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Morphological and functional criteria for the effectiveness of recreational activities in children

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Objective. The study aimed to perform a comprehensive morphofunctional assessment of the effectiveness of recreational activities in children aged 9–12 years in the summer of 2019. **Materials and methods.** The study was conducted by the "Problem scientific laboratory of physical methods of diagnosis and treatment" of RostGMU in the children's health and recreation camp "Mir" (Krasnyi Desant village, Gulf of Taganrog). Procedures and time of the study: somatometry, bioimpedance analysis, cardiointervalography, stabilometrics on the 2nd day of stay and 2.5 weeks after. Two groups were formed: Group I included overweight children (OW), n = 15 (boys, n = 9; girls, n = 6); Group II included children with normal physical development (NPD), n = 37 (boys, n = 17; girls, n = 20). The children received a non-drug complex of camp resource provision for 3 weeks. **Results.** Health measures did not lead to significant changes in the somatometric parameters. According to the results of the cardiointerval recording, an authentic increase in the variational range and vegetative rhythm index was found in children with NPD, which indicates an increase in the parasympathetic activity of regulation. The stress index decreased by 30% in the case of NPD, and by 6% in the case of OW. Data from the stabilometric "Balls" simulator showed that after the recovery, the regulation of postural control was optimized, and decision-making processes were accelerated, especially in children with NPD. **Conclusion.** The study showed that in order to assess the effectiveness of recreational activities, along with "mandatory" methods, it is advisable to use functional methods such as cardiointervalography and stabilometrics, which can be recommended for use in health and rehabilitation institutions to assess the adaptive capabilities of the organism.

Keyword: improving children's health, somatometry, bioimpedance analysis, cardiointervalography, stabilometry.

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Морфологические и функциональные критерии эффективности оздоровительных мероприятий у детей

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Цель: комплексная морфофункциональная оценка эффективности оздоровительных мероприятий у детей 9–12 лет в летний период 2019 г. Материалы и методы: исследование проводилось «Проблемной научной лаборатории физических методов диагностики и лечения» РостГМУ в детском санаторном оздоровительном лагере «Мир» (х. Красный Десант, Таганрогский Залив). Порядок и время исследования: соматометрия, биоимпедансометрия, кардиоинтервалография, стабилометрия на 2-е сутки пребывания и через 2,5 недели. Сформированы две группы: I группа — избыточная масса тела (ИзМТ), n = 15 (мальчики, n = 9); девочки, n = 6); II группа — нормальное физическое развитие (НФР), n = 37 (мальчики, n = 17; девочки, n = 20). В течение трёх недель дети получали немедикаментозный комплекс ресурсного обеспечения лагеря. Результаты: оздоровительные мероприятия не привели к значимым изменениям соматометрических показателей. По результатам КИГ установлено достоверное повышение вариационного размаха и вегетативного показателя ритма у детей с НФР, что свидетельствует о повышении парасимпатической активности регуляции. Индекс напряжения при НФР снижался на 30%, а с ИзМТ — на 6%. Данные стабилометрического тренажёра «Мячики» показали, что после оздоровления оптимизируется регуляция позного контроля, ускоряются процессы принятия решения, особенно у детей с НФР. Заключение: исследование показало, что для оценки эффективности оздоровительных мероприятий наряду с «обязательными» методами целесообразно использовать такие функциональные методы, как кардиоинтервалография и стабилометрия, которые могут быть рекомендованы к использованию в оздоровительных и реабилитационных учреждениях для оценки адаптационных возможностей организма.

Ключевые слова: оздоровление детей, соматометрия, биоимпедансометрия, кардиоинтервалография, стабилометрия.

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An important indicator of children and adolescents' health status is their physical growth and development, which is traditionally characterized by the assessment of morphological features such as basic somatometric indicators (length and body weight), somatic type (body type), less often the component composition of body weight [1, 2]. However, for a developing organism, an equally important aspect is the study of the child's adaptive capabilities, as one of the health indices. Based on the theory of functional system concepts, it becomes possible not only to state the fact of health at a given time but also to answer the question by what mechanisms and at what cost of adaptation this state is achieved and maintained when the external and internal environment conditions change [3].

