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Correction of Body Posture Disorders in Young Children of School Age in the Process of Physical Education Classes

Korekcja zaburzeń postawy ciała u małych dzieci w wieku szkolnym w trakcie zajęć wychowania fizycznego

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SUMMARY

Aim: To develop, substantiate and experimentally test the method of correction of body posture disorders in 6-10-years-old girls in the process of their coordination skills development.

Materials and Methods: The research involved 138 girls including 40 girls who had various deviations in body posture development and 98 girls without body posture disorders. The experimental (EG) and the control group (CG) of 20 girls each were formed to organize the experiment. The EG was engaged according to the developed method of correction of body posture disorders, the CG – according to the current school curricula of physical education.

Results: It was found that 29.0 % of primary high schoolers have various deviations in body posture development. Kyphotic body posture is observed in 80.6 % of cases and scoliotic body posture – in 19.4% of cases. The research determined the relationship between the level of coordination manifestation and the state of body posture in schoolers, in particular the presence of abnormalities in its development. The method of correction of body posture disorders in 6-10-years-old girls during physical education training sessions was developed.

Conclusions: The obtained results indicate the effectiveness of the developed method. The EG girls revealed significantly better indicators of motion coordination and coordination skills when changing body position as well as static balance than the CG girls ($p \leq 0.05$). The number of girls with various deviations in body posture development decreased by 9.9%.

Key words: body posture disorders, coordination skills, 6-10-years-old girls, physical education, correction

Słowa kluczowe: zaburzenia postawy ciała, koordynacja ruchowa, dziewczynki w wieku 6-10 lat, wychowanie fizyczne, korekcja

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INTRODUCTION

The analysis of current statistics shows that the number of children with chronic diseases increases 2.5 times during school life: about a third of primary high schoolers already have various health disorders, while only up to 20% of school leavers remain virtually healthy [1, 2]. Deviations in the development of body posture occupy one of the leading places in the structure of morbidity of school-age children, moreover having recorded positive dynamics with age [3, 4]. Body posture disorders, in addition to a significant cosmetic defect, create the preconditions for the general deterioration of health, reduced physical development, the emergence of pathological processes in the body of schoolers [5, 6].

The primary school age is characterised by active formation of the musculoskeletal system of children, which increases the risk of disorders in the formation of physiological curves of the spine under the influence of anatomical and physiological factors: hereditary constitutional features, individual development of motor function and irrationally organized motor activity [7, 8]. At the same time, according to the scientists [9, 10], the vast majority of

cases of body posture disorders in primary high schoolers have an unstable functional nature i.e. can successfully be corrected.

The researchers [11, 12], argue that the constant use of precisely dosed tensions of the muscular corset on the basis of learning different in terms of coordination structure and direction motions develops skills to maintain physiologically correct torso positions in static and dynamic positions. At the same time, 6-10-years-old children actively develop motor function, in particular most types of coordination skills, the ability to coordinate motions and control them [13]. Along with sufficient elaboration of the problem of children's body posture formation, prevention and correction of its disorders by means of physical exercises, there is not enough research in modern theory and practice devoted to the peculiarities of motor function development in primary high schoolers with deviations in body posture development. The question of correction of body posture disorders in the process of coordination skills development in 6-10-years-old girls remains open, which requires scientific research.

AIM

The aim of the research is to develop, substantiate and experimentally test the method of correction of body posture disorders in 6-10-years-old girls in the process of their coordination skills development.

MATERIALS AND METHODS

Scientific research methods included theoretical analysis of literature sources, medical and biological methods, pedagogical testing, pedagogical experiment, statistical methods.

