

Correction of motor stereotypes using dance exercises in children with Down syndrome

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Abstract:

Physical activity is essential in rehabilitation strategies for children with Down syndrome (DS). Enhancing methods to effectively address their physical impairments remains a continuing challenge. **Purpose:** The aim of this study was to design and evaluate the effectiveness of a dance exercise program in comparison with traditional adaptive physical education methods for correcting motor patterns in children with DS. **Materials and methods:** Twenty-four boys aged 11–13 years with DS participated in this study. They were divided into a control group (CG) and an experimental group (EG), with each group attending one 45-min lesson per week over eight months. The CG engaged in adaptive physical education based on the Federal State Educational Standards for Students With Intellectual Disabilities. For the EG, a method incorporating dance exercises with selected standard choreographic positions, organized into three blocks, was proposed and tested as part of a rehabilitation program. Assessments included boundary testing of strength, strength endurance, static and dynamic balance, fine motor skills, and quality of life. **Results.** The testing of the proposed method, designed to correct asymmetric muscle tone, enhance coordination of body movements, and improve spinal stabilization in children with DS, demonstrated superior effectiveness compared to traditional rehabilitation approaches. Boundary testing results for strength abilities, static and dynamic balance, and fine motor skill development in the EG revealed significantly higher values compared to the CG. Additionally, children in the EG achieved the highest quality of life scores, as reported by both the children and their parents. **Conclusions.** The proposed method for correcting motor stereotypes through dance-based techniques has been tested and can be effectively incorporated into rehabilitation practices for children with DS.

Keywords: Down syndrome (DS), motor activity, dance exercises, physical education

Introduction

Down syndrome (DS) is a severe mental disorder and the most common chromosomal abnormality (Beqaj et al., 2018; Vandoni et al., 2023), with a frequency of 1 in 1000 births (de Graaf et al., 2021). It results from a chromosomal anomaly where individuals have 47 chromosomes in their cells instead of the usual 46. This extra chromosome disrupts the normal development of cells and tissues in the body (Sydoruk et al., 2021). Consequently, individuals with DS face significant communication challenges, as well as cognitive and language difficulties, warranting the classification of DS as an intellectual disability (Daniel Medina-Rebollo et al., 2023). These individuals also exhibit reduced physical activity levels compared to healthy peers (Alwhai-bi et al., 2022; Borji et al., 2023). Such reduced physical activity, coupled with metabolic disturbances (Wentz et al., 2021; Quinzi et al., 2022), frequently leads to overweight and obesity in this population (Palomba et al., 2020; Cai & Baek, 2022). Research suggests that the underlying cause of low physical performance in individuals with DS is related to insufficient maximal oxygen consumption (VO₂max) and impaired exercise economy (Mendonca et

al., 2010). This genetic condition is associated with a broad spectrum of health complications affecting the cardiovascular, respiratory, musculoskeletal, immune, endocrine, and other systems (Daniel Medina-Rebollo et al., 2023). These comorbidities compromise overall health and decrease quality of life, as evidenced by research performed in various countries (Adorno et al., 2022; Morán et al., 2022; Fong Yan et al., 2024). Children with DS exhibit considerably lower levels of social and academic functioning (Chan et al., 2024), posing challenges for their education and integration in educational settings. Given the limited research on the quality of life in individuals with DS, some researchers advocate for further investigation in this area (Lee et al., 2022). Motor development in individuals with DS exhibits distinctive characteristics, including delayed development of motor skills. As a result, the acquisition of basic motor skills occurs later, with delayed sensitive periods and a different developmental order compared to their healthy peers. In normally developing children, the average age of walking onset is approximately 13 months, with a range of 7–17 months. In contrast, the average age of walking onset in children with DS is approximately 24 months, with a range of 13–48 months. These children often present with underdeveloped muscles and impaired connective tissue (Wentz et al., 2021), which can contribute to various skeletal abnormalities, including hip dysplasia and scoliosis. Consequently, children with DS require ongoing monitoring by an orthopedist and regular consultations with a specialist in physical rehabilitation and development. To effectively monitor the physical development of children with DS, it is crucial to use normative indicators specifically designed for this population (Palomba et al., 2020; Yılmaz & Mirze, 2022). The unique characteristics of their motor development can lead to substantial postural disturbances. This is attributed to discoordination among various body systems responsible for maintaining and regulating body position, both at rest and during movement.