To compensate for mental and physical stress, physical inactivity, unbalanced nutrition, and computer «aggression», recreational activities are necessary for traditional summer holidays. The degree of recovery effectiveness, as a rule, consists of the dynamics of height, weight, muscle strength, and vital capacity[1],[2]. These are the so-called «obligate» indices for assessing health improvement effectiveness. However, practice shows that with short health improvement periods (2–3 weeks), there are minor changes in these indices, especially height and weight. Growth rates are also different in different periods of childhood. Health improvement indices should be compared in appropriate groups for age and gender, body mass index (BMI), and other indices.

In the authors' opinion, an important factor in assessing health improvement is an integrated approach based on morphological and functional criteria. The study of functional indices allows establishing positive shifts even without the dynamics of «obligate» indices. As an example, the task was set to comprehensively assess the health improvement of children in the prepubertal period of 9–12 years using anthropometry, bioimpedansometry, cardiointervalography, and stabilometry methods.

The selection criteria for these methods were the following. The advantages of bioimpedansometry are acceptable accuracy and high reproducibility of measurement results, the comfort of research, and the convenience of automatic data processing. The obtained indices correlate with those of other more laborious and most accurate research methods [4, 5]. The study of heart rate variability is an accessible and not difficult method for a child to assess the regulation mechanisms of physiological functions in the human body, in particular heart neurohumoral regulation, the sympathetic/parasympathetic part ratio of the autonomic nervous system [6]. The study of children's statokinetic indices by computer stabilometry in the adaptive restructuring process is a method that is relatively rarely used to assess the efficacy of health-improving measures. It shows changes in the brain regulatory functions and is also not burdensome, and the technique is simple [7, 8].

The goal of the research is a comprehensive assessment of the effectiveness of recreation activities in children aged 9–12 years in the summer by anthropometry, bioimpedansometry, cardiointervalography, and stabilometry.

Materials and methods

The research was carried out by the staff of the «Problem Scientific Laboratory of Diagnostic Physical Methods and Treatment» of the Rostov State Medical University based on children's sanatorium recreation camp «Mir» on the Taganrog Bay shore (Rostov Region, Krasny Desant farmstead). For 21 days, children received the entire non-drug complex of center resource support.

Fifty-two children (26 boys and 26 girls) aged 9–12 years were examined on the 2nd day and after 2.5 weeks of a health improvement course in the summer (August 2019, 4th session).

At the beginning and the end of health improvement, the studies were carried out as follows: somatometry, bioimpedansometry, cardiointervalography, and stabilometry. The entire study complex was carried out for 35–40 minutes.

Somatometry was carried out according to the method of Bunak [9] in the morning using standard instrumentation. The results obtained were evaluated according to centile tables recommended in practical health care for medical status monitoring of children's groups by age and gender group.

Anthropometric indices related to the «obligate» ones such as body weight, body length, followed by calculation

[1] Effectiveness assessment tool for health improvement in out-of-town stationary institutions for rest and recuperation for children: Guidelines. – Moscow: Federal Center for Hygiene and Epidemiology of Rospotrebnadzor; 2011.

[2] Effectiveness assessment tool for health improvement in stationary organizations for rest and recuperation for children. Guidelines. – Moscow: State sanitary and epidemic regulation of the Russian Federation; 2018.

of Quetelet's BMI, and the indices necessary for carrying out bioimpedansometry (chest circumference, waist circumference, hip circumference, thigh circumference, wrist circumference, belly fat fold) were measured.

According to the value of BMI, children were further divided into two groups: Group I – obese children (oBMI), n = 15 (boys – n = 9, age 10.3 ± 0.4 years); girls – n = 6, age 11.2 ± 0.5 years); Group II – children with normal somatic growth (NSG), n = 37 (boys – n = 17, age 9.9 ± 0.3 years; girls – n = 20, age 9.7 ± 0.2 years). There were no children deficient in body mass in this sample.

The indices of muscle strength (dynamometry), vital capacity [2, 3], blood pressure, and heart rate per 1 minute were measured.

