



ORIGINAL ARTICLES. PHYSICAL THERAPY

Inclusive physical education program of schoolchildren with autism spectrum disorders

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Abstract

Purpose. The purpose was to develop an inclusive physical education program for schoolchildren with autism spectrum disorders and experimentally test its effectiveness.

Materials and methods. An inclusive physical education curriculum for children with autism spectrum disorders was made up and incorporated into the process of physical education in secondary schools. At the beginning and the end of the pedagogical experiment, 12-year-old children were tested in the experimental (involved in the author's program, n=9) and control groups (involved in the traditional curriculum, n=11). The indicators of psychophysical fitness of children were determined according to the results of 19 test exercises. The reliability of the differences was determined by the Mann-Whitney U test.

Results. Under the influence of the author's program, physical fitness of children of the experimental group improved significantly. Whereas the trend towards improving almost all indicators of the physical fitness of children with autism spectrum disorders in the traditional program has not been confirmed statistically. The traditional physical education program was most effective in promoting flexibility (inclinations forward) and coordination (passing and catching a ball against a wall) in children with autism spectrum disorders.

Conclusions. The author's program was proven to be significantly more effective than the traditional ones in the formation of the strength of shoulder extensors and hand flexors, fine coordination of hand muscles, the speed-strength of leg muscles, and balance. This allows us to recommend it for use in physical education lessons in institutions of general secondary education.

Key words: autism, students, fitness, inclusion, physical education, school



Анотація

Іванна Боднар, Юлія Павлова, Алі Хамаде. Програма інклюзивного фізичного виховання школярів з розладами аутичного спектра.

Мета: розробити інклюзивну програму фізичного виховання школярів з розладами аутичного спектра та експериментально перевірити її ефективність.

Матеріали і методи. Складено програму інклюзивного фізичного виховання дітей з розладами аутичного спектра, яка впроваджена в процес фізичного виховання в загальноосвітніх школах. На початку та в кінці педагогічного експерименту було проведено тестування дітей 12 років експериментальної (займалися за авторською програмою, n=9) та контрольної груп (займалися за традиційною програмою, n=11). Показники психофізичної підготовленості дітей визначали за результатами виконання 19 тестових вправ. Достовірність відмінностей визначали за U-критерієм Манна-Уїтні.

Результати. Під впливом авторської програми фізична підготовленість дітей експериментальної групи значно покращилася. Тоді як тенденція до покращення практично всіх показників фізичної підготовленості дітей з розладами аутичного спектра за традиційною програмою статистично не підтверджена. Традиційна програма фізичного виховання була найбільш ефективною у розвитку гнучкості (нахили вперед) і координації (передача та ловля м'яча об стіну) у дітей з розладами аутичного спектра.

Висновки: доведено, що авторська програма значно ефективніша за традиційні у формуванні сили розгиначів плеча та згиначів кисті, тонкої координації м'язів кисті, швидкісно-силової сили м'язів ніг, рівноваги. Це дозволяє рекомендувати її для використання на уроках фізичної культури в закладах загальної середньої освіти.

Ключові слова: аутизм, школярі, фітнес, інклюзія, фізичне виховання, школа

Аннотация

Иванна Боднар, Юлия Павлова, Али Хамаде. Программа инклюзивного физического воспитания школьников с расстройствами аутистического спектра.

Цель: разработать программу инклюзивного физического воспитания школьников с расстройствами аутистического спектра и экспериментально проверить ее эффективность.

Материалы и методы. Разработана инклюзивная учебная программа по физическому воспитанию детей с РАС, внедренная в процесс физического воспитания в общеобразовательных школах. В начале и в конце педагогического эксперимента 12-летние дети экспериментальной (занятые по авторской программе, n=9) и контрольной групп (занятые по традиционной программе, n=11) были протестированы. Показатели психофизической подготовленности детей определяли по результатам выполнения 19 тестовых упражнений. Достоверность различий определяли с помощью U-критерия Манна-Уитни.

Результаты. Под влиянием авторской программы значительно улучшилась физическая подготовленность детей экспериментальной группы. Тогда как тенденция к улучшению практически всех показателей физической подготовленности детей с расстройствами аутистического спектра в традиционной программе статистически не подтверждена. Традиционная программа физического воспитания оказалась наиболее эффективной в развитии гибкости (наклоны вперед) и координации (передача и ловля мяча о стену) у детей с расстройствами аутистического спектра.

