THE INFLUENCE OF THE AUTHOR'S TECHNOLOGY ON THE CONDITION OF THE SUPPORT-SPRING PROPERTIES OF THE FEET OF CHILDREN OF PRIMARY SCHOOL AGE WITH HEARING IMPAIRMENT

Burdaiev Kyrylo, Afanasiev Sergiy, Мукytchyk Olha, Sydorchuk Tetiana, Tolstykova Tetiana, Bocharova Svitlana

Prydniprovsk State Academy of Physical Culture and Sport

Annotations

Relevance of the research topic. Although we observe a certain percentage of scientists who dealt with the issues of determining the dynamics of the support-spring features of the foot in children of primary school age, this issue has not yet been definitively investigated. **The purpose** of our study was to determine the impact of the author's technology of forming the statodynamic posture of children of primary school age with hearing impairments on the state of the support-spring properties of the foot. **Research material and methods.** 7-year-old schoolchildren took part in the research with hearing disorders who study in a special boarding school for children with diminished hearing. **Results.** The technology of forming the statodynamic posture of children of primary school age with hearing impairments in the process of adaptive physical education is substantiated and implemented. The author's technology contains corrective and preventive exercises that are part of the "Statodynamic Posture" School, which includes a number of studios: «Correction Study», «Prevention Study», «Dynamic Posture Studio», «Study of static posture», «Studio of mobile games and relay races». **Conclusions.** The positive influence of the means and methods of the author's technology on the formation of the support-spring properties of the foot of children of primary school age with hearing impairment has been established.

Keywords: adaptive physical education, statodynamic posture, corrective and preventive exercises

ВПЛИВ АВТОРСЬКОЇ ТЕХНОЛОГІЇ НА СТАН ОПОРНО-РЕСОРНИХ ОСОБЛИВОСТЕЙ СТОПИ У ДІТЕЙ МОЛОДШОГО ШКІЛЬНОГО ВІКУ З ПОРУШЕННЯМ СЛУХУ

Бурдаєв Кирило, Афанасьєв Сергій, Микитчик Ольга, Тетяна Сидорчук, Тетяна Толстикова, Світлана Бочарова

Анотація

Актуальність теми дослідження. Нині спостерігається актуалізація питання визначення динаміки опорно-ресорних особливостей стопи у дітей молодшого шкільного віку. Певний відсоток науковців займалися цими питаннями, проте вони ще остаточно не досліджені. **Метою** нашого дослідження було визначити вплив авторської технології формування статодинамічної постави дітей молодшого шкільного віку з вадами слуху на стан опорно-ресорних властивостей стопи. **Матеріал і методи дослідження.** У дослідженні брали участь 7-річні школярі з вадами слуху, які навчаються в спецшколі-інтернаті для дітей зі зниженим слухом. **Результати.** Обґрунтовано та реалізовано технологію формування статодинамічної постави дітей молодшого шкільного віку з порушеннями слуху в процесі адаптивного фізичного виховання. Авторська технологія містить корекційно-профілактичні вправи, які є частиною Школи «Статодинамічної постави», до складу якої входять ряд студій: «Корекційна студія», «Профілактична студія», «Динамічна студія постави», «Дослідження статичної постави», «Студія рухливих ігор та естафет». **Висновки.** Встановлено позитивний вплив засобів і методів авторської технології на формування опорно-ресорних властивостей стопи дітей молодшого шкільного віку з порушенням слуху.

Ключові слова: адаптивне фізичне виховання, статодинамічна постава, корекційно-профілактичні вправи

Introduction. In all spheres of society, there is currently a paradigm shift in which a person becomes a priority and a long-term goal [7, 14, 16]. Unfortunately, the number of children with the sensory development disorders worldwide is increasing every year, a significant proportion of which are children with hearing impairments [2, 10, 11].

The problems of education and upbringing of children with deprivation of sensory systems (partial or complete deprivation of external influence on the organs of hearing) are actively studied by scientists from many countries. The profile of amblyopia in children aged 5 to 15 in the tertiary care center in Kumaon region [8] and the influence of early visual depression of children on the features of verbal working memory [5], the criterion of functional perception of children with hearing derivation has been studied [24].

There are a large number of scientific researches which substantiate introduction of innovative approaches, means and technologies of physical education of schoolchildren with hearing impairments. For example, the APRehab methodology to develop the games for the psychomotor rehabilitation of children with hearing impairments has been scientifically tested [19], various correctional programs for deaf children with the use of physical education means have been developed [21, 22].

Numerous studies [1, 15, 17] found that the process of development of the musculoskeletal system of school-age children with sensory systems deprivation is influenced by various factors and subject to certain changes. According to scientists [8, 13, 22] one of the causes of deviations in the state of health, the reduced rate of physical development, occurrence of pathological processes is a violation of the statodynamic posture of a person, in particular, the state of the support-spring properties of the foot.

