day, 15 minutes. The course took 5 weeks.

Table

The preliminary testing results in primary school children with kyphotic posture disorder, X±σ

Index	Result	
	Quantitative criteria	Qualitative criteria
Strength endurance of the neck muscles, s	64.1±9.7	Weak muscle endurance
Strength endurance of the abdominal muscles, s	19.2±3.6	Weak muscle endurance
Strength endurance of the back muscles, s	24.8±6.8	Weak muscle endurance
Spine mobility, cm	-0.5±2.6	Insufficient spinal mobility
Visual poster diagnosis, points	2.6±1	Poorly formed posture

Fig. 1. Example of special corrective exercises for kyphotic posture (lying on the stomach)

Fig. 2. Example of special corrective exercises for kyphotic posture (lying on the back)

At home, under the parents' supervision, morning hygienic gymnastics, a set of special correcting exercises and unloading positions learned earlier at the therapeutic gymnastics classes were applied (fig. 1, 2).

After the course, strength endurance of the stabilizing muscles has significantly improved. Indices of static endurance have substantially improved as well after the contraction test ($p<0.5$): for the neck muscles – by 65.8% (from 64.1±9.7 to 106.3±11.5 s), the abdominal muscles – by 69.8% (from 19.2±3.6 to 32.6± 5.9 s), the back muscles – by 60.1% (from 24.8±6.8 to 39.7±5.6 s). The spinal mobility has improved by 60% (from -0.5±2.6 to 3±2.3 cm) ($p<0.5$). The visual posture diagnostic results have also improved by 165.4%, a number of points scored has increased from 2.6±1 to 6.9±0.9 points ($p<0.5$).

Conclusion. Improving dynamics of strength endurance, spinal mobility and visual posture diagnosis in primary school children with kyphotic disorder reflect a pronounced corrective effect of the physical rehabilitation measures applied in the fitness center.

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REFERENCES

1. Kudryashova Yu.A., Saburova S.S., Berdichevskaya E.M., Polovnikova M.G., Kudryashov E.A. Role of functional and morphological asymmetries in the formation of posture disorders and their consideration in the organization of physical therapy classes. *Physical culture, sport – science and practice*, 2020, no. 1, pp. 73-79. (in Russ.)

2. Zakrevskij L.A. Neurotrophic processes and pathogenesis of idiopathic scoliosis. Topical issues of treatment and prevention of spine diseases. Kazan: University Publishing House, 2005. pp. 86-87. (in Russ.)

3. Lunina N.V., Gubskaya K.D. Correction of scoliotic deformities in elite gymnasts. *Modern Issues of Biomedicine*, 2022, vol. 6, no. 4. DOI: 10.51871/2588-0500_2022_06_04_28. (in Russ.)

4. Zinyankov N.N., Boldyrev S.Yu., Zinyankov N.T., Bartashevich V.V. To the question about the prevalence of infringements of a bearing among students. *Kuban Scientific Medical Bulletin*, 2008, no. 8, pp. 91-92. (in Russ.)

5. Chernitsyna N.V. Correction and prevention of background disorders in children of senior preschool age by means of fitball gymnastics. *International Journal of Experimental Education*, 2018, no. 11, pp. 29-34. (in Russ.)

6. Lovejko I.D., Fonarev M.I. Therapeutic physical culture for spine diseases in children. Leningrad: Meditsina, 1988. 144 p. (in Russ.)

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PHYSICAL CULTURE AND SPORTS

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DEVELOPMENT OF PHYSICAL CULTURE AND SPORTS IN THE UK

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Annotation. The study's main goal is to examine the development of physical culture and sports in the UK. Speaking about physical education and sports in the UK, it should first be noted that each of the regions of Britain has its own unique approaches to teaching, learning and practicing sports and other physical activities, so each of the main regions will have to be considered separately. The work is based on research related to such countries as England, Wales, Scotland and Northern Ireland. There are quite a lot of sports that are popular in the UK, among them there are both world-famous, loved by people all over the world, and absolutely unique ones, which are not practiced almost anywhere except Britain.
Keywords: physical culture in the UK, sports development in the UK, netball, hurling, Gaelic football and Gaelic handball, cnapan, shinty, bando game.