In the system of treatment and rehabilitation measures for people with DS, physical activity plays an important role. It provides adequate symptomatic treatment, is effective in changing the patient's quality of life and maintaining an appropriate level of health (D'isanto, 2023). Adaptive physical education is especially necessary in childhood and adolescence for patients with DS, through which they learn to express themselves through movement (Sydoruk et al., 2021). The formation of motor skills is effective for the development of cognitive, emotional and physical aspects in children with DS (Vandoni et al., 2023), which is an important basis for school and vocational education of children. For effective acquisition of motor skills by sick children, an important role is given to the personal participation in physical activity of parents or siblings of the sick child (Sollerhed, & Hedov, 2021), which indicates a close dependence of physical activity on family support. Important findings on the correlation between the level of home participation and functional skills in children with DS were made by Brugnaro et al., (2024). The authors found positive correlations between the frequency of a child's participation at home in daily activities, social/cognitive function, and responsibility.

There are examples of the use of effective means and methods of physical education for children with DS in the scientific literature. Such means include the use of physical exercises based on the game method (Regaieg et al., 2020; Wentz et al., 2024). The use of this method allowed researchers to improve locomotor and cognitive functions in sick children. Good recovery results in adult patients with DS were obtained by W. Cai, & S. Baek (2022) using elements of the basketball game. This made it possible to recommend this game as an effective means of rehabilitation for children, adolescents, and adults. Japanese researchers Ito et al. (2017) used dance exercises for children with mental retardation and DS. The authors found that in the third month of the experiment, academic performance and language proficiency scores for many students improved significantly. Further studies by these authors on younger schoolchildren who used an inexpensive dance program showed an improvement in grip strength, lower limb muscle strength, and dynamic balance during movement (Ito et al., 2024). Positive psychophysical changes were obtained by Fong Yan et al. (2024) during dance interventions in individuals who suffered from Parkinson's disease, anxiety, and depression. They noted an increase in motivation for physical activity and social cognition, and improved memory. Summarizing the literature data on the effect of physical activity on the motor qualities of people diagnosed with DS M. Méndez-Martínez, & E.I. Rodríguez-Grande (2023) concluded that combined exercises significantly increased muscle strength in the upper and lower extremities. Aerobic exercises improved dynamic balance, while combined exercises significantly increased static balance. Despite the available literature data on the positive impact of dance exercises on the psychological, social and physical state of people with DS, some authors point to the need for further research to determine the optimal dose of exercise, the comparative effectiveness of dancing compared to other types of activity, and the impact on the motor stereotype (Chen et al., 2022). Our analysis of the literature indicates a lack of research on the use of dance to correct the physical condition, quality of life and the impact on the motor stereotype in children with Down syndrome. It is known that the main task of the motor stereotype is to form the automation of walking, posture and distribution of efforts in muscles of various functional orientations, which are necessary to maintain posture and motor activity. We believe that the study of these issues will allow the use of research results for the rehabilitation of children with DS, which will significantly improve their psychophysical condition and quality of life.

Purpose. The aim of this study is to evaluate and compare the efficacy of a methodology using dance exercises versus the conventional approach of adaptive physical education in improving motor coordination in children with DS.

Materials and methods

This study was performed from September 2022 to May 2023 at the regional branch of the All-Russian public charitable organization supporting individuals with intellectual disabilities (Siberian Federal District, Russia). The study included 24 male participants aged 11–13 years (mean age: 12.8 ± 1.3 years) who had received a diagnosis of DS. The participants were randomly assigned to either the control group (CG; $n = 12$) or the experimental group (EG; $n = 12$). Both groups engaged in weekly 45-min lessons over an 8-month period, totaling 26 lessons. Before the study's commencement, written informed consent was obtained from the parents of all participating children. The research adhered to the ethical principles outlined in the 2008 World Medical Association Declaration of Helsinki regarding medical and biological research involving human subjects.