The theoretical analysis of literature sources involved the study of 17 literature sources from different scientometric databases, which allowed to comprehensively investigate the problem on the research topic and discuss the results in comparison with the conclusions of scientists in this field. The medical and biological methods included somatometry and somatoscopy: determination of the body type of children; determination of the type of children's body posture disorders using the method of indices: scoliotic body posture by the index of vertical curvature of the spine, kyphotic body posture (stooping) by the shoulder index. We used pedagogical testing to check the level of manifestation of coordination skills of junior high schoolers, in particular static and dynamic balance of the body, coordination of motions and coordination skills when changing body position. The static balance of the body was determined using the modified Romberg test [14]. The ability to maintain balance was assessed as follows: holding the position of "attention" for less than 15 seconds – grade "1"; holding the position of "attention" for 15 seconds – grade "2"; raise your hands forward, stand for another 15 seconds – grade "3"; close your eyes (or lower the bandage) and stand for another 15 seconds – grade "4"; raise your head with your eyes closed and stand for another 15 seconds – grade "5". Yarotsky's test was used to determine the dynamic balance [14]. The exercise was performed from the standing preparatory position with eyes closed, while the persons under investigation began to continuously turn their heads in one direction at a rate of two motions per second at the word of command. The time was recorded with an accuracy of 0.1 seconds from the beginning of the rotation to the loss of balance. "Ten Eights" test was used to determine the level of motion coordination [14]. This coordination test provided for the performance of ten cycles of hand motions by the high schooler with a tennis ball in the shape of "eight" between the legs from the angle position in the legs straddled position, passing the ball from one hand to another. Coordination skills when changing the position of students' bodies were determined using the test developed by us. The high schoolers under examination were asked to perform a sequence of motions in 10 seconds: 1 – squat rest position; 2 – front plank; 3 – squat rest position; 4 – location normal standing position. The eventual result of the test is to record the number of complete cycles and partial performance of the exercise in 10 seconds. The assessment of partial performance was as follows: ¼ – performance of motion on the count of 1; ½ – performance of motion on the count of 2; ¾ – performance of motion on the count of 3. The integrated indicator of coordination skills of junior high schoolers with deviations in body posture development was evaluated by the index of coordination skills, which is calculated as the difference in the speed of 3x10m shuttle running and 30m running.

The pedagogical experiment lasted 1 year and was conducted in order to substantiate the content of the method of correction of body posture disorders in the development of coordination skills of 6-10-years-old girls during physical education training sessions and test its effectiveness. The research involved 138 girls studying in 1-4 forms of secondary schools in Kyiv, including 40 girls with various deviations in body posture development and 98 girls without body posture disorders. The experimental (EG) and the control group (CG) of 20 girls each were formed to organize the pedagogical experiment. There was no special selection, the homogeneity of the groups was confirmed by the absence of a significant difference between all the studied indicators at the beginning of the experiment ($p>0.05$). The EG was engaged according to the developed method of correction of body posture disorders of 6-10-years-old girls in the process of developing their coordination skills, the CG – according to the current school curricula of physical education.

The methods of statistical data processing include the method of sampling and the pair correlation of Pearson, the Student's criterion for quantitative and qualitative processing of research results, determining their reliability.

The procedure for organizing the research was previously agreed with the Committee on compliance with Academic Integrity and Ethics of the National Pedagogical Drahomanov University. Prior consent to participate in the research was obtained from all the participants.

RESULTS

In the process of studying the peculiarities of physical development of modern high schoolers, it is important to assess the type of their body build, as the development of bone and muscle components of the body may be a prerequisite for various abnormalities in the development of children's body posture. Somatometry showed that primary high schoolers are presented by 39.9% of girls with asthenoid somatotype, 30.3% of female high schoolers having thoracic body type, 21.3% of girls being characterized by muscular type of body build and 8.5% of schoolgirls with digestive somatotype. The obtained results were confirmed by visual assessment of the body build.

According to the index method, it was found that 29.0% among the general contingent of 6-10-years-old girls is characterised by various deviations in body posture development. At the same time, the majority of girls with body posture disorders (92.7%) have an asthenoid somatotype. Herewith, 80.6% of cases are characterised by stooping (kyphotic body posture) and the remaining 19.4% of cases – by scoliotic body posture in different variants of vertical curvature of the spine.