Выводы. авторская программа оказалась значительно эффективнее традиционных в формировании силы разгибателей плеча и сгибателей кисти, тонкой координации мышц кистей, скоростно-силового силы мышц ног, баланса. Это позволяет рекомендовать его для использования на уроках физической культуры в учреждениях общего среднего образования.

Ключевые слова: аутизм, школьники, фитнес, инклюзия, физическое воспитание, школа



Introduction

Children with autism spectrum disorders (ASD) have more significant health problems and lower volumes of physical activity than their neurotypically developing peers; they lag in terms of physical development and physical fitness [1, 2]. Physical exercises are considered one of the effective means of improving the psychophysical fitness of children with ASD. Physical activity interventions are of great social and economic importance. They can reduce or avoid disbursements for psychological and medical care for children with ASD. Exercises help children socialize and adapt to daily challenges [3–5].

Scientific studies that aim to test the effectiveness of different physical education programs for such children are also relevant because the number of children with ASD in the world is constantly increasing, and its growth rate is accelerating every year. At the same time, inclusive education has just begun to be introduced into the educational process of secondary schools in Ukraine. Therefore, little methodology and experience have been gained in organizing and conducting inclusive physical education lessons for children with ASD. When designing physical education programs for schoolchildren with ASD in the conditions of inclusive education in secondary schools, the best practices of applying various types of sports and physical therapy can be used [3, 4, 13–21, 5–12].

The positive effect of physical therapy programs for children with ASD was proven using swimming [6, 7] and hippotherapy [5, 8]. Such means of physical education as martial arts [9, 10], outdoor and sports games (table tennis, darts, pinball, frisbee, croquet, bowling, as well as UNO and LEGO board games) [11] had a positive effect on the psychophysical state of children with ASD. It should be pointed out that rehabilitation programs usually consist of one type of physical activity, while the effectiveness of programs with a complex combination of means of physical education is rarely studied and described in special literature [22]. The use of programs using only one type of physical activity inhibits the harmonious comprehensive development of physical qualities of children, the formation of their skills in mastering different types of physical activity, which limits their motor experience and then decreases the volume of motor activity. Furthermore, limited physical activity is potentially fraught with obesity and a

low functional reserve capacity of the cardiovascular system [23, 24].

Existing studies were conducted on a small number of children (sometimes on three or even one person) without comparison with the control group. In every second study, heterogeneous age groups of the participants were involved, which requires clarification of the conclusions made by specialists [22]. Significant values of the standard deviation of the arithmetic mean show that the duration of physical education programs (13.55 ± 10.70 weeks), the frequency of classes (2.57 ± 1.14 times a week), and the duration of classes (50.20 ± 21.18 minutes) fluctuate significantly. Therefore, there is no unambiguous answer to the rational parameters of an effective physical education program for schoolchildren with ASD.

Thus, inclusive physical education programs for children with ASD within Ukrainian secondary schools have not been created; partial information available today does not allow the formation of an effective physical education program to improve the psychophysical fitness of schoolchildren with ASD. However, the comprehensive physical education program in an inclusive school, built on the means of physical education with proven effectiveness, will help to improve the mental, and physical development, as well as physical fitness of schoolchildren with ASD, increase their physical activity, improve health and quality of life, and reduce the gap with neurotypically developing peers.

The research aimed to establish a program of inclusive physical education for schoolchildren with autism spectrum disorders to improve their psychophysical fitness and experimentally test its effectiveness.

Material & Methods

Participants of study

The study involved schoolchildren (males, $n = 20$, age – 12 years) with ASD from five secondary schools in Lviv. Participants were randomly divided into two groups during the pedagogical experiment – the experimental group ($n = 9$; age – 11.47 ± 1.39 years) and the control group ($n = 11$, age – 11.60 ± 1.44 years).

Program and measurement tools

The program was created in several stages. At the first stage, the work of other scientists was analyzed, and best practices were identified. The



second stage provided the study of the Ukrainian experience. The indicators of children with ASD were determined and compared with the indicators of neurotypically developing peers. Based on the results of the content analysis of scientific articles on the foreign experience of rehabilitation programs for children with ASD [22], and from the data obtained by us at the confirmatory stage of the study, – the first version of the program of inclusive physical education for children with ASD in secondary schools was developed. The next stage involved discussing the first version of the program with parties concerned (parents and guardians, teachers, teaching assistants, and physical education teachers). Based on the received recommendations, the program's content was modified, and its final version was developed.