The CG participants engaged in rehabilitation physical education in accordance with the Federal State Educational Standard for Education of Students with Intellectual Disabilities (Order of the Ministry of Education and Science of the Russian Federation dated December 19, 2014 No. 1599). The corrective classes for children in the CG aimed to develop and enhance basic motor skills, including speed, strength, endurance, flexibility, coordination, and agility. These classes also focused on developing the children's ability to monitor their physical condition and activity levels, as well as to appropriately regulate their physical exertion. The children were introduced to the fundamentals of various sports (e.g., athletics, gymnastics, skiing) in a manner tailored to their age and psychophysical characteristics. They also participated in sports and active games. The children in this group used traditional methods and approaches of adaptive physical education commonly employed for individuals with intellectual disabilities. For children in the EG, the choreotherapy method was employed. This method involves rehabilitating individuals through dance, using movement to music for emotional, physical, and social integration (Matskevich, 2017). A distinctive characteristic of this approach in correcting motor patterns is the implementation of the principle of sequential movement organization. This entails the formation of complex dance movements that are integrated into a single, meaningful, rhythmic motor act. The correction of motor patterns through choreotherapy encompasses the development of fine and gross motor skills, stimulation of motor activity, the establishment of proper posture, the formation of basic knowledge about one's body, and the fostering of teamwork abilities. These elements collectively contribute to addressing developmental impairments in body perception, delays in various types of perception and coordination, balance, and spatial orientation.

The introductory part of the experimental lesson lasted 8 min. Its objectives were to engage the children's attention and stimulate their cerebral cortex through asynchronous cheerleading movements. The pace of these exercises was maintained at a slow to moderate tempo. The main part of the lesson consisted of three blocks, each allocated 25 min. This part focused on addressing asymmetric muscle tone, which plays a crucial role in maintaining an upright body position and enhancing spinal stability, thereby facilitating its correction. Additionally, these exercises aimed to improve the coordination of body movements in space, leading to normalized balance and posture. Engaging in exercises during the main part of the lesson promoted the development of static endurance in the trunk muscles and increased the body's overall physical performance.

The first block of the lesson comprised corrective and strengthening exercises for the deep back muscles, performed in a supine position. The second block involved static–dynamic loading exercises to reinforce the body's upright posture. To achieve this, three positions were employed, with a focus on foot placement, arm movements, and head turns. The third block incorporated dance exercises performed in pairs with a volunteer providing visual supervision to ensure proper posture maintenance. Elements from the Cha-cha-cha, Salsa, and Waltz dance styles were used.

Table 1. Structure and content of physical and dance exercises in the main part of the lesson at different stages of motor pattern correction in children from the experimental group

Blocks of lessons	Tasks	1–2 months	3–4 months	5–6 months
Block I. Corrective and strengthening exercises for back muscles	Correct asymmetric muscle tone to support proper biomechanics of the vertical body position; enhance overall physical performance	Duration: 8 min; Tempo: slow; Starting position: standing, lying; Number of exercises: 4; Repetitions: 6	Duration: 6 min; Tempo: medium; Starting position: standing, lying; Number of exercises: 4; Repetitions: 6–8	Duration: 6 min; Tempo: medium; Starting position: standing, lying; Number of exercises: 4; Repetitions: 8–10
Block II. Standard choreographic positions	Improve spinal stabilization for further correction; build static endurance in trunk muscles	Duration: 6 min; Tempo: slow; Exercises performed in front of a mirror at the barre; Number of exercises: 3	Duration: 6 min; Tempo: slow; Exercises performed in front of a mirror at the barre; Number of exercises: 3	Duration: 5 min; Tempo: slow; Exercises performed in front of a mirror at the barre; Number of exercises: 3
Block III. Dance practice	Enhance coordination and movement in space to improve balance, posture, and ability to participate in physical activities; normalize nervous processes and emotional state	Duration: 11 min; Dance style: Cha-Cha-Cha	Duration: 13 min; Dance style: Waltz	Duration: 14 min; Dance style: Salsa

The final part of the lesson lasted 7 min. Its purpose was to gradually reduce the intensity of the exercises to normalize heart rate and restore breathing. This was achieved through breathing exercises, stretching, relaxation, and calming techniques. The pace of these exercises was slow, with each exercise repeated four times.

