

## Technology for correcting postural disorders in primary school-age children with hearing impairment during physical education

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### Abstract

**Purpose:** The article presents the structure and content of a technology for correcting postural disorders in primary school age children with hearing impairment from special boarding school. **Material & methods:** theoretical analysis and consolidation of information from scientific literature, Internet resources, pedagogical observation, teaching experiment, visual screening of posture (R. Bibyk, V. Kashuba, N. Nosova, 2012); photographing, mathematical and statistical. 139 students of 1–4 grades from special comprehensive boarding school of I–III levels for children with hearing impairment participated in ascertaining experiment – 73 boys and 66 girls, and 186 their apparently healthy mates. **Results:** In the process of research the type of posture was determined and the visual screening of bio-geometric posture profile in primary school age children with hearing impairment and with different types of posture and express testing of posture at the beginning and at the end of teaching experiment were performed. As a result of transformative experiment, it was established: in 9-year-old children with hearing impairment and with scoliotic posture or sway back there were positive changes in indices of bio-geometric posture profile ( $p < 0,05$ ). As demonstrated by the calculations performed, in 9-year-old boys with hearing deprivation statistically significant changes occurred in indices in sagittal plane (head inclination angle, trunk inclination angle, lumbar lordosis, knee flexion angle), in 9-year-old girls with hearing deprivation changes occurred in all indices under investigation ( $p < 0,05$ ), which, in our view, is related to the favorable effect of motor activity increase during introduction of technology for correcting postural disorders in children with hearing deprivation. **Conclusions:** The developed technology for correcting postural disorders in primary school age children with hearing deprivation has been successfully tested during transformative experiment: its efficiency is proved by quantitative changes (at the level of  $p < 0,05$ ) of indices under investigation. The performed research confirms the effectiveness of technology for correcting postural disorders in primary school age children with hearing deprivation in order to provide harmonious development and social adaptation to the society of healthy age mates.

**Keywords:** children, primary school age, deprivation, hearing, technology, correction.

### Introduction

The most severe types of health disorders – determinants of social impairment, social insufficiency, disability – include sensory development disability, hearing deprivation (Winnik, 2004; Yevseiev, 2007). In numerous researches (Kashuba, Savliuk, 2018) it was confirmed, that abnormal development of a child is always accompanied by motor disabilities and lack of exercise. The combination of sensor and motor deprivation leads to extreme difficulties in perception, mastering, preservation and reproduction of educational material, and also significantly complicates vital functions of the child with a disability (Kashuba, Savliuk, 2017).

The critical situation with the health of primary school age children especially emphasizes the problem of improving the health of children by means of physical education in the process of physical education activities (Mykhaylova, 2013; Alioshyna, 2015; Butenko, 2017; Afanasiev, Futorny, 2018). Primary school age is special in the system of school education as the main period of gaining social experience, in particular the intensive creation of interests, needs, reinforcing cognitive abilities, active physical development (Mykhaylova, 2014; Demchuk, 2015; Goncharova, 2016; Butenko, 2016; Kashuba, 2017). Nowadays, in the practice of physical education, modern forms of health improving fitness are increasingly being used, aimed at strengthening and

improving health of children (Howley, 2004; Kashuba, 2017; Imas, Dutchak, 2018; Nesterchuk, 2019). Scientific resources are devoted to the implementation of a wide range of innovative approaches, tools, methods and technologies of physical education of school students with hearing deprivation (Yevseiev, 2007; Kashuba, Savliuk, 2017).

The purpose of this study is to determine the effectiveness of developed and implemented technology for correcting postural disorders of children with hearing deprivation in the process of physical education at special boarding school.

### Material and methods

**Methods of study:** theoretical analysis and consolidation of information from scientific literature, Internet resources, pedagogical observation, teaching experiment, visual screening using an improved map for express testing of bio-geometric profile of posture (R. Bibyk, V. Kashuba, N. Nosova, 2012) to determine the level of bio-geometric profile of posture in 6–10-year-old children with hearing deprivation; photographing – type of posture of such children; mathematical and statistical.