Changes in body composition were assessed by bioimpedansometry using a Diamant-AIST a body composition analyzer (ZAO Diamant, St. Petersburg) complete with a computer and special software. The measurements were carried out according to the standard four-electrode scheme in the supine position of the child with the electrode location on the wrist and ankle joints. The researchers studied such indicators as BMI, absolute values of fat, fat-free, and active cell mass (FM, FFM, ACM in kg), relative values of fat, fat-free, and active cell mass (%FM, %FFM, %ACM), total water, total fluid volume, extracellular fluid volume, intracellular fluid volume, and basal metabolism.

The functional state of the autonomic nervous system was determined by variation pulsometry. An «ANKAR-131» cardioanalyzer with software (OOO Medicom MTD, Taganrog) was used. Recording time was 5 minutes with the recommended standard conditions for the procedure (in the first half of the day, 2 hours after eating, dark room, room temperature 23–26 °C, the absence of auditory and visual irritation with preliminary adaptation to recording in the supine position 8–10 minutes). Statistics, variation pulsometry, spectral analysis were studied.

Stabilometry was carried out using a Stabilan-01-2 stabilograph with biofeedback (ZAO OKB RITM, Taganrog). The complex has a significant range of assessment of the center-of-pressure coordinates (± 200 mm from the force plate center) which allows eliminating restrictions in the subject's feet setting and is convenient for children. The «Balls» simulator with a game component carried out on a force plate was used. In the test process, the child must with a cross showing the center of pressure position on the force plate plane grab the ball that appears in a random place on the black field of the game, and change the position of the body to place it in one of the three baskets highlighted in yellow. The basket can be in any of three randomly distributed positions. For each ball placed in the yellow basket, 2 points are awarded, and for a ball placed in another (gray) basket, the number of errors increases. The goal of the game is to score maximum points and make a minimum of mistakes [5]. Before the study, a preliminary test was carried out.

Statistical analysis of results. In the beginning, the samples were checked for normal distribution using the Shapiro-Wilk test. When the coefficient was $p \geq 0.05$, the null hypothesis was accepted, that is, the sample complied with the normal distribution law. The parametric Student's t-test was used to compare the indexes in the groups. In the absence of a normal distribution, the Mann-Whitney test was used. When comparing before and after recreation activities within one group, the samples were dependent, when comparing indexes between the first and the second groups, the sample was independent. Differences were considered statistically significant at $p \leq 0.05$. At $p > 0.05$, the differences were considered statistically insignificant.

Results

Anthropometry and bioimpedansometry in Groups I and II are presented in Table 1. The task of comparative performance analysis of children with oBMI and NSG in these studies was not the main one. However, the table shows that all of these parameters in both groups have a significant statistical difference. Thus, the average body weight of children with oBMI exceeds the weight of children with NSG by almost 37%, but at the same time, the growth of these children is 7% higher. A significant difference is an excessive adipose mass (31.4% versus 19.8%) in children with NSG. However, %ACM has significant differences between children with NSG (50.8%) and children with oBMI (45.2%).

The next criterion for assessing recreation activities was functional shifts in the heart autonomic regulation. Probably, an extended movement regimen, water procedures, sports competitions should have a more significant effect on the cardiointervalogram parameters. The research results are presented in Table 2.

Table 2 shows that the initial levels of heart rate regulation in children with oBMI and NSG also differ. This includes the data of the rhythmogram spectral analysis. The high frequency (HF) wave power reflecting the spectral power of respiratory waves and the parasympathetic cardio-inhibitory center activity of the medulla oblongata is significantly lower in children with oBMI. A decrease in parasympathetic tone and an increase in sympathetic tone in this category of children is confirmed by an increase in the vagosympathetic balance coefficient (LF/HF) and the relative value of the low-frequency wave (LF) power which also reflect the activity of the medulla oblongata sympathetic centers. The sympathetic tone activation in children with oBMI comes against the backdrop of an increase in the very low-frequency wave (VLF) power reflecting the activity of the central ergotropic and humoral-metabolic mechanisms of heart rate regulation.