Functional research methodologies were employed to fulfill the research objectives. These assessments were performed at the beginning of the study, in the middle, and at the end.

To evaluate the comparative efficacy of the employed methods for correcting motor patterns in the CG and EG, several functional tests were used. The "Swallow" test was administered to assess postural muscles and evaluate the strength endurance of trunk muscles. Beginning in a prone position, the subject extends their arms backward, lifts their head and shoulders, and simultaneously raises their legs while maintaining them straight. The ability to hold this position for 20 s is considered the norm.

The "Corner" test was employed to assess postural muscles and evaluate the strength endurance of abdominal muscles. Maintaining the pose for 15 s is considered the norm. The "Walking along the line" test was used to assess dynamic balance. A straight yellow tape measuring 5 m in length and 7 cm in width was affixed to the floor. The subject was instructed to walk forward at a normal pace with their hands placed on their waist, reach the end of the tape, turn around, and walk back. The time taken to complete this task was recorded. The norm was defined as walking the length of the line in less than 17 s. Children's static balance was evaluated using a simplified Romberg test. Wrist dynamometry of both hands was used to assess their strength capabilities. The "9-Holes" (Nine-Hole Peg Test) method was used to analyze the development of fine motor skills in the groups. This method involves the child placing pegs into 9 holes on a wooden board. The time elapsed from the start of the task to its completion is recorded. Typically, a healthy child requires approximately 18 s to complete this test (Belova, 2018).

The quality of life was assessed based on responses provided by children and their parents at the beginning and end of the project. The PedsQL 4.0 Generic Core Scales questionnaire (Quality of Life Scale) developed by Vami et al. (1999) was used. Participants were asked to respond to 23 questions assessing physical, emotional, and social quality of life, as well as functioning in an educational setting. The indicators of the studied parameters were determined by summing the points obtained (maximum of 100 points).

The digital data were processed using conventional statistical methods. The arithmetic mean, its margin of error, and the standard deviation were calculated. The reliability of the results was evaluated based on the value of the t-Student coefficient. A difference was deemed statistically significant at $p < 0.05$.

Results

The results of testing strength abilities and balance in children with DS in both the CG and EG at the beginning, middle, and end of the experiment are presented in Table 2.

Table 2. Values of boundary testing indicators for children with DS in both groups, $M \pm m$

No	Test	Groups	Beginning of the experiment	Middle of the experiment	End of the experiment	Normal
1.	"Swallow" (strength endurance of the back muscles), sec	CG	9.14 ± 1.46	11.20 ± 2.62	12.65 ± 2.54	20 sec
		EG	9.05 ± 1.21	11.38 ± 2.88	$14.63 \pm 2.73^*$	
2.	"Corner" (strength endurance of the abdominal muscles), sec	CG	8.23 ± 1.24	9.75 ± 2.23	10.23 ± 1.32	15 sec
		EG	7.96 ± 2.27	11.81 ± 2.16	$15.2 \pm 1.67^*$	
3.	"Walking along a line" (dynamic balance), sec	CG	23.56 ± 2.43	22.14 ± 2.13	20.65 ± 2.02	<17 sec
		EG	25.21 ± 2.74	20.29 ± 2.95	$16.42 \pm 1.52^*$	
4.	Romberg test (static balance), sec	CG	10.53 ± 1.86	12.7 ± 1.93	12.92 ± 1.97	>15 sec
		EG	9.15 ± 2.21	13.38 ± 1.8	$15.63 \pm 2.23^*$	

Note. * Significant difference in value compared to the beginning of the study, $p < 0.05$

At the beginning of the research project, no statistically significant differences were observed in the values of the indicators for strength, endurance, dynamic and static balance tests between the children in both groups ($p > 0.05$). This suggests that the participants were appropriately distributed into the groups, allowing for the subsequent implementation of the experiment.