*Procedure:* 139 students of 1–4 grades from special comprehensive boarding school of I–III levels for children with hearing impairment participated in ascertaining experiment. 6–10-year-old children with hearing deprivation consisting of 139 people: 73 boys and 66 girls were the main group of hems and 186 of their apparently healthy mates. In transformative pedagogical experiment 24 children at the age of 9 with hearing deprivation and with scoliotic posture or sway back (10 boys and 14 girls) participated.

### Results

On the basis of data analysis, copying from medical records in the state of health of 6-10-year-old children with hearing deprivation, basic disease, secondary disabilities and co-morbidity were determined. Posture functional disease is among the most common developmental disorder of musculoskeletal system in 6–10-year-old children with hearing deprivation: according to the results of the research of bio-geometric posture profile, a normal posture was found in only 34,5 % of the total number of 6–10-year-old children with hearing deprivation. As a result of the analysis of the results of bio-geometric posture profile, it has been found that 6-year-old children with hearing deprivation at the time of entering a school have a rather high level of postural disorders – 54,5 %, which increases to 71,8 % before finishing studying at primary school. The most common disorder in 6–10-year-old children with hearing deprivation is postural disorder in sagittal plane: sway back – 17,2 % of children, rounded back – 12,2 %, hollow posture – 5,0 %, flat back – 5,0 %, flattened back – 5,0 %; scoliotic posture determined in 20,8 % of children with hearing deprivation. Such data prove the necessity and expediency of developing a technology for correcting postural disorders in children, which will correspond to abilities and educational needs of primary school age children with hearing deprivation, their introduction into the system of physical education at special educational facilities.

As a result of the visual screening of posture in 6–10-year-old children with hearing deprivation and their apparently healthy mates it was found that primary school age children with hearing deprivation statistically significantly inferior ( $p < 0.05$ ) to their healthy peers in terms of bio-geometric posture profile. Postural disorder is a significant determinant of indices of bio-geometric posture profile in 6–10-year-old children with hearing deprivation and different types of posture (confirmed by the results of non-parametric Kruskal-Wallis test at a  $p < 0,05$  significance level). According to the evaluation results of bio-geometric posture profile, it has been determined that 63,3 % of children with hearing deprivation and correct posture have an average level of bio-geometric posture profile, and 40,0 % of children with hearing deprivation and different types of postural disorders fall into the risk zone of functional disorders of musculoskeletal system, reflecting the so-called pre-morbid state of musculoskeletal system – a state before the disease onset, requiring further continuous control of bio-geometric posture profile, as well as the use of methods to correct its disorders.

The purpose of the technology is correcting postural disorders in primary school age children with hearing deprivation, aimed at their harmonious development and social integration in a society of healthy mates. In the structure of the technology for correcting postural disorders in children with hearing deprivation coherent and harmonious, content interrelated sequence of using means, methods and methodical techniques, as well as forms of organization of activities for primary school students with hearing disorders during various classes is maintained. The main approaches, the overall purpose, tasks, conditions and principles of adaptive physical education have been chosen as the basis for theoretical justification of the technology for correcting postural disorders with hearing deprivation in the process of motor activity. It is necessary to give consideration to such pedagogical conditions to implement technology effectively: compliance with didactic principles, creation of an educational environment (atmosphere of trust and amiability in relationships, necessary equipment, game situations), the correspondence of load with functional capacity of the children's organism, integration of theoretical knowledge about prevention and correction of posture disorders in children with hearing deprivation. An integral component of the technology for correcting postural disorders in primary school age children with hearing deprivation was a comprehensive diagnosis of indices of postural bio-geometric profile.

The arrangement of motor activity of 6–10-year-old children with hearing deprivation in a regimen of a school day at a special boarding school had the following forms: lesson time – exercises before lessons, physical education lessons, physical activity breaks; extracurricular time – morning hygienic gymnastics, differentiated lessons on therapeutic exercises, individual lessons, individual motor activity as part of a class (several classes) before self-learning, sessions in specialized sport clubs, public recreational activities.