The next stage in the health improvement assessment was a recovery simulator related to the stabilographic game based on the biofeedback principle. The test processing results are presented in Table 3. After health improvement in both groups, the number of points scored significantly

Table 1 / Таблица 1

Dynamics of anthropometry and bioimpedance metrics during summer health events (M±m)
Динамика показателей антропометрии и биоимпедансометрии при летних оздоровительных мероприятиях (M±m)

Показатели *Parameters*	I группа *I group*		II группа *II group*		p
	до / *before*	после / *after*	до / *before*	после / *after*	
	1	2	3	4	5
МТ, кг / *Body weight, kg*	53,8±2,1	52,4±2,1	33,8±0,9	33,5±0,9	$p_{12до}$=0,001* $p_{12после}$=0,001*
p до/после / *p before/after*	0,92		0,85		
ДТ, см / *Body length, cm*	152,4±2,2	152,7±2,2	142,4±1,4	142,8±1,4	$p_{12до}$=0,0003* $p_{12после}$=0,0004*
p до/после	0,8		0,8		
ИМТ, кг/м² / *Body mass index, kg/m²*	23,1±0,8	22,5±0,7	16,5±0,3	16,2±0,3	$p_{12до}$=0,0001* $p_{12после}$=0,0002*
p до/после	0,5		0,78		
ЖМ, кг / *Fat mass, kg*	16,1±1,7	16,3±1,2	6,8±0,4	6,5±0,4	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,64		0,53		
%ЖМ, % / *%Fat mass, %*	31,4±1,4	30,6±1,4	19,8±0,6	19,0±0,6	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,68		0,36		
БЖМ, кг / *Fat-free mass, kg*	36,7±1,2	36,4±1,3	26,9±0,6	27,1±0,6	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,86		0,84		
АКМ, кг / *Active cellular mass, kg*	24,2±0,7	24,1±0,8	17,1±0,4	17,3±0,5	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,95		0,75		
%АКМ, % / *%Active cellular mass,%*	45,2±0,8	46,1±0,8	50,8±0,4	51,4±0,5	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,44		0,3		
ОВ, л / *Total water, l*	26,8±0,9	26,6±0,9	19,7±0,5	19,8±0,5	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,86		0,83		
ООЖ, л / *Total fluid volume, l*	24,7±0,9	24,5±0,9	17,0±0,6	17,3±0,5	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,85		0,72		
ОВнек.Ж, л / *Total extracellular fluid, l*	8,2±0,4	8,0±0,4	6,0±0,2	6,1±0,2	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,75		0,88		
ОВнук.Ж, л / *Total intracellular fluid, l*	16,6±0,5	16,5±0,6	11,0±0,4	11,2±0,4	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,92		0,67		
ОО, ккал / *Basic metabolism, kcal*	1436±24	1436±32	1189±12	1188±13	$p_{12до}$=0,0001* $p_{12после}$=0,0001*
p до/после	0,99		0,94		

Note: * *— statistically significant differences.*
Примечание: * — статистически значимые различия.

Table 2 / Таблица 2

Dynamics of cardiointervalogram during summer health events (M±m)
Динамика кардиоинтервалограмм при летних оздоровительных мероприятиях (M±m)