In the middle of the research project, improvements were observed in the indicator values for both groups. However, no test value in either group significantly exceeded its initial value ($p > 0.05$).

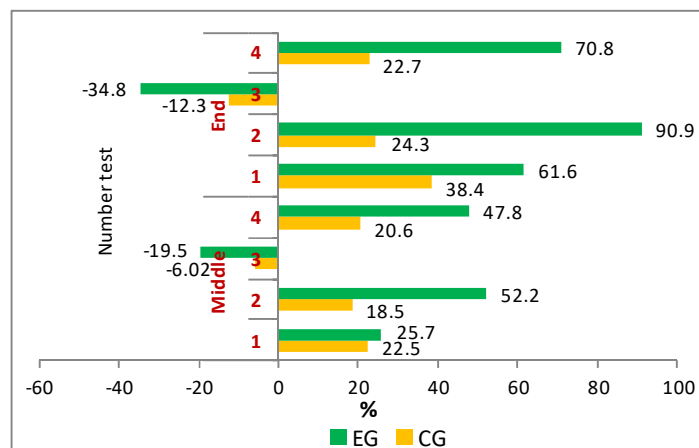


Fig. 1. Marginal increase in the values of strength, endurance, dynamic and static balance test indicators in children in the CG and EG

At the end of the experiment, the most substantial increase in the indicators was observed in children in the EG in test trial No. 2 ("Corner," which assesses the strength endurance of the abdominal muscles) and test No. 4 (Romberg test). In these tests, the increase in values was 90.9% and 70.8%, respectively, compared to the beginning of the research project. During the experiment and at its conclusion, an increase in the strength of both hands and an improvement in the characteristics of fine motor skills were observed in children in both groups (Table 3).

Table 3. Values of hand dynamometry and "9-Hole" test indicators in children in both groups, $M \pm m$

No	Test	Groups	Beginning of the experiment	Middle of the experiment	End of the experiment
1.	Dynamometry (hand strength), kg	CG	10.32 $\pm$ 0.44	11.45 $\pm$ 0.67	12.74 $\pm$ 0.86*
			11.41 $\pm$ 0.56	12.23 $\pm$ 0.68	13.38 $\pm$ 0.97*
		EG	10.0 $\pm$ 0.36	12.56 $\pm$ 0.79*	14.32 $\pm$ 0.78*
			11.84 $\pm$ 0.65	13.34 $\pm$ 0.92*	15.73 $\pm$ 1.12*
2.	"9 holes" (development of fine motor skills), sec	CG	37.73 $\pm$ 3.34	28.47 $\pm$ 2.45*	25.42 $\pm$ 2.89*
		EG	39.95 $\pm$ 3.36	26.22 $\pm$ 2.89*	24.34 $\pm$ 2.23*

Note. * Significant difference in value compared to the beginning of the study, $p < 0.05$

At the beginning of the experiment, the values of the indicators characterizing the state of fine motor skills in all children indicated an insufficient level of development in this area. At the beginning of the testing, the time to complete the "9-Hole" test for all children was more than twice the standard value (18 s). The implementation of rehabilitation measures significantly improved fine motor skills in both experimental groups by the middle and end of the experiment ($p < 0.05$). By the middle of the experiment, the test completion time decreased by 24.5% in the CG and by 34.4% in the EG. At the end of the experiment, even more positive changes in the development of fine motor skills were observed. In the CG and EG children, the test execution time decreased by 32.6% and 39.1%, respectively, by the end of the experiment. An important focus of rehabilitation measures for children with DS is improving their quality of life. The results of the study on this indicator, assessed using the PedsQL questionnaire, at the beginning and end of the experiment are presented in Table 4.