Introduction. Development of physical culture and sports at the modern stage is the one of the most important tasks of any country in order to support development of the nation, its health, as well as improvement of national well-being. In this regard, a study based on an analysis of around-the-world sources for obtaining up-to-date information is of relevance and interest [1].

The study's objective – examine development of physical culture and sports in the UK.

The study's task: to investigate regional differences in the development of sports and their causes, to reveal the features of the development of physical culture, to analyze the role of the development of physical culture and sports in the UK.

Methods and organization. The work included content analysis of research papers and materials of foreign authors presented in foreign databases. In total, 40 sources were analyzed, 20 were selected

Results and discussion. *Development of physical culture and sports in Scotland*. Sport play one of the key roles in Scottish culture. The most popular sports are golf and football.

However, other sports, such as curling (not to be confused with hurling), rugby, hockey, Highland games and water polo, are flourishing in Scotland as well.

History of development of football in Scotland is of high interest, since it goes back to 14-15 centuries. In Scottish archives, there are recordings on many variations of football, some of them are associated with carrying the ball in hands, others – with kicking and pushing the ball.

In the Scottish Highlands, the so-called traditional types of football, Ba games, as well as Kirkwall Games, which are held on Kirkwall Island and include various variations of ball games, are very popular.

In Scotland, as well as Ireland, rugby is very well developed. The region also has a number of rugby associations, and Scottish teams are traditionally the strongest ones in the kingdom.

Another peculiar fact is that American football also has a big following, although it is only played in an amateurish manner.

Cricket, however, is not so developed in Scotland; it is most popular in the south, in the region where Scotland borders England.

In the Scottish Highlands, such outdoor activity as cricket is considered as exclusively English sport, which is the reason why many Scottish professional cricket players play in the national team of England, not Scotland.

Few people know, but Scotland is the birthplace of golf. This sport is extremely

old, because the first entries on matches on the fields in Scotland date back to the 15th century.

It is no surprise that Scotland is in the number of the best golf countries. The world-known fields are located here: Murfield, Carnoustie, St. Andrews [2].

Scotland is also famous for another traditional sport – shinty. This sport is extremely popular across the country, and shinty teams are participating in a great number of tournaments, the main of which is the Scotland Cup. The game is similar to bandy and is most related to the Irish hurling, but it has slightly different rules [3].

The rest popular sports are cycling and curling.

Curling also originated in Scotland. Despite the fact that is it not that popular in the present, and Canada has more professional teams than Scotland, the Scottish national team is the second best curling team in the world with more than 30 medals.

It should also be noted that the famous Scottish motorsport, which has a huge number of fans around the world, is widely represented in the international arena.

Formula-1, rally, races, endurance races and many others are highly developed in Scotland.

Development of physical culture and sports in England. England is considered as one of the most sportive nations, a number of sports is extremely popular, and coaching in these sports is a prestigious and well-paid job. There are three major sports, in which large investments are attracted every year and their development takes place at all levels.

The most popular sport in England is football. The ancestor of this sport and the country that set a trend for this game is considered to be England. Cricket takes the second place, followed by less popular rugby, golf, badminton, horse races etc. [4-5].

The first mention of football dates back to the second half of the 14th century, when the British began to associate the weather with the ball game. The oldest teams in the world are also English, founded in the second half of the 19th century, and the oldest football competition is the FA Cup, which has been held since 1871 [6].

Football is loved and respected here, the Premier league is considered as one of the best leagues of the world, as well as the most expensive. It is followed by Serie A (Italy), Bundesliga (Germany) and La Liga (Spain).

The English Football Association is the oldest football governing body in the world.

The English national tram is rightfully considered as one of the best in the world, since players from this country have won all possible medals and titles in professional football. England is home to hundreds and thousands of legendary players, whose names will forever be immortalized in the annals of history.

The second sport – rugby, main winter sport, although recently professional matches were held in summer.

The third one is cricket. England is a recognized cricket champion, English players are worth their weight in gold and have an unshakable authority.

Lacrosse is an interesting phenomenon in England. Along with basketball, it takes a secondary place, but it is also gaining popularity.

A special attention must be given to a development of martial arts in England. It is known that it was England that gave a great stimulus to the development of martial arts in the world. It was the first to prove that championships and fights can be extremely spectacular and profitable for investors [7-8].