Показатели *Parameters*	I группа *I group*		II группа *II group*		p
	до / *before*	после / *after*	до / *before*	после/ *after*	
	1	2	3	4	5
ЧСС, уд. мин / *Heart rate, bpm*	76,7±2,6	72,2±3,2	79,8±1,7	77,1±1,5	$p_{12до}$=0,31 $p_{12после}$=0,11
p до/после / *p before/after*	0,25		0,21		
AMo, %	42,4±4,7	38,9±5,2	37,6±2,0	34,1±1,6	$p_{12до}$=0,24 $p_{12после}$=0,22
p до/после	0,6		0,16		
DX, с	0,35±0,03	0,40±0,04	0,36±0,01	0,41±0,01	$p_{12до}$=0,59 $p_{12после}$=0,9
p до/после	0,26		0,03*		
ИН, усл. ед. / *Voltage index*	108,8±23,9	102,7±42,8	82,6±9,2	63,3±6,5	$p_{12до}$=0,2 $p_{12после}$=0,16
p до/после	0,89		0,08		
ИВР, усл. ед. / *Index of vegetative balance*	160,8±32,9	148,9±50,4	117,3±10,8	93,0±8,2	$p_{12до}$=0,09 $p_{12после}$=0,09
p до/после	0,83		0,07		
ВПР, $1/с^2$ / *Vegetative rhythm indicator, $1/s^2$*	4,38±0,57	3,94±0,88	4,05±0,24	3,46±0,19	$p_{12до}$=0,43 $p_{12после}$=0,34
p до/после	0,67		0,05*		
ПАПР, 1/с *Indicator of the adequacy of regulatory processes, 1/s*	56,2±7,4	49,7±9,2	51,9±3,5	45,7±2,8	$p_{12до}$=0,57 $p_{12после}$=0,54
p до/после	0,21		0,16		
SDNN, мс	64,6±9,1	77,2±9,5	65,2±4,2	74,9±3,6	$p_{12до}$=0,94 $p_{12после}$=0,77
p до/после	0,32		0,07		
RMSSD, мс	68,8±11,1	88,0±13,4	68,9±6,0	82,4±5,5	$p_{12до}$=0,99 $p_{12после}$=0,63
p до/после	0,26		0,09		
TP, $мс^2$	4666±1336	6439±1273	4444±706	5782±755	$p_{12до}$=0,88 $p_{12после}$=0,65
p до/после	0,33		0,19		
HF, %	32,3±4,4	30,5±3,8	41,4±2,2	37,7±2,2	$p_{12до}$=0,03* $p_{12после}$=0,08
p до/после	0,74		0,22		
LF, %	36,4±2,5	40,1±2,6	34,5±1,5	36,0±1,6	$p_{12до}$=0,49 $p_{12после}$=0,16
p до/после	0,29		0,47		
VLF, %	31,3±4,1	29,5±3,0	24,1±1,6	26,3±1,9	$p_{12до}$=0,04* $p_{12после}$=0,37
p до/после	0,7		0,3		
LF/HF, ед	1,56±0,28	2,01±0,54	0,96±0,09	1,14±0,12	$p_{12до}$=0,008* $p_{12после}$=0,02*
p до/после	0,43		0,21		
HFnorm, %	44,8±4,3	42,1±4,6	53,9±2,1	50,4±2,1	$p_{12до}$=0,03* $p_{12после}$=0,05*
p до/после	0,65		0,22		
LFnorm, %	55,2±4,3	57,9±4,5	46,1±2,1	49,6±2,1	$p_{12до}$=0,02* $p_{12после}$=0,04*
p до/после	0,65		0,22		

Note: ** — statistically significant differences.*
Примечание: * — статистически значимые различия.

increased. However, the number of errors has also significantly increased. The authors associate this with the fact that the brain motor cortex activity has become higher as shown in the speed of laying and significant intensity of the ball grasp. With this test, children with NSG also showed significantly better results in a decrease in the ball laying intervals and an increase in the ball laying speed.

Discussion

The data analysis showed that summer recreation activities over 2.5 weeks did not lead to significant reliable shifts in the parameters of anthropometry and impedance in children both with oBMI and NSG. At the same time, in children with BMI, the initially significant difference was an excess of adipose mass and a lack of active cell mass. This indicates inadequate protein metabolism and, probably, the diet in children with oBMI. Low values of %ACM are also commonly associated with hypodynamia which a priori is more often inherent in these children.

What shifts in heart rate regulation occur after health improvement? In children of two groups, unidirectional, but insignificant positive shifts are noted: a decrease in heart rate, mode amplitude, %, stress index, VBI, VRI, IARP;

Table 3 / Таблица 3

Dynamics of stabilometry indicators of the test "Simulator "Balls" during summer health events (M±m)
Динамика показателей стабилометрии теста «тренажер «Мячики» при летних оздоровительных мероприятиях (M±m)