The pedagogical testing showed that the static balance indicator of 6-8-years-old female high schoolers who do not have body posture disorders is 3.1±1.1 points, the peers with body posture disorders – 2.1±0.8 points and this indicator makes 3.1±0.9 points and 2.1±0.8 points, respectively, in 9-10-year-old female high schoolers. The indicator of dynamic balance in healthy girls is 27.4±7.3 seconds in the age of 6-8 years and 28.4±10.9 seconds in the age of 9-10 years; the female high schoolers with deviations in body posture development are characterised by 19.2±3.8 seconds in the age of 6-8 years and by 19.8±5.4 seconds in the age of 9-10 years. The indicator of motion coordination in healthy female high schoolers is 18.1±1.6 seconds in the age of 6-8 years and 15.2±1.5 seconds in the age of 9-10 years, and it makes 21.5±2.3 seconds and 18.5±1.9 seconds, respectively, in 6-8-years-old and 9-10-years-old girls with body posture disorders. The indicator of the sample, which measures the level of coordination skills when changing body position in space, in healthy 6-8-years-old female high schoolers and 9-10-years-old girls is 6.2±0.5 times and 7.3±0.5 times, respectively, while in the peer indicators with body posture disorders are 5.6±0.4 times and 6.4±0.4 times, respectively. The index of coordination skills in 6-8-years-old girls and 9-10-years-old ones without signs of body posture disorders is 4.0±0.2 seconds and 3.9±0.2 seconds, respectively, and it makes 4.4±0.3 seconds and 4.3±0.2 seconds, respectively, in 6-8-years-old female high schoolers with body posture disorders. Thus, it was found that the indicators of coordination skills are significantly ($p \leq 0.05$) better in healthy 6-10-years-old children than in their peers who have deviations in body posture development.

The correlation analysis was used to determine the relationship between the level of manifestation of coordination skills of primary female high schoolers and the state of their body posture i.e. scoliotic or kyphotic (Table 1).

Correlations of moderate strength between the indicator of static balance and scoliotic body posture ($r=\leq 0.35$, at $p \leq 0.05$), the indicator of dynamic balance and scoliotic body posture ($r=\leq 0.31$, at $p \leq 0.05$), the indicator of motion coordination and scoliotic body posture ($r=0.33$, at $p \leq 0.05$) were established. Correlations of moderate strength between the indicator of dynamic balance and kyphotic body posture ($r=\leq 0.28$, at $p \leq 0.05$), the indicator of motion coordination and kyphotic body posture (stooping) ($r=0.45$, at $p \leq 0.05$), the indicator of coordination skills when changing body position and kyphotic body posture ($r=\leq 0.40$, at $p \leq 0.05$) were also recorded. The relationship between the level of development of motor coordination in 6-10-years-old girls formed the basis of the method of correction of posture disorders in 6-10-years-old girls in the process of developing their coordination skills during physical education training sessions.

The main purpose of the developed method is to emphasize the impact on the vestibular, motor and visual analysers through a system of exercises aimed at controlling motions in space under conditions of static positions and during movement. The content of the method was based on the principle of combined action on motion coordination and correction of muscle asymmetry, which consists in the variable application of physical activity associated with the reproduction of spatial, rhythmic, dynamic, plastic characteristics of static body postures or motions. Differentiation of the content of physical activity was ensured by taking into account the type of body posture disorder in girls, in particular the characteristic features of the asymmetry of the spine and informative types of coordination skills. The selection of coordination exercises

Table 1. Relationship between the level of manifestation of coordination skills with posture disorders in 6-10-years-old girls

Indicators of coordination skills	Index of vertical curvature of the spine (scoliotic body posture)	Shoulder index (kyphotic body posture)
Static balance	-0.35*	-0.28*
Dynamic balance	-0.31*	-0.20
Motion coordination	0.33*	0.45*
Spatial coordination	-0.17	-0.40*

*Note: * – a reliable relationship between the studied indicators at $p \leq 0.05$*

Table 2. Dynamics of coordination skills development in the EG and the CG girls in the course of the experiment (Mean±SD)