The sports sector at universities and schools is also of great interest. It should be noted that training in sports and physical education in England is mandatory for all children up to the age of 16, and then on a voluntary basis.

Unfortunately, not enough finances are given for teaching sport and physical culture in educational institutions, but it does not prevent talented young athletes from making their way up to the top.

It is thanks to the high level of development of various specialized sports academies and schools that young talents find their place in the world of sports. Many of them, obviously, prefer to engage in football as the most popular

and developed sport in England, but young talents can still be found everywhere [9-11].

Development of sports and physical culture in Wales. In Wales, unlike Scotland and Ireland, the situation in sports is ambiguous, since the Welsh are the most loyal to the English.

Despite the fact that 90% of Wales residents participate in all international tournaments as part of the British national team, in some sports, such as football, the country has its own representatives and national teams.

Native Celtic sports are very popular in Wales and have some relation to Scotland, Ireland and other regions of Celtic settlement.

One of them is cnapan, which is a kind of an ancient football possessing some similarities with the modern rugby. It was actively played until the end of the 90s of the 20th century, and later recognized as a traditional sport.

Another interesting phenomenon is the bando game, which occurred in the 18th century and had a lot in common with shinty, field hockey and throwing. The players were divided into 2 teams, the number of which could reach up to thirty people, armed with clubs with a curved hook, as if in field hockey. The main goal was to get a ball into an improvised gate in a field. Despite the fact that in the 19th century the sport was officially recognized as nonexistent, to this day in some counties they continue to play it at Easter, paying tribute to the traditions of their ancestors.

Speaking of modern sports, in Wales, as in the whole of Britain, football, rugby, athletics (track-and-field), basketball and cycling are extremely popular.

The so-called Welsh baseball, the original sport of South Wales, which until recently was played in some counties of England, is of interest. This sport is extremely similar to lapta and is also traditional in Wales [12].

Development of physical culture and sports in Northern Ireland. Ireland is divided into two parts, Republic of Ireland and Northern Ireland. The first one is not included in the United Kingdom, but the second one is [13].

In this regard, there are some problems with holding various kinds of tournaments, organizing leagues and forming teams.

The sports that are taught in schools and practiced in Northern Ireland and the Republic of Ireland include, for example, rugby, cricket and hockey.

Football and netball are arranged separately for Northern Ireland and the Irish Republic. However, Northern Ireland does not have its own strong football teams, so the absolute majority of residents of the region prefer to support teams from England and Scotland.

However, despite the absence of strong teams in Northern Ireland itself, its national team shows relatively good results, since about 90% of the players come from one of the strongest football leagues in the world – the English Premier League.

The second in significance in rugby. Both parts of Ireland have their own rugby league and rugby association. The association has about two hundred rugby teams, in which over 20 thousand male players play.

In modern Ireland rugby becomes even more popular than football. Many young families encourage their children engage in this sport, and match broadcasts are gaining a lot of views.

The number of people who consistently attend matches is estimated in the tens of thousands, which has an extremely fruitful effect on the rugby financing in the region.

The other interesting sport in Northern Ireland is the Gaelic games. They include traditional sports and games, which go back in history: hurling, Gaelic football and Gaelic handball.

Hurling is a specific sport, which is played in the summer or other warm season on the grass. It is a team sport, the main task of each team is to score more points and goals than their opponent. Each player has a wooden club of a specific shape. Remotely, this sport resembles hockey or bandy, but it has its own rules.

Much attention is also paid to another sport – cricket, which is very popular throughout the territory of the UK. However, in Northern Ireland, throughout its history, cricket has not been a mass sport. Moreover, evidence suggests that cricket was considered as a sport for the lower classes and ethnic minorities.

The Ireland cricket team has been gaining and continues to gain popularity among fans and annually graduates elite professional players from their academies.

Other sports and physical activities are also popular in Northern Ireland: golf, boxing, wrestling, basketball and ice hockey.

Special attention should be paid to Irish motorsport, which is known all over the world thanks to motorcycle races held in two provincial districts. There are two Grand Prix events in Northern Ireland: Ulster and North-West Grand Prix 200.

History knows many names of Irish who have broken various records and gained fame and respect among racing fans, including Joey Dunlop, George Best, Philip McKellen et al [14-16].