The goal of the inclusive physical education program was to improve the psychophysical fitness of children with autism spectrum disorders. The duration of the proposed curriculum was nine months, i.e., the academic year. Since the inclusive physical education program was implemented in general secondary education establishments, the structure of the school year (divided into terms and semesters) was considered for its development.

The content of the curriculum consisted of 2 components: variable and invariant following the decree of the Ministry of Education and Science of Ukraine on approval of the standard program for general secondary education establishments of 20.04.2018. This document envisages that the variable component is determined by general secondary education establishments independently, taking into account the features of the educational process and individual educational needs of

schoolchildren, regional specificities, the level of teaching, and staffing. Invariant component is common to all general secondary education establishments, regardless of subordination and ownership. In the developed inclusive physical education program, each of these components contained standard (for all schoolchildren in the class) and additional (separate for schoolchildren with ASD) components.

The standard invariant component of the program was formed by general physical training and theoretical training. General physical training contributes to the formation of basic physical qualities of schoolchildren. Theoretical training is the basis of a person's physical literacy.

The standard variable component of the program of inclusive physical education of children with ASD included variable modules, which contained means of physical education that promote the formation of basic applied and sports motor skills. During the school year, such modules as athletics, sports games, gymnastics, swimming, and football were consistently implemented. Teachers most often use these modules in the educational process of physical education in general secondary education establishments of Ukraine.

An additional variable component of the program was selected from those tools that were proven to be effective [3, 4, 13–15, 17, 18, 20, 21, 5–12] for improving the psychophysical development of children with ASD and following the content of the modules of the standard variable component. The additional invariant component of the program included asanas, katas, imitation of horseback riding or trampoline jumping, and breathing exercises – they were used in each lesson, regardless of its focus (Table 1).

Table 1

Teaching tools for physical education lessons and homework assignments of the author's program of inclusive physical education for children with ASD

Modules	Variable component		Invariant component		Tools for homework assignments
	Standard variable component (duration in hours)	Additional variable component	Standard invariant component	Additional invariant component	
Module 1 (September – October)	Athletics (10 h), football (14 h)	General physical training, theoretical training	Outdoor games, relay-races (with track and field (athletics) elements)	Yoga (asanas), karate (katas), imitation of horseback riding, meditation	Walks, hiking, metered walking and running, jumping, throwing, swimming, rowing (on a simulator)



Module 2 (November – December)	Gymnastics (14 h), swimming (13 h)		fitball, step aerobics, water games, aqua fitness	elements, and breathing exercises	walking, exercises on simulators, dancing, rope-jumping, balance exercises
Module 3 (January – March)	Basketball (15 h), volleyball (15 h)		Tennis, ping pong, badminton		Walking, playing snowballs, skiing, swimming, exercises on simulators, mobile games, LEGO, UNO, darts, bowling, frisbee, croquet, petanque
Module 4 (April –May)	Football (12 h), athletics (10 h)		Oriental martial arts, cycling, skateboarding, scootering		Walking, cycling, skateboarding, scooters, swimming, rowing (on the simulator)

Physical fitness was determined using tests. The participants have made two attempts; the result of the best of them has been recorded into the protocol. The tests' characteristics were described previously in detail [25–27].

Tilt to the left/right. The participant stood pressing his palms to his hips. The end point of the distal phalanx of the middle finger was marked on the thigh (with tailor's chalk or soap). The participant performed a right/left tilt and stayed in this position for 2–3 seconds. They put a second mark. The distance between the two marks was measured (with an accuracy of 1 mm). In order to avoid leaning forward, the exercise was performed near the wall and it was ensured that the student did not move the shoulder blades away from the wall.

Pushing a medicine ball (1 kg of weight) with two hands from the chest has been performed in a sitting position, leaning back against the wall.

Circle Jumping. Six hoops have been laid down on the floor in two rows of 3 hoops in each. The participants was the task to perform six wave jumps on one leg (like "snake").

The Romberg Test. The participant stood on the floor, heels together, arms forward, fingers apart. The time during which the research participant did not lose balance was recorded.

The plank test. The participants had to hold the position of the plank on the forearms as far as possible

Passing and catching the ball against the wall with two hands at a distance of 2 m far away from the wall.

For the *test "4 balls"* balls have been placed in the center of a circle with a diameter of 2 m, each at a distance of 2 m to the goal marked with cones. The participant approached one ball,

kicked it into one "goal" and returned to the center of the circle, then tried to kick another ball into the other "goal," etc.