Table 4. Quality of life indicators based on surveys of children and their parents at the beginning and end of the research project, $M \pm m$

No p/p	Quality of life components	Groups	Children		Parents	
			Beginning of the experiment	End of the experiment	Beginning of the experiment	End of the experiment
1.	Physical Component	CG	39.4 $\pm$ 3.2	60.5 $\pm$ 5.4	32.2 $\pm$ 2.3	55.7 $\pm$ 4.6*
		EG	40.3 $\pm$ 3.5	71.8 $\pm$ 5.8*	31.7 $\pm$ 2.6	62.6 $\pm$ 5.3*
2.	Emotional Component	CG	55.8 $\pm$ 4.5	61.9 $\pm$ 5.2	42.3 $\pm$ 3.4	57.3 $\pm$ 4.1*
		EG	53.2 $\pm$ 4.2	73.4 $\pm$ 5.8*	44.3 $\pm$ 3.6	66.4 $\pm$ 5.8*
3.	Social component	CG	57.6 $\pm$ 4.9	68.7 $\pm$ 5.1	42.8 $\pm$ 2.2	57.3 $\pm$ 4.9*
		EG	54.5 $\pm$ 4.1	77.5 $\pm$ 4.3*	44.6 $\pm$ 3.7	70.2 $\pm$ 6.5*
4.	Children's Functioning in School	CG	53.7 $\pm$ 5.4	61.9 $\pm$ 6.3	41.3 $\pm$ 3.4	56.8 $\pm$ 5.2*
		EG	51.8 $\pm$ 5.3	69.3 $\pm$ 6.8*	40.2 $\pm$ 3.0	65.4 $\pm$ 5.9*
5.	Total Score	CG	51.6 $\pm$ 3.4	63.3 $\pm$ 4.0*	39.4 $\pm$ 2.8	56.7 $\pm$ 4.3*
		EG	49.9 $\pm$ 2.9	73.0 $\pm$ 5.4*#	40.2 $\pm$ 3.5	66.9 $\pm$ 5.0*#

Note:

* Significant differences between the responses of children and their parents at the end of the experiment compared to the beginning, $p < 0.05$;

Significant differences between the responses of children and their parents in the CG and EG, $p < 0.05$

It was determined that at the beginning of the research project, the responses indicated no significant differences in the quality of life indicators between the children in both groups and their parents' answers ($p > 0.05$; Table 4). However, the parents' assessments of their children's quality of life were significantly lower than the children's own responses across all components. By the end of the experiment, all children showed an increase in the quality of life indicators across all components.

Meanwhile, only children in the EG group, where dance exercise elements were implemented, exhibited a significant improvement in their quality of life ($p < 0.05$). Moreover, parental responses at the end of the experiment also indicated a substantial improvement in their children's quality of life across all domains. Figure 2 shows the increase in the quality of life indicator values based on the responses of children and their parents at the end of the experiment compared to the beginning of the research project.