Conclusion. Specifics of developing physical culture and sports in the UK at the regional level are identified by such factors as the national identification of individual regions and nationalities, traditions, the history of the formation and development of sports in the country, the economic component, as well as the climate and terrain of the country. Based on these laws, various sports stand out and develop at different levels, such as rugby, cricket, hockey, football, netball, hurling, Gaelic football and Gaelic handball, cnapan, shinty, English lacrosse, martial arts, bando game, track-a10.24412/2782-6570-nd-field, basketball, cycling, Welsh baseball, golf, hockey [17-20].

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REFERENCES

1. General history of physical culture and sports. 2020. Available at: https://ebooks.grsu.by/ist_sporta/3-zarozhdenie-i-razvitie-invasporta-i-paralimpijskogo-dvizheniya.htm (accessed 20.08.2023)
2. Golf – UK. Leisure & Sports: Golf. 2019. Available at: https://www.bsigroup.ru/country/gbr/info/gbr_golf (accessed 02.08.2023). (in Russ.)
3. History of field hockey. When and where did it appear. 2020. Available at: https://sportsgroup.ru/letnie-vidyi-sporta/istoriya-hokkeya-na-trave.html (accessed 02.08.2023). (in Russ.)
4. Equestrian sport in UK private schools. 2022. Available at: https://www.mercury-education.com/publication/konnyj-sport-chastnyh-shkolah-velikobritanii (accessed 02.08.2023)
5. Equestrian sport. Champions. 2020. Available at: https://coderlessons.com/tutorials/sportivnyi/konnyi/konnyi-sport-chempiony-2 (accessed 05.08.2023)
6. Kosheleva A.V. The sport of the Great Britain in the context of international relations. Olympic Bulletin no. 16. Moscow: Chelovek, 2016. pp. 100-104. (in Russ.)
7. Boxing in England. 2022. Available at: http://www.adelanta.info/encyclopaedia/sport/box (accessed 30.08.2023)
8. Boxing – Sport in Britain. 2020. Available at: https://londonmania.ru/stories/sport-in-britain/boxing (accessed 28.08.2023). (in Russ.)
9. London 2012. Available at: http://olimp-history.ru/node/358 (accessed 09.08.2023). (in Russ.)
10. Overview of the most popular horse races in England. 2020. Available at: https://favoritnr1.com/223-samye-populyarnye-skachki-v-anglii.html (accessed 22.08.2023)
11. Symbols of the 2012 Summer Olympics. Available at: https://stihi.ru/2012/07/22/202 (accessed 07.08.2023). (in Russ.)
12. The most popular sports in the UK. 2023. Available at: https://thebiggest.ru/drugoe/vidy-sporta-v-velikobritanii.html (accessed 02.08.2023). (in Russ.)
13. UK government. 2020. Available at: https://www.gov.uk/government/publications/get-active-a-strategy-for-the-future-of-sport-and-physical-activity (accessed 12.08.2023)
14. The most famous athletes in England – All about everything. 2018. Available at: https://kakprostoyes.ru/samye-izvestnye-sportsmeny-anglii.html (accessed 02.08.2023). (in Russ.)
15. The most famous athletes of England, famous Russian athletes. 2022. Available at: https://www.kakprosto.ru/kak-865513-samye-izvestnye-sportsmeny-anglii (accessed 01.08.2023). (in Russ.)
16. Everybody active, every day: framework for physical activity. 2022. Available at: https://www.gov.uk/government/publications/everybody-active-every-day-a-framework-to-embed-physical-activity-into-daily-life (accessed 16.08.2023).

17. Traditional British sports. 2022. Available at: https://lingua-airlines.ru/articles/traditsionnye-britanskie-vidy-sporta (accessed 19.08.2023). (in Russ.)
18. Sporting Future: A New Strategy for an Active. 2020. Available at: https://assets.publishing.service.gov.uk (accessed 06.08.2023).
19. Statistics on Obesity, Physical Activity and Diet. England, 2015. Available at: https://webarchive.nationalarchives.gov.uk/ukgwa/20130107214441 (accessed 02.08.2023)
20. Experience of foreign countries in organizing the physical education system. 2021. Available at: http://fcomofv.ru/files/ioe/documents/CKI7OBUBTHV549SX72ZB.pdf?ysclid=lm2948fly4638803332 (accessed 02.08.2023). (in Russ.)

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