Показатели *Parameters*	I группа *I group*		II группа *II group*		P
	до / *before*	после / *after*	до / *before*	после / *after*	
	1	2	3	4	5
Очки, ед / *Points, units*	16,9±0,8	19,5±0,9	16,4±0,6	19,8±0,7	$p_{12до}$=0,68 $p_{12после}$=0,85
p до/после / *p before/after*	0,03*		0,009*		
Ошибки, ед / *Errors, units*	2,13±0,35	2,73±0,48	1,71±0,23	2,35±0,31	$p_{12до}$=0,68 $p_{12после}$=0,85
p до/после	0,03*		0,009*		
Интенсивность захвата (длительность интервалов захвата), с / *Capture intensity (duration of the intervals capture), s*	3,34±0,19	2,83±0,15	3,30±0,11	2,83±0,11	$p_{12до}$=0,84 $p_{12после}$=0,98
p до/после	0,03*		0,003*		
Интенсивность укладки (длительность интервалов укладки), с / *Laying intensity (duration of the intervals of laying), s*	3,08±0,15	2,66±0,18	3,31±0,12	2,72±0,12	$p_{12до}$=0,3 $p_{12после}$=0,77
p до/после	0,07		0,001*		
Интенсивность ошибки (длительность интервалов ошибки), с / *Error intensity (duration of error intervals), s*	2,09±0,38	1,58±0,26	2,71±0,39	1,82±0,23	$p_{12до}$=0,35 $p_{12после}$=0,53
p до/после	0,25		0,06		
Скорость захвата, мм/с / *Capture speed, mm/s*	75,4±3,5	76,3±4,5	77,2±1,9	82,1±2,2	$p_{12до}$=0,63 $p_{12после}$=0,18
p до/после	0,86		0,1		
Скорость укладки, мм/с / *Laying speed, mm/s*	72,4±4,1	73,5±4,6	72,9±2,0	82,5±3,2	$p_{12до}$=0,89 $p_{12после}$=0,12
p до/после	0,84		0,01*		
Скорость ошибки, мм/с / *Error speed, mm/s*	80,0±10,0	78,2±11,6	66,4±6,6	87,3±10,2	$p_{12до}$=0,27 $p_{12после}$=0,6
p до/после	0,9		0,09		

Note: * *— statistically significant differences.*
Примечание: * — статистически значимые различия.

unreliable increase in SDNN and RMSSD. This indicates a general decrease in sympathetic activity. However, only in children with NSG, there was a significant increase in the variation range (DX, s) and VRI which indicates an increase in the parasympathetic activity of regulation. These changes led to the fact that the stress index in this category of children decreases by 30%, in children with oBMI only by 6%. Such changes associated with recreation activities indicate positive sanogenic shifts in heart rhythm regulation.

It is known that postural regulation is associated with the function of many physiological systems of the body and includes sensory and musculoskeletal systems, various levels of the central nervous system. Its effortful control, in contrast to reflex and automatic stem and subcortical reactions, is largely subordinate to consciousness. As can be seen from the data obtained, in children in the health improvement process, the regulation of postural control is significantly optimized, decision-making processes are accelerated especially in children with NSG.

The age of the second childhood or prepubertal period (9–11 years for girls and 10–12 years for boys) is important and interesting as gender differences begin to appear in the physical development parameters, hormonal and vegetative status associated with the background of pronounced individual variability. Therefore, an integrated approach to the recreation activity assessment allows a broader approach to this problem. In the authors' opinion, health improvement will be considered effective not only when the weight of obese children decreases, but also when in children with NSG, a change in body weight will lead to a change not in the level of physical development, but in the processes of body regulation at the level of heart and brain activity.

Conclusion

Thus, the studies performed have shown that the proposed health improvement programs with a non-drug complex of resource provision for a children's sanatorium recreation camp can be assessed not only using the «obligate» indices for the efficacy of health improvement (height, body weight, muscle strength, and vital capacity), which are not can always correctly reflect this process, but also by functional methods of cardiointervalography and stabilometry. They have practical significance and can be recommended for use at recreational and rehabilitation institutions to assess the body's adaptive capabilities.