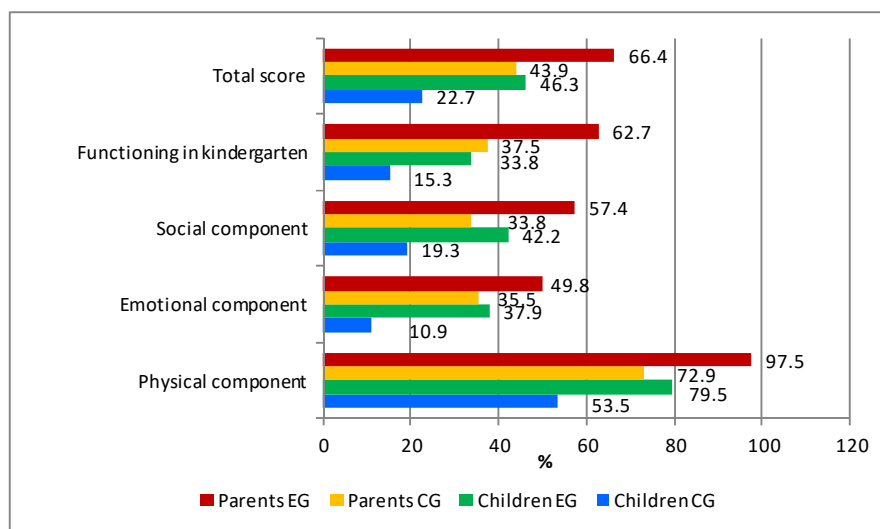


Fig. 2. Increase in quality of life indicator values at the end of the experiment based on survey data from children and their parents in both groups

At the end of the research project, children and parents in the EG group reported considerably greater improvements in quality of life indicators across all domains and in the total score compared to the CG group. Notably, the most substantial increase was observed in the physical component, as indicated by both EG children and their parents. In the other quality of life components, the increase in indicators among EG children was two to three times greater than that observed in the CG group. The data obtained in the study indicate high efficiency of improving the quality of life in children with DS using the proposed dance technology method compared to the result in patients where traditional methods of adaptive physical education were used.

Discussion

An analysis of the scientific literature shows that individuals with DS have characteristic physical and mental developmental features. These include reduced muscle tone (Wentz et al., 2021), insufficient muscle contraction, distorted proprioception, low adequacy of postural reactions, and joint hypermobility (Daniel Medina-Rebollo et al., 2023). Patients with DS show hypodynamia compared to healthy people (Alwhaibi et al., 2022; Borji et al., 2023). Fine motor skills are significantly reduced; in which they demonstrate significant difficulties. Impaired postural self-control is often noted. It was found that deterioration of postural stability, that is, the processes of coordination of various body systems that ensure the ability to maintain and regulate body position at rest and in motion, is of some importance for the general motor development of these people. Postural stability is a prerequisite for the development of a large number of basic motor skills. Therefore, the acquisition of basic motor skills in children with DS occurs later with delayed sensitive periods and proceeds in a different order compared to their healthy peers.

Serious deviations in cognitive abilities are noted, in particular, a slow rate of information perception, poor development and low level of memorization, concentration and stability of attention, thinking, speech, as well as the emotional sphere (Daniel Medina-Rebollo et al., 2023). Mental defects have an inhibitory effect on

speech development. Children with DS have a small vocabulary, they have difficulty understanding other people's speech, and speak in phrases from adult speech. Often this pathology is accompanied by the presence of other diseases of various organs and systems of the human body.

The leading direction of rehabilitation of people with DS is the use of physical education tools and methods. This allows for symptomatic treatment, they are necessary to maintain an appropriate level of health of patients, develop motor skills, coordination abilities, which is especially important in childhood and adolescence for patients with DS (Sydoruk et al., 2021). We agree with the authors (Vandoni et al., 2023) that the formation of motor skills is effective for the development of cognitive, emotional and physical aspects in children with DS.

Our data obtained in the research project confirm the opinion of the above authors about the need for widespread use of motor activity in the rehabilitation of children with DS. The use of physical activity in children in the control and experimental groups made it possible to significantly improve the motor skills of all children with DS by the end of the experiment. We found that children in both experimental groups showed an improvement in the strength endurance of the trunk and abdominal muscles, and the strength of the hands of both hands according to dynamometry data. Static and dynamic balance also improved in children in both observation groups, indicating an improvement in coordination skills, and the value of the fine motor skills indicator, which is most weakly expressed in patients with such a genetic disease, increased. The greatest increase in motor skills and static and dynamic balance indicators was most pronounced in the experimental group, where dance exercises were used in the rehabilitation system.

Our materials on assessing the effectiveness of dance exercises are consistent with the results of studies by Japanese scientists (Ito et al., 2017; Ito et al., 2024). According to their data, the use of dances for children with mental retardation and DS allowed to improve the grip strength, muscle strength of the lower extremities and dynamic balance during movement. Given the positive effect of dances, dance-rhythmic exercises are included in physical education classes for schoolchildren in a number of schools in Japan.