Preventive-correctional block of the technology included two modules:

1. Preventive module:
  - traditional means of physical education (sets of special physical exercises for preventing postural disorders; sets of physical exercises for preventing foot support-spring function disorders);
  - not traditional means of physical education (sets of physical exercises by Katsudzo Nishi's method; special yoga breathing exercises, based on Katsudzo Nishi's method; Tibetan recreational gymnastics);
  - modern means of physical education (sets of special physical exercises in stretching, physical exercises for preventing ophthalmological disorders);
2. Correctional module:
  - traditional means of physical education (sets of correctional physical exercises for creating correct posture; sets of special physical exercises for strengthening foot arch muscles);
  - not traditional means of physical education (sets of special yoga physical exercises by Richard Giltman's method; sets of Surya Namaskar yoga exercises; breathing exercises by B. Tolkachov);
  - modern means of physical education (set of Pilates exercises; exercises with Fit ball).

Correctional module included the means of physical education focused on correcting posture disorders in children with hearing deprivation in frontal and sagittal planes; preventive module combined the means of physical education which included exercises aimed at preventing and keeping on track the results, achieved by performing the exercises from correctional module. The choice of methodological techniques meant individual approach with taking into consideration the following characteristics of children with hearing deprivation: severity of the main disorder, presence/absence of concomitant and secondary disorders, age, physical development, preservation or lesion of sensory system, medical indications and contraindications, type of posture disorder, results of factor analysis.

Effectiveness of the technology of correcting posture disorders in 6–10-year-old children with hearing deprivation was provided by implementation of gaming method as the most important one for social adaptation and integration. During the research approximately 200 action-oriented games for primary school age children with due consideration of peculiarities of children with hearing deprivation were selected and classified. Correctional action-oriented games were classified in accordance with recommendation of N. V. Karachevska, Ye. V. Novychykhina, O. A. Stepanova and for children with hearing deprivation.

Correctional action-oriented games were classified by the commitment to development and improvement of: functions, damaged as a result of sensory systems lesion (functions of vestibular apparatus; functions of visual and acoustic analyzers; development of fine motor skills; formation of correct posture); mental processes (attention, mental capacity, memory, concentration of attention, speed of response); intensity level (by N. V. Ganzina) – games of light physical load, games of medium physical load, stimulating games; training games, physical abilities: games to develop coordination capacity (dexterity, accuracy, balance), speed and power capacities, stamina and flexibility.

Due to the fact that as a result of ascertaining experiment a big number of 9-year-old children with hearing deprivation were transferred to group with reduced load – 27,5 %, 41,3 % of 9-year-old children with hearing deprivation were transferred to specialized group. The biggest number of postural disorders and disharmonious physical development were recorded in 9-year-old children with hearing deprivation and scoliotic posture or sway back, that is why they participated in transformative experiment.

The main objective of transformative experiment was to establish effectiveness of the proposed technology implementation with due consideration of the indices of bio-geometric posture profile of 9-year-old children with hearing deprivation. Taking into account that 9-year-old children with hearing deprivation most often suffer such posture disorders as scoliotic posture and swayback, comparative analysis of children's physical condition indices before and after implementation of the technology was provided. The developed technology was successfully tested during the transformative experiment. The effectiveness of the developed technology during gradual comparative experiment was proved by quantitative (at the level of  $p < 0,05$ ) improvement of the indices of bio-geometric posture profile of primary school age children with hearing deprivation.

The results of comparative analysis of indices of bio-geometric posture profile of 9-year-old children with hearing deprivation and sway back before and after implementation of the technology of correcting children's postural disorders are show in Table 1.