4.5 m walking place their heel against the toes of the foot in each step as fast as they can.

The *standing long jump, tilt forward, raising the torso to the seat from the lying position, bench push-ups, right / left hand grip strength* were carried out according to standard methods, so we do not describe them here.

Method of testing the level of physical fitness (clapping hands, writing the letter "O," number of two-leg squats in 10 seconds, keeping the "Flamingo" pose) have been described in [25].

Procedure and data collection

A pedagogical experiment was organized to test the effectiveness of the author's program of physical education for schoolchildren with ASD in inclusive education. During the school year, schoolchildren in the control group (CG) attended physical education lessons with schoolchildren in their class who were involved in a traditional physical education curriculum and did exercises selected by the teacher. Schoolchildren of the experimental group (EG) attended classes designed under the author's grounded and developed program of inclusive physical education. From October to December and from March to May 2020, because of the quarantine due to the Covid-19 pandemic, study participants did not visit educational establishments. They practiced independently at their homes under the supervision of their parents according to the plans developed by the author of the program (EG) or physical education teacher (CG).



Children were tested at the beginning and the end of the pedagogical experiment.

To obtain objective information, children with ASD were interviewed in the presence of their parents, psychologists, physical education teachers/assistant teachers. All the parents signed informed consent of participation in this study. The study protocol was approved by the University Research Bioethics Committee (Decision no. 2/2018).

Statistical analysis

Descriptive statistics were made. The arithmetical mean (M) and the value of its standard deviation (SD) were calculated. Data were checked for normality of distribution. Since the obtained indicators did not have a normal distribution, the reliability of the differences between the indicators of the groups of children was ascertained by the Mann-Whitney U-test (for related and unrelated samples). The minimum level, which was taken as critical, was $p < 0.05$ for these discrepancies. All data analyses were completed using Origin 8.1 (OriginLab Corporation, Northampton USA).

Results

The higher efficiency of the author's program of inclusive physical education in comparison with the traditional one was proven by the larger values of the increase in the indicators of psychophysical fitness of children with ASD (Figure 1). Under the influence of lessons according to the traditional program of physical education, almost all indicators of physical fitness of children with ASD tended to improve. A traditional physical education program was most effective in promoting flexibility (improvement in forward bends results) and coordination (results of passing and catching a ball against the wall improved).

At the same time, under the influence of the author's program of inclusive physical education, practically all indicators of psychophysical fitness in children from the EG significantly ($p < 0.05 - 0.01$) improved; only some of them tended to improve (tilt to the right,

circle jumping, the Romberg Test, "Plank" exercise, clapping hands).

On the completion of the pedagogical experiment (Table 2), the greatest differences in the results of children from the EG and the CG were observed in the results of handgrip dynamometry (right hand $p = 0.06$; left hand $p = 0.01$), and bench push-ups ($p = 0.02$). The benefits for children with ASD who trained under the author's program of physical education proved to be also significant in passing and catching the ball against the wall for 30 s and in the "Plank" exercise. However, they were not statistically confirmed due to the large scatter of the data. On completion of the pedagogical experiment, the children from the EG were significantly ahead of the children from the CG according to the results of the Flamingo exercise ($p = 0.03$), writing the letter "O" in 10 s ($p = 0.02$), pushing the medicine ball ($p = 0.04$), and squats on 2 legs in 10 s ($p = 0.04$).

Relatively larger, especially proven increases in the results of the children from the EG under the test conditions, as well as significant differences between the EG and CG at the end of the study, demonstrate the higher efficiency of the author's curriculum compared to the traditional one. This allows us to recommend the curriculum developed by the author for use in physical education lessons in general secondary education establishments.