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ЛИТЕРАТУРА

1. Никитюк Д.Б., Клочкова С.В., Алексеева Н.Т., Рожкова Е.А., Карпова А.В. Конституциональные подходы в оценке физического развития детей // *Всероссийская научно-практическая конференция «Достижения современной морфологии – практической медицине и образованию»*; Май 21-23, 2020; Курск. eLIBRARY ID: 43782144
2. Кондрашев А.В., Соколов В.В., Чаплыгина Е.В., Соколова Н.Г., Осипов Д.П., Елизарова Е.С. Соматотипологическая характеристика подростков и лиц юношеского возраста – жителей Юга России // *Морфология*. – 2008. – Т. 133, № 2. – С. 66. eLIBRARY ID: 11641832
3. Анохин П.К. *Очерки по физиологии функциональных систем*. – М.: Медицина; 1975.
4. Николаев Д.В., Смирнов А.В., Бобринская И.Г., Руднев С.Г. *Биоимпедансный анализ состава тела человека*. – М.: Наука; 2009.
5. Эдлеева А.Г., Хомич М.М., Леонова И.А., Богданов В.А. Биоимпедансометрия как метод оценки компонентного состава тела у детей старше 5 лет // *Детская медицина Северо-Запада*. – 2011. – Т. 2, № 3. – С. 30-35. eLIBRARY ID: 17799923
6. Галеев А.Р., Игишева Л.Н., Казин Э.М. Вариабельность сердечного ритма у здоровых детей в возрасте 6-16 лет // *Вестник ХНУ им. В.Н. Каразина (Серия «Медицина»)*. – 2002. – № 3 (545). – С. 35–40. eLIBRARY ID: 21423661
7. Переяслов Г.А., Слива С.С. Методическое обеспечение стабилоанализатора «СТАБИЛАН – 01» // *Известия ТРТУ. Тематический выпуск*. – 2002. – № 5(28). - С. 82-88. eLIBRARY ID: 12836378

REFERENCES

1. Nikityuk D.B., Klochkova S.V., Alekseeva N.T., Rozhkova E.A., Karpova A.V. Constitutional approaches to assessing children's physical development. *Vserossijskaja nauchno-prakticheskaja konferencija «Dostizheniya sovremennoj morfologii – prakticheskoj medicine i obrazovaniyu»*; Maj 21-23, 2020; Kursk (In Russ.). eLIBRARY ID: 43782144
2. Kondrashev A.V., Sokolov V.V., CHaplygina E.V., Sokolova N.G., Osipov D.P., Elizarova E.S. Somatotypological characteristic of adolescents and youths - inhabitants of the South of Russia. *Morfology*. 2008; 133 (2): 66. (In Russ.). eLIBRARY ID: 11641832
3. Anohin P.K. *Ocherki po fiziologii funkcional'nyh sistem*. Moscow: Medicina; 1975. (In Russ.).
4. Nikolaev D.V., Smirnov A.V., Bobrinskaya I.G., Rudnev S.G. *Bioimpedansnyj analiz sostava tela cheloveka*. Moscow: Nauka; 2009. (In Russ.).
5. Edleeva A.G., Homich M.M., Leonova I.A., Bogdanov V.A. Bioimpedansometriya kak metod ocenki komponentnogo sostava tela u detej starshe 5 let. *Detskaya medicina Severo-Zapada*. 2011;2(3):30-35. (In Russ.). eLIBRARY ID: 17799923
6. Galeev A.R., Igisheva L.N., Kazin E.M. Variabel'nost' serdechnogo ritma u zdorovyh detej v vozraste 6-16 let. *Vestnik HNU im. V.N. Karazina (Seriya «Medicina»)*. 2002;3(545):35–40. (In Russ.). eLIBRARY ID: 21423661
7. Pereyaslov G.A., Sliva S.S. Metodicheskoe obespechenie stabiloanalizatora «STABILAN – 01». *Izvestiya TRTU. Tematicheskij vypusk*. 2002;5(28):82-88. (In Russ.). eLIBRARY ID: 12836378

8. Тришин А.С., Бердичевская Е.М. Стабилографические тренажеры в оценке специфических навыков позной координации у квалифицированных баскетболистов // *Вестник АГУ.* – 2016. – Вып. 1 (176). – С. 55-59. eLIBRARY ID: 26028489
9. Бунак В.В., Нестурх М.Ф., Рогинский Я.Я. *Антропология. Краткий курс.* – М.: Учпедгиз; 1941.

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8. Trishin A.S., Berdichevskaya E.M. Stabilograficheskie trenazhery v ocenke specificheskih navykov poznoj koordinacii u kvalificirovannyh basketbolistov. *Vestnik AGU*. 2016;1(176):55-59. (In Russ.). eLIBRARY ID: 26028489
9. Bunak V.V., Nesturh M.F., Roginskij YA.YA. *Antropologiya. Kratkij kurs.* Moscow: Uchpedgiz; 1941. (In Russ.).

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