A certain percentage of scientists dealt with the issues of determining the dynamics of the support-spring characteristics of the foot in children of primary school age [1, 6, 10, 11, 14], however, this issue has not yet been fully investigated. The aim of the research is the scientific substantiation of the technology of formation of statodynamic posture of children of primary school age with hearing disorders in the process of adaptive physical education according to the state of the support-spring properties of the foot.

Material and methods. *Participants* 7-year-old schoolchildren took part in the research with hearing disorders who study at a special boarding school for children with diminished hearing, of which 16 children were in the main group, and 16 children were in the control group. The total number of participants is 32 people. Written consent of parents for their children's participation in the study was obtained. The average age of children is 7.23±0.34.

The legal guardians of the children gave their consent for participation in the research. The results were collected in 2019-2020.

Measurements. The indicators of the state of the support-spring properties of the children's foot were evaluated according to 6 indicators: the length of the supporting part of the foot (mm), the height of the ankle joint (mm), the hight of the upper edge of the navicular bone (mm), the metatarsal angle α (degrees), the heel angle β (degrees), angle γ (degrees).

Statistical analysis. Statistica 13.0 software was used for statistical data processing. Descriptive statistical parameters (mean, standard deviation) were calculated in the groups. The significance of the differences was assessed by the Mann-Whitney U-test,

which was calculated according to the formula:

$$U_{эмп.} = (n_1 \cdot n_2) + \frac{n_x \cdot (n_x + 1)}{2} - T_x$$

To determine the effectiveness of the author's technology, we used a description based on non-parametric characteristics – sample median (Me), interquartile range (values of the 25th and 75th percentiles) [4].

Median was calculated according to the formula:

$$M_e = \frac{x_{\frac{n}{2}} + x_{\frac{n}{2}+1}}{2}$$

Xn – measurement result

n – number of the subject.

In descriptive statistics, the interquartile range (IQR) is a measure of statistical dispersion, which is the spread of the data. The IQR may also be called the midspread, middle 50%, fourth spread, or H-spread. It is defined as the difference between the 75^{th} and 25^{th} percentiles of the data. To calculate the IQR, the data set is divided into quartiles, or four rank-ordered even parts via linear interpolation. These quartiles are denoted by Q_1 (also called the lower quartile), Q_2 (the median), and Q_3 (also called the upper quartile). The lower quartile corresponds with the 25^{th} percentile and the upper quartile corresponds with the 75^{th} percentile, so

$IQR = Q_3 - Q_1$.

Results. In the process of adaptive physical education of children of the main group the author's technology of formation of statodynamic posture was introduced. The technology included a number of interconnected structural components (organizational, diagnostic, methodological, control-corrective and effective). The organizational component provided for the assessment of the feasibility of using the technology of formation of statodynamic posture of children of primary school age with hearing disorders, the conditions of its implementation. The diagnostic component made it possible to determine the somatoscopic indicators, the level of biogeometric profile of posture, indicators of support and spring properties of the foot, static balance of the body, walking kinematics of primary school children with hearing disorders. The methodological component was used to plan preventive and corrective measures in the process of adaptive physical education, taking into account the level of the biogeometric profile of posture, support-spring properties of the foot, static body balance and the temporal characteristics of walking phases of primary school children. The control and correction component was focused on assessing the intermediate results of the formation of statodynamic posture of children. The effective component included the diagnosis of the level of biogeometric profile of posture, the support-spring properties of the foot, the static balance of the body and walking kinematics of primary school children with hearing disorders and evaluation of the effectiveness of the author's technology.

The author's technology included the preparatory, basic and supporting stages, which were integrated into the curriculum of the 1st grade. At the preparatory stage, the state of the biogeometric profile of the posture and support-spring properties of the foot was screened; the initial level of static balance of the body, walking kinematics, adaptation of the body of schoolchildren to physical activity was determined. The main stage was aimed at forming of statodynamic posture of primary school children with

hearing impairments. The supporting stage was aimed at maintaining the established skill of statodynamic posture of children.The developed technology included corrective and preventive exercises, which were included in a number of study classes of the School "Statodynamic Posture":

- "Correction Study" included the inclusion of the exercises aimed at correcting posture disorders, improving the biogeometric profile of posture, static balance of the body, ensuring the natural development of temporal characteristics of the phases of walking; strengthening the muscles of the foot. It contained 5 sets of physical exercises that were integrated into the content of the "School of Movement Culture with Elements of Gymnastics" (18 hours) of the curriculum of the first class of special secondary schools for children with diminished hearing;