**Table 1. Indices of bio-geometric posture profile of 9-year-old children with hearing deprivation before and after the experiment (n = 24), points**

Posture types	Experiment stages	Statistical indicators	1. Sagittal plane				2. Frontal plane				
			1.1. Head inclination angle ( $\alpha_1$ )	1.2. Trunk inclination angle ( $\alpha_2$ )	1.3. Lumbar lordosis ( $\beta_3$ )	1.4. Knee flexion angle ( $\alpha_3$ )	Anterior view	Posterior view			
							2.1. Hip bones position ( $\alpha_4$ )	2.2. Upper arms symmetry ( $\alpha_5$ )	2.3. Waist triangles	2.4. Symmetry of inferior angle of scapula ( $\alpha_6$ )	2.5. Foot position
1	2	3	4	5	6	7	8	9			
Boys (n = 10)											
Scoliotic posture (n = 6)	I	$\bar{X}$	1,3	1,3	1,3	1,3	1,2	1,2	1,2	1,2	1,2
		S	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
	II	$\bar{X}$	2,7*	2,7*	2,7*	2,7*	2,7	2,7	2,7	2,7	2,7
		S	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Sway back (n = 4)	I	$\bar{X}$	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
		S	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
	II	$\bar{X}$	2,8*	2,8*	2,8*	2,8*	2,8	2,8	2,8	2,8	2,8
		S	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
Girls (n = 14)											
Scoliotic posture (n = 8)	I	$\bar{X}$	1,4	1,4	1,4	1,4	1,1	1,1	1,1	1,1	1,1
		S	0,5	0,5	0,5	0,5	0,3	0,3	0,3	0,3	0,3
	II	$\bar{X}$	2,6*	2,6*	2,6*	2,6*	2,6*	2,6*	2,6*	2,6*	2,6*
		S	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Sway back (n = 6)	I	$\bar{X}$	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2
		S	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
	II	$\bar{X}$	2,7*	2,7*	2,7*	2,7*	2,7*	2,7*	2,7*	2,7*	2,7*
		S	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3

Notes: \* – difference between indices as a result of the experiment, statistically significant at a rate of  $p < 0,05$ ; I stage – ascertaining experiment; II – transformative experiment

At the end of transformative experiment it was found out that there were positive changes in the indices of bio-geometric posture profile (head inclination angle, trunk inclination angle, lumbar lordosis, knee flexion angle) ( $p < 0,05$ ) of 9-year-old children with hearing deprivation and scoliotic posture or sway back as a result of implementing the technology of correcting posture disorders, which is, to our mind, connected to positive influence in increased amount of motor activity as a part of implemented technology of correcting disorders of children's posture. The calculations proved that there were statistically significant changes in the sagittal plane indices (head inclination angle, trunk inclination angle, lumbar lordosis, knee flexion angle) in 9-year-old boys with hearing deprivation, and 9-year-old girls with hearing deprivation had positive changes in all indices under investigation ( $p < 0,05$ ). At the beginning of ascertaining experiment the boys with hearing deprivation and scoliotic posture got 13,8 points as evaluation of their bio-geometric posture profile, the level of their bio-geometric posture profile was assessed as below average; at the end of transformative experiment they improved their result till 29,7 points and the level became above average (Table 2).

**Table 2. Evaluation of bio-geometric posture profile of 9-year-old children with hearing deprivation (n = 24), points**

Posture types	Experiment stages	Boys	Girls
		(n = 10)	(n = 14)
Scoliotic posture (n = 14)	I	13,8	13,9
	II	29,7	28,6
Sway back (n = 10)	I	14,3	13,2
	II	30,8	29,7

Note: I stage – ascertaining experiment; II – transformative experiment

At the beginning of ascertaining experiment the boys with hearing deprivation and sway back got 14,3 points, the level of their bio-geometric posture profile was assessed as below average; at the end of transformative experiment they improved their result till 30,8 points and got high evaluation of their bio-geometric posture profile (Table 2).

At the beginning of ascertaining experiment, the girls with hearing deprivation and scoliotic posture got 13,9 points, the level of their bio-geometric posture profile was assessed as below average; at the end of transformative experiment they improved their result till 28,6 points and the level became above average. At the beginning of ascertaining experiment the girls with hearing deprivation and sway back got 13,2 points, the level of their bio-geometric posture profile was assessed as below average; at the end of transformative experiment they improved their result till 29,7 points and got above average evaluation of their bio-geometric posture profile (Table 2).