Researched indices	Groups	Stages of the experiment		Increase in the indicator,%	Significance of the difference
		Beginning	End		
6-8-years-old girls (EG: n=11, CG: n=10)					
Static balance, points	CG	2.1±0.8	2.5±0.7	17.4	p>0.05
	EG	2.2±0.9	4.3±0.9	64.6	p≤0.05
Dynamic balance, seconds	CG	19.2±1.8	19.7±1.3	2.6	p>0.05
	EG	19.0±1.3	19.8±1.6	4.1	p>0.05
Coordination skills when changing body position, number of times	CG	5.6±0.4	5.8±0.2	25.7	p>0.05
	EG	5.5±0.3	7.0±0.7	24.0	p≤0.05
Motion coordination, seconds	CG	21.5±0.3	21.9±0.4	1.8	p>0.05
	EG	21.3±0.5	23.9±1.2	11.5	p>0.05
Index of coordination skills, seconds	CG	4.56±0.1	4.33±0.2	5.2	p>0.05
	EG	4.59±0.2	4.11±0.1	11.0	p≤0.05
9-10-years-old girls (EG: n=9, CG: n=10)					
Static balance, points	CG	2.1±0.8	2.7±0.6	25	p>0.05
	EG	2.0±0.9	4.0±0.8	66.7	p≤0.05
Dynamic balance, seconds	CG	19.8±1.4	20.2±1.1	2.0	p>0.05
	EG	19.9±1.2	20.3±0.9	1.9	p>0.05
Coordination skills when changing body position, number of times	CG	6.4±0.4	6.6±0.6	3.1	p>0.05
	EG	6.6±0.5	8.2±0.9	21.6	p≤0.05
Motion coordination, seconds	CG	18.5±0.9	19.0±0.7	2.7	p≤0.05
	EG	18.3±0.8	20.2±0.9	9.8	p≤0.05
Index of coordination skills, seconds	CG	4.29±0.2	4.01±0.2	6.8	p>0.05
	EG	4.31±0.3	3.78±0.2	13.1	p≤0.05

for children with body posture disorders took into account the sensitive phases of development of certain types of coordination skills of children of different types of somatic constitution, followed the methodological peculiarities of coordination skills development, focused on learning proper breathing during exercise. In order to increase the health orientation of physical education training sessions, organizational and pedagogical conditions for the effective development of coordination skills in primary high schoolers with posture disorders were determined, in particular: elimination of causes that stipulate the occurrence of functional disorders of high schoolers' body posture; stable motivation, need and habit for a healthy lifestyle and exercise; creating a healthy school environment and cooperation with parents; systematic medical and pedagogical control over the dynamics of children's body posture; combined development of motor skills with measures to correct body posture and prevent its disorders; providing feedback based on the assessment of high schoolers' academic achievements during physical education classes.

Considering the fact that the majority of indicators of motion coordination and body proportions of primary female high schoolers do not differ significantly, age differentiation took into account the most informative indicators of coordination skills of 6-10-years-old female high schoolers who have scoliotic or kyphotic body posture. Thus, the content of the method of developing coordination skills of girls with scoliotic body posture included exercises to develop static and dynamic balance, coordination of motions, whereas girls with kyphotic body posture – exercises to develop static balance, motion coordination and spatial orientation.

We used constant variation of exercises in the process of developing the coordination skills of children of primary school age with posture disorders. First, it helps to learn new forms of motions, and secondly, to improve motor memory, the stereotype of correct body position, motor sensations. Particular attention in the development of coordination skills of students with body posture disorders was paid to learning proper breathing: lifting the chest envisages intake of breath, lowering – outward breath, during muscle tightness – intake of breath, during relaxation – outward breath.

When planning motor tasks of coordination orientation for junior high schoolers with body posture disorders, the possibility of regulating such components of physical activity as complexity, intensity, duration of the exercise and the number of repetitions, duration of rest pauses between individual exercises and its nature were taken into account. A wide range of coordination difficulties was used to develop coordination skills: 30-60% of the individually accessible level for optimal stimulation of sensory analyzers, activation of the development of adaptive reactions of the neuromuscular system to new forms of motions and body positions.