- "Prevention Study" included the inclusion of exercises aimed at normalizing the geometry of the articular components of the foot and strengthening its musculoskeletal system. 4 sets of physical exercises were developed and included in the "School of Movements" (13 hours);

- "Dynamic Posture Studio" included the inclusion of the exercises aimed at forming the correct body position when performing various physical exercises. 6 sets of physical exercises were developed and included in the "Ball School" (8 hours);

- "Study of static posture" included the inclusion of exercises aimed at strengthening the muscles that form an orthograde posture, the development and improvement of vertical stability of the body of children. 4 sets of physical exercises were developed and integrated into the "Jumping School" (4 hours);

- "Studio of mobile games and relay races" included mobile games and relay races aimed at improving physical preparedness, developing skills of the stereotypes of the correct posture and statodynamic posture and contains the mobile games and relay races, which took into account the recommendations of the leading experts in physical education of primary school children. The studio of mobile games and relay races was included in the "School of Active Recreation" (recreation).

In the process of technology implementation, the teaching methods were used taking into account the peculiarities of children's perception of educational material, a certain stock of knowledge and skills, the presence of previous motor experience. At physical education classes, the teachers introduced schoolchildren, through a multimedia presentation, to the importance of using exercise to improve health and form a proper posture.

The criteria for the effectiveness of the developed technology determined statistically significant changes in physical development, biogeometric profile of posture, vertical stability of the body, support and spring properties of the foot and the dynamics of the temporal characteristics of the phases of walking.

With the children of the control group, physical education classes were conducted according to the curriculum of the subject "Physical Culture" for grades 1-4 of special secondary schools for children with diminished hearing [20].

Table 1 shows the absolute values of the results of the support-spring properties of children's feet before and after the experiment.

Table 1.

Indicators of the state of the support-spring properties of children's feet before and after the experiment

Indicators	Group	Before the experiment					After the experiment				
		X	Me	25%	75%	S	*X*	Me	25%	75%	S
The length of the supporting part of the foot, mm	Control (n=16)	120,5	120,0	119,0	122,0	3,2	123,4	123,0	121,0	125,5	3,4
	Main (n=16)	119,8	120,0	117,5	121,0	3,2	122,7	123,0	119,5	124,5	3,6
The height of the ankle joint, mm	Control (n=16)	49,6	50,0	48,0	51,0	2,8	51,8	52,0	50,5	53,0	2,5
	Main (n=16)	49,4	50,0	48,0	51,0	2,6	52,1	52,5	51,0	53,5	2,5
The hight of the upper edge of the navicular bone, mm	Control (n=16)	30,4	30,5	29,0	32,0	2,2	31,2	31,0	30,0	33,0	2,4
	Main (n=16)	30,4	30,5	29,0	32,0	2,2	31,5	31,8	30,5	33,0	2,2
The metatarsal angle α, degrees	Control (n=16)	18,3	18,5	17,0	20,0	1,7	17,9	18,0	16,5	19,0	1,5
	Main (n=16)	18,1	18,0	16,5	20,0	1,7	19,0	19,5	17,0	20,5	1,7
The heel angle β, degrees	Control (n=16)	20,6	20,0	19,5	22,0	1,5	21,1	21,0	20,0	23,0	1,7
	Main (n=16)	20,6	20,0	19,5	22,0	1,5	21,4	21,0	20,5	23,0	1,7
Angle γ, degrees	Control (n=16)	126,8	127,5	124,5	129,5	3,0	141,0	141,0	140,0	142,0	1,8
	Main (n=16)	141,3	141,5	140,0	143,0	1,9	139,6	139, 0	138,0	141,5	2,3

It should be noted that before the experiment, statistically significant ($p>0.05$) differences between the indicators of the state of the support-spring properties of the foot in the children of the main and control groups were not observed.

In the main group, the following indicators increased: the length of the supporting part of the foot (by 3,2 mm, $p<0,01$), the height of the ankle joint (by 2,5 mm, $p<0,01$), the hight of the upper edge of the navicular bone (by 1,1 mm, $p<0,01$), the metatarsal angle α (by 1.9 degrees, $p<0,01$), the heel angle β (by 1,4 degrees, $p<0,01$), angle γ (by 1.7 degrees, $p<0,01$).