The positive impact of dance elements may be due to the combined nature of these exercises. According to M. Méndez-Martínez, & E.I. Rodríguez-Grande (2023), combined exercises more effectively increase muscle strength of the upper and lower extremities, as well as dynamic and static balance. We believe that the use of complex dance movements combined into one meaningful sequential rhythmic motor act allows for a significant increase in all studied indicators in relation to the beginning of the experiment, which may be due to the high emotionality of the classes. In addition, the scientific literature provides information on positive psychophysical changes during dance interventions in individuals who suffered from neuropsychiatric disorders. After using dance classes, they noted an increase in motivation for physical activity and social cognition, and improved cognitive functions (Fong Yan et al., 2024). We assign an important role in rehabilitation to the assistance of volunteers in mastering and implementing dance exercises by children with DS. They ensure the implementation of an individual approach to rehabilitation measures, which increases their effectiveness. It is known from scientific literature that people with DS experience a significant decrease in the level of quality of life in all its components (Morán et al., 2022; Adorno et al., 2022; Fong Yan et al., 2024; Chan et al., 2024).

Therefore, the use of a variety of physical activities has a positive effect not only on the psychophysical state of patients with DS, but also on various parameters of quality of life. We agree with the opinion of other researchers (D'isanto, 2023) that physical activity in children with DS provides an increase in the quality of life of children with this disease. According to our data, the use of dance exercises in the rehabilitation system for children allowed us to significantly improve all components and the total score of quality of life by the end of the experiment compared to the results of using traditional means and methods of adaptive physical education, which confirms similar findings of other researchers.

At the end of the experiment, we established higher test results for all components of quality of life and the total score according to the survey data of the children themselves and their parents. The greatest increase in the values of quality of life indicators was found in its physical component, which can be regarded as a positive result of increasing the physical activity of children with DS. The increase in the value of quality of life indicators at the end of the experiment in children in the experimental group was greater in relation to the result of children in the control group. The quality of life of children in the experimental group turned out to be significantly higher according to the results of a survey of their parents compared to the data obtained in the control group. This, we believe, can be explained by the use of dance technologies with tutoring in rehabilitation activities. The positive results of the conducted study indicate the effectiveness of the method of using dance exercises developed by us, which is aimed at correcting the motor stereotype in people with DS. Tutor support for each student allowed us to build an effective lesson process, which successfully improved the studied indicators in children of the experimental group.

Conclusion

To address motor pattern abnormalities in children with DS, a new method using dance exercises in a comprehensive rehabilitation program has been proposed and evaluated. This method incorporates asymmetrical cheerleading exercises during the preparatory phase of the lesson. Subsequently, the main component of the lesson begins with corrective and developmental exercises for the lumbar, thoracic, and cervical spine muscles,

performed from an initial lying position. This is followed by statodynamic exercises aimed at reinforcing the body's spatial orientation using specific standard choreographic positions. After statodynamic exercises, a dance practice lesson is performed with the guidance of an instructor and volunteers. The concluding phase of the lesson involves breathing exercises, stretching, and relaxation techniques. The implementation of this proposed method, designed to correct asymmetrical muscle tone, enhance body movement coordination in space, and improve spinal stabilization in children with DS, demonstrated superior efficacy compared to traditional rehabilitation approaches after an eight-month period. Notably, during the evaluation of strength capabilities, static and dynamic balance, and fine motor skill development, children in the EG exhibited significantly higher performance scores than those in the CG.

Based on the responses of both children and their parents, an improvement in quality of life indicators was observed in patients with DS across both groups. Notably, the most substantial improvements in quality of life components were reported by children who engaged in dance exercises. An important positive result of the rehabilitation intervention was the improvement in quality of life indicators in the physical component, reflecting an increased interest in motor activities among children with DS.

The demonstrated effectiveness of the proposed method supports its use as part of a comprehensive rehabilitation program to correct motor patterns in children with DS.

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