The intensity of exercises at the initial stage of implementation of the method was relatively low. Gradual increase in the intensity of motor tasks occurred with the formation of mechanisms of adaptation and growth of functional capabilities of the musculoskeletal and vestibular sensory systems of the body. The duration of a particular motor task or a set depended on the task: we used exercises lasting from 1-5 seconds to 180 seconds depending on the coordination complexity and intensity of the motor task to ensure proper muscle regulation and quality exercise prior to fatigue or reduction of children's attention.

The developed method was used in the first half of the main part of the training session in the form of sets of coordination exercises and partly in the preparatory part during drill practice and general developmental exercises in motion and stationary exercises. Under such conditions, sets of coordination exercises with high schoolers having posture disorders should be performed in rooms with mirrors, as body posture formation is based on musculoskeletal sensation, and mirrors allow the high schoolers to visually control the correct body position in the process of body posture holding and in motion. Since coordination skills are developed during the learning of new motions in different sections of the curriculum in physical education for high schoolers of 1-4 forms, and when using exercises to develop other physical qualities (strength, speed, flexibility, endurance), then the impact on improving coordination of motions, beyond the method, took place in parallel throughout the physical education training session. Inasmuch as rhythmic, strength and spatial images of motions are perceived by primary high schoolers first and foremost in feelings, imagination and generalized impressions, than learning new motions and forming their dynamic stereotype using a holistic method of learning at this age is more successful than learning in parts.

The results obtained in the process of pedagogical experiment indicate the effectiveness of the proposed method (Table 2).

In addition, it was found that the number of girls with various deviations in body posture development decreased by 9.9% on average (from 29.0% to 19.1%). At the same time, the number of girls with stooping (kyphotic body posture) decreased by 6.4% and the number of girls with scoliotic body posture in different variants of vertical curvature of the spine decreased by 3.5%.

DISCUSSION

The theoretical analysis of the literature [5, 6, 13, 15, 16] has shown that one of the main means of body posture correction is exercise, which has a stabilizing effect on the spine, improves respiratory function and strengthens the muscles of the torso. Herewith, since the formation of the correct motor stereotype of body posture depends on muscle tone and coordination of symmetrical muscles of the torso, muscles that support physiological curves of the spine, so the development of coordination of motions of primary high schoolers is a necessary condition for consolidating physiologically correct torso positions while maintaining a stable body position and performing movements.

The primary school age (6-10 years old) is characterised by active anatomical and physiological changes in the body of children, the course of which is smooth in nature without significant gender differences. It is instantiated by complex morphofunctional and mental changes: high growth rates, weight gain, intense changes in both the structure and functions of individual organs and systems of the body. The scientists [1-4] found that the main cause of functional disorders of body posture in primary high schoolers is limited motion, i.e. prolonged forced static position and simultaneously low physical activity during learning activities, which coincides with the period of active development of the child's body.

It is determined that the performance of any motion, keeping body posture or movement of the body and its parts in space is due to the motor function of a human being. At the same time, motor dysfunction is functionally dependent on the state of health [7, 10, 17]. It was found that the degree of development and ability to improve the motor sphere of children is limited by the presence of disorders of sensory and physiological systems of the body, including disorders of the musculoskeletal system, which include abnormalities in body posture. Since the age of 6-10 years is favourable for the development of most motor skills and is an active period in the development of motor function, so deviations in the development of body posture at this age are unstable and successfully subject to pedagogical influence. In our work we have studied the physical condition of 6-10-years-old girls, which provides for their biological needs in motion and the development of coordination skills in the most favourable age. It is established that the primary school age is a period of active development of various types of coordination skills. Thus available means for primary high schoolers' development are form building exercises of dynamic character with and without objects, at the same time covering the basic groups of muscles, exercises in balance, dance exercises, acrobatic exercises, elements of martial arts, mobile and sports games, movement with obstacles, related to mastering the correct technique of natural motions: jumping, running, climbing, throwing. Based on the research, we have substantiated and developed the method of correcting body posture disorders in 6-10-years-old girls in the process of developing coordination skills during physical education training sessions. Proper dosing of coordination loads contributes to the health effect of exercises: improves motor coordination of children, corrects static and dynamic stereotypes of body posture, improves muscle tone, strengthens the muscular corset and stimulates a rational level of spinal mobility. Therefore, the sets of exercises in the training sessions were built taking into account the gradual increase of coordination complexity of motor tasks and increasing the intensity of motions. Coordination exercises were differentiated by: anatomical features (for specific muscle groups of the torso, lower and upper extremities); type of body posture disorder (scoliotic, kyphotic, the presence of signs