Discussion. It has been scientifically proven that currently there is a significant number of children of primary school age with hearing impairment. According to the research data of a number of specialists [1, 11, 12, 14], pathology of the shape of the foot is quite common among children aged 7-10 with hearing impairment. At the same time, special scientific researches [9, 11, 12, 18] testify that in order to ensure the effective functioning of the system of physical education of schoolchildren with hearing impairments in the conditions of radical variability of modern society, there is an acute problem of finding effective "innovative" systems of physical education and improving the health of the young generation**.**

The systematization and generalization of literary sources allows us to state that due attention is paid to the problem of developing modern approaches to correcting violations of the statodynamic posture of schoolchildren with deprivation of sensory systems in the process of adaptive physical education. But at the same time, issues related to scientific substantiation and development of technology for the formation of statodynamic posture of children of primary school age are far from being resolved. Therefore, the research in the direction of the formation of statodynamic posture of children aged 7-10 with hearing impairment in the process of adaptive physical education is currently relevant. [**Ошибка! Источник ссылки не найден.**10, 11, 14]. It was assumed that the influence of the author's technology of forming the statodynamic posture of children of primary school age with hearing impairments on the state of the support-spring properties of the foot will be determined in the course of the research.

We substantiated and implemented the technology of forming the statodynamic posture of children of primary school age with hearing impairments in the process of adaptive physical education. The technology is based on structural components (organizational, diagnostic, methodical, control-corrective, informational, and effective) and includes preparatory, main, and supporting stages. The author's technology contains corrective and preventive exercises that are part of the "Statodynamic Posture" School, which includes a number of studios: «Correction Study», «Prevention Study», «Dynamic Posture Studio», «Study of static posture», «Studio of mobile games and relay races».

The positive influence of the means and methods of the author's technology on the formation of support-spring properties of the foot has been established: the length of the supporting part of the foot by 2,4% ($p<0,01$). the height of the ankle joint by 5,3% ($p<0,01$), the height of the upper edge of the navicular bone by 3,5% ($p<0,01$), metatarsal angle α by 5,0% ($p<0,01$), heel angle β by 3,9% ($p<0,01$), angle γ by 2,37% ($p<0,01$). The obtained data are consistent with the researches data of Ben Jeddu Adele Ben Larbi [3], who investigated the peculiarities of walking of children with a violation of the spatial organization of the body and, at the same time, are new, as the specified changes in children of the main group took place due to introduction of the author's technology.

The changes that occurred in children of the control group complement the results of researches by a number of specialists in this direction. Thus, our research expands and supplements the information on age-related changes in indicators of the formation of morphobiomechanical characteristics of the foot [1, 6, 15, 23].

Prospects for further research are related to the experimental substantiation of means and methods of physical education aimed at correcting statodynamic posture violations for secondary school students with hearing impairments in the process of adaptive physical education.

Conclusion. The technology of forming the statodynamic posture of children of primary school age with hearing impairments in the process of adaptive physical education has been substantiated and developed, which is based on the following structural components: organizational, diagnostic, methodical, control-corrective, informational and effective. The technology includes stages: preparatory, basic, supporting. The author's technology also includes suggested corrective and preventive exercises, which are included in the technology of formation of statodynamic posture developed by us – the "Statodynamic Posture" School, which includes a number of studios: «Correction Study», «Prevention Study», «Dynamic Posture Studio», «Study of static posture», «Studio of mobile games and relay races».

The positive influence of the means and methods of the author's technology on the formation of the support-spring properties of the foot of children of primary school age with hearing impairment has been established. This indicates the effectiveness of the implemented technology, which gives every reason to recommend it for use in the process of adaptive physical education in special secondary schools for children with hearing impairment.

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Відомості про авторів:

Бурдаєв К.В.; https://orcid.org/0000-0002-2502-9104; kaffism111@gmail.com; Придніпровська державна академія фізичної культури і спорту, вул. Набережна Перемоги, 10, м. Дніпро, 49094, Україна

Афанасьєв С.М.; https://orcid.org/0000-0001-7739-3461; admin_infiz@ukr.net; Придніпровська державна академія фізичної культури і спорту, вул. Набережна Перемоги, 10, м. Дніпро, 49094, Україна

Микитчик О.С.; https://orcid.org/0000-0002-0047-4359; molga.0604@gmail.com; Придніпровська державна академія фізичної культури і спорту, м. Дніпро, Україна

Сидорчук Т.В.; https://orcid.org/0000-0001-7129-1616; *sydorchuk1704@gmail.com;* Придніпровська державна академія фізичної культури і спорту, вул. Набережна Перемоги, 10, м. Дніпро, 49094, Україна

Толстикова Т.М.; https://orcid.org/0000-0002-8433-378x; tolstikova108@gmail.com; Придніпровська державна академія фізичної культури і спорту, вул. Набережна Перемоги, 10, м. Дніпро, 49094, Україна

Бочарова С.А.; https://orcid.org/0000-0003-3499-8502; forlang-infiz@ukr.net; Придніпровська державна академія фізичної культури і спорту, вул. Набережна Перемоги, 10, м. Дніпро, 49094, Україна