As a result, at the end of transformative experiment 2 of 6 boys with scoliotic posture were moved to the group of children with regular posture after medical examination of vertebroneurologist; 2 of 4 boys with sway back were moved to the group of children with regular posture. Among the girls with scoliotic posture 2 went to the group of children with regular posture; among the girls with sway back 2 went to the group of children with regular posture during transformative experiment with implementation of differentiated program of preventing and correcting children's postural disorders.

### Discussion

The analysis of special scientific resources proves that theoretical and practical aspects of adaptive physical education of children with hearing deprivation demand solving a number of problems, in particular preventing and correcting functional disorders of musculoskeletal system, which, as established by our research, are found in 88,4% of 6–10-year-old children with hearing deprivation, where posture disorders take 65,4%, which proves the results of other scientists' investigations (Yevseiev, 2007; Winnik, 2004 and others). By the data from scientific sources (Kashuba, 2003, 2008), presence of different types and levels of posture disorders in addition to weak physical development can be considered as the condition of pre-existing back bone disease, because adaptive reactions of musculoskeletal system are reduced. The severity of the problem of posture disorders in primary school age children is caused by the fact that without timely correction functional disorders of posture become favorable factor for developing structural changes in back bone and visceral diseases, that leads to decrease or loss of labor capacity at a mature age. Malfunctioning of nervous system, caused by posture disorders, as noted by some scientists (Winnik, 2004; Alioshyna, 2015; Kashuba, 2003, 2008), influences all other body systems and functions.

Despite big interest of the scientists and the data which has already been collected, the issue of preventing and correcting functional disorders of musculoskeletal system in the process of adaptive physical education of primary school age children with hearing deprivation has not been solved. It is proved by the fact that we managed to find a few scientific researches in this topic. Our research is in line with (Kashuba, 2003; Alioshyna, 2015) and proves that while preventing functional disorders of musculoskeletal system the attention should be mainly focused on exercises for strengthening muscles of back, abdomen, thorax, ankle and foot, as well as choice of rest positions, which contribute to decreasing the load on back bone and lower limbs muscles. There is difference of opinions regarding usage of exercises with various modes of muscles work in physical education of primary school age children.

As a result of the research it was proved that, unfortunately, organization of the process of adaptive physical education of children with hearing deprivation is conducted without taking into consideration the peculiarities of schoolchildren's posture. At the same time, we consider that the process of physical education should be organized in the way which enables formation of correct posture in children with hearing deprivation by means of developing the technology of correcting children's posture disorders in the process of physical education in conditions of boarding school. The numerous researches, which have been recently conducted, define topicality and need of the developed theory, as well as the component of its practical realization – justification and implementation of the efficient technology of correcting posture disorders in children with hearing deprivation.

The analysis of the results of transformative experiment proved that there were positive changes in the indices of bio-geometric posture profile in primary schoolchildren with hearing deprivation, who were training by the developed technology.

The conducted research proves effectiveness of the technology of correcting posture disorders in primary school age children with hearing deprivation, which is focused on their harmonious development and social adaptation to the society of healthy age mates.

### Conclusions

The developed technology of correcting posture disorders in primary school age children with hearing deprivation was successfully tested during transformative experiment: its efficiency is proved by quantitative changes (at a rate of  $p < 0,05$ ) in the indices under investigation. At the end of transformative experiment it was

found out that there were positive changes in the indices of bio-geometric posture profile ( $p < 0,05$ ) in 9-year-old children with hearing deprivation and scoliotic posture or sway back as a result of implementing the technology of correcting posture disorders, which is, to our mind, connected to positive influence in increased amount of motor activity as a part of implemented technology of correcting disorders of children's posture. During pedagogical experiment primary school age boys and girls with hearing deprivation and scoliotic posture improved the level of bio-geometric posture profile from below average to above average. The boys with hearing deprivation and sway back improved the level of bio-geometric posture profile from below average to high; the girls with hearing deprivation and sway back improved the level of bio-geometric posture profile from below average to above average.

Integrated research results proved effectiveness of realization and significant focus of implemented technology on improving the indices of bio-geometric posture profile of primary school age children with hearing deprivation in the process of physical education in specialized boarding school in order to provide harmonious development and social adaptation to the society of healthy age mates.

#### Conflicts of interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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