of both disorders); character (static, dynamic); orientation (on the coordination of motions, static, dynamic balance, spatial orientation, spatial-dynamic accuracy, arbitrary muscle relaxation, etc.); complexity of execution (simple and complex); method of application (repeated repetition of the same type of exercises, changes in conditions and methods of performance, game orientation). The results of the pedagogical experiment prove the effectiveness of our proposed method of correction of posture disorders in 6-10-years-old girls in the process of developing their coordination skills.

CONCLUSIONS

1. It was found that 29.0% among the general contingent of primary female high schoolers is characterised by various deviations in body posture development. Herewith, 80.6% of cases are characterised by children stooping (kyphotic body posture) and the remaining 19.4% of cases – by scoliotic body posture in different variants of vertical curvature of the spine. It was found that the vast majority (92.7%) of female high schoolers with deviations in body posture development have an asthenoid body type. At the same time, the indicators of coordination skills are significantly higher in healthy 6-10-years-old children than in their peers who have deviations in body posture development (at ($p \leq 0.05$).
2. The research determined the relationship between the level of coordination manifestation and the state of body posture in junior high schoolers, in particular the presence of abnormalities in its development (scoliotic or kyphotic body posture). Thus, correlations of moderate strength between scoliotic body posture and the indicator of static balance ($r = \leq 0.35$, at $p \leq 0.05$), the indicator of vestibular tolerance (dynamic balance) ($r = \leq 0.31$, at $p \leq 0.05$), the indicator of motion coordination ($r = 0.33$, at $p \leq 0.05$), correlations of moderate strength between kyphotic body posture (stooping) and the indicator of dynamic balance ($r = \leq 0.28$, at $p \leq 0.05$), the indicator of motion coordination ($r = 0.45$, at $p \leq 0.05$), the indicator of coordination skills when changing body position and the presence of kyphotic body posture ($r = \leq 0.40$, at $p \leq 0.05$) were established in girls.
3. The method of correction of body posture disorders in 6-10-years-old girls in the process of their coordination skills development during physical education training sessions was developed. The purpose of the method is to emphasize the impact on the vestibular, motor and visual analysers through a system of exercises aimed at controlling motions in space under conditions of static positions and during movement.
4. The results of the pedagogical experiment indicate the effectiveness of the proposed method. The EG female high schoolers revealed significantly higher indicators of motion coordination, coordination skills when changing body position and static balance than the CG girls ($p \leq 0.05$). There was a significant improvement in the indicators of general motion coordination in the EG girls at the end of the experiment ($p \leq 0.05$), in contrast to the CG female high schoolers, where the increase in the indicator is insignificant ($p > 0.05$). Thus, this indicator in 7-8-years-old and 9-10-years-old female high schoolers improved by 10.4% seconds and 9.4% seconds, respectively. In addition, it was found that the number of primary female high schoolers with various deviations in body posture development decreased by 9.9%. At the same time, the number of girls with kyphotic body posture decreased by 6.4% and the number of girls with scoliotic body posture by 3.5%.

Prospects for further research are to test the effectiveness of the developed method for body posture correction in 11-12-years-old children.

References

1. Yam TTT, Fong SSM, Tsang WWN. Foot posture index and body composition measures in children with and without developmental coordination disorder. PLoS One. 2022;17(3): e0265280. doi:10.1371/journal.pone.0265280.
2. Neiva PD, Kirkwood RN, Mendes PL et al. Postural disorders in mouth breathing children: a systematic review. Braz J Phys Ther. 2018;22(1):7-19. doi:10.1016/j.bjpt.2017.06.011.
3. Deconinck FJ, De Clercq D, Savelsbergh GJ et al. Differences in gait between children with and without developmental coordination disorder. Motor Control. 2006;10(2):125-142. doi:10.1123/mcj.10.2.125.
4. Morrison SC, Ferrari J, Smillie S. Assessment of gait characteristics and orthotic management in children with Developmental Coordination Disorder: preliminary findings to inform multidisciplinary care. Res Dev Disabil. 2013;34(10):3197-3201. doi:10.1016/j.ridd.2013.06.012.
5. Prysiazhniuk S, Oleniev D, Tiazhyna A et al. Formation of heath preserving competence of students of higher educational institutions of information technologies specialties. Inter J Appl Exer Physiol. 2019;8(3.1):283-292. doi: 10.26655/IJAEP.2019.10.1.
6. Griban G, Prontenko K, Yavorska T. et al. Non-traditional means of physical training in middle school physical education classes. Inter J Appl Exer Physiol. 2019;8(3.1):224-232. doi: 10.26655/IJAEP.2019.10.1.
7. Molina-Garcia P, Mora-Gonzalez J, Migueles JH et al. Effects of exercise on body posture, functional movement, and physical fitness in children with overweight/obesity. J Strength Cond Res. 2020;34(8):2146-2155. doi:10.1519/JSC.0000000000003655.
8. Mannapova K, Okhrimenko I, Tverdokhvalova I et al. Peculiarities of providing psychological assistance to abused children. BRAIN. Broad Research in Artificial Intelligence and Neuroscience. 2020;11(2.1):139-156. https://doi.org/10.18662/brain/11.2Sup1/100
9. Babiak O., Okhrimenko I., Lyakhova N. et al. The impact of levels of emotional intelligence development in high schoolers with intellectual disabilities on their health status. Acta Balneol. 2022;64(2):155-159. doi:10.36740/ABAL202202110
10. Brusa J, Maggio MC, Giustino V et al. Upper and lower limb strength and body posture in children with congenital hypothyroidism: An observational case-control study. Int J Environ Res Public Health. 2020;17(13):4830. doi:10.3390/ijerph17134830.
11. Molina-Garcia P, Plaza-Florido A, Mora-Gonzalez J et al. Role of physical fitness and functional movement in the body posture of children with overweight/obesity. Gait Posture. 2020;80:331-338. doi:10.1016/j.gaitpost.2020.04.001.

12. Arefiev V, Tymoshenko O, Malechko T et al. Methodology of differentiation of health-improving classes in physical education for primary school students. Inter J Appl Exer Physiol. 2020;9(7):134-143.
13. Prontenko K, Bublei T, Marushchak M, Bondar T. A computer program for evaluation of children's fitness at football classes. Infor Tech Lear Tools. 2020;77(3):90-100.doi: 10.33407/itlt.v77i3.3277.
14. Serhiienko LP. Sportyvna metrolohiia: teoriia i praktychni aspekty [Sports metrology: theory and practical aspects]. Kyiv: KNT. 2010:773. (in Ukrainian)
15. Zhamardiy V, Shkola O, Ulianova V et al. Influence of fitness technologies on the student youth's physical qualities development. Revista Dilemas Contemporáneos: Educación, Política y Valores. 2019:49.
16. Griban G, Filatova O, Bosenko A. et al. Water in students' life and its impact on their health. Acta Balneol. 2021;2 (164):99-104. doi: 10.36740/ABAL202102104.
17. Aleksandrov D, Okhrimenko I. Psychological risk factors of the neurotization of adolescents under the conditions of quarantine measures of the COVID-19 epidemic. BRAIN. Broad Res Artif Intell Neur. 2020;11(2.1):29-36. doi:10.18662/brain/11.2Sup1/91.

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