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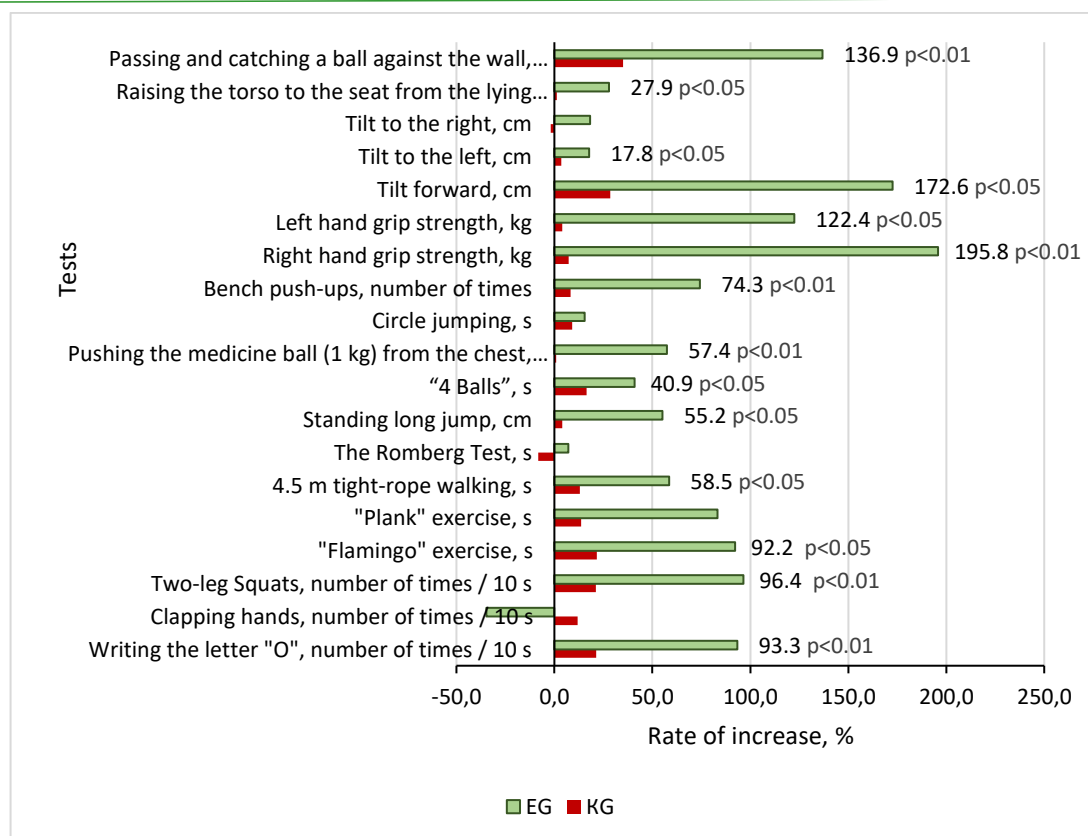


Fig. 1. Rate of increase in physical fitness indicators for children with ASD of the control and experimental groups under the conditions of the experiment: EG – experimental group; KG – control group

Discussion

Regular physical activity is essential for preventing disease and maintaining a healthy weight [28, 29], one of the most effective means of improving the physical fitness of all children, including children with special educational needs [30]. Physical education has a great positive effect on the psycho-emotional state of children, helps to increase their self-esteem, attention, and the ability to concentrate, it influences their strength of will, makes it possible to find new friends and actively spend time in the fresh air [31]. Motor activity is an excellent incentive for the development of the psychomotor and the cognitive and emotional spheres of all schoolchildren [32]. Unfortunately, most of the conducted studies reporting the positive effects of physical exercises refer only to neurotypical children, whereas physical exercises may be especially beneficial for individuals with special educational needs.

Analysis of the data obtained suggests that in many studies of the effectiveness of rehabilitation programs for children with ASD, the level of evidence is insufficient. However, the trends identified by these researchers should be

taken into account, as curricula with the integrated use of potentially effective types of motor activities in their combination can provide more overall positive effects than one type of motor activity itself. Therefore, the effectiveness of a comprehensive physical education program that combines various physical exercises of different types of physical activity should be further explored to improve the psychophysical fitness of children with ASD.

The study found out that the author's program was more effective than the traditional one for the formation of hand strength (shoulder extensors and hand flexors). Because once it was introduced, children from the EG had the most significant advantages in the results of hand dynamometry in bending and unbending the arms at bench push-ups. Significant differences were also observed in the passing and catching a ball against the wall for 30 s and in the "Plank" exercise. However, the preferences of the children from the EG were not statistically proven.



Table 2

Indicators of psychophysical fitness of children in the control (CG) and experimental (EG) groups on the completion of the experiment

Indicators	EG							CG							Z	p
	W Shapiro-Wilk	p-value	Min	Q1	Me	Q3	Max	W Shapiro-Wilk	p-value	Min	Q1	Me	Q3	Max		
Writing the letter "O", number of times per 10 s	0.952	0.715	9	10.5	14	16	18	0.903	0.237	4	5.5	7.5	12.75	15	2.34	0.02
Clapping hands, number of times per 10 s	0.939	0.576	21	22.5	30	38.5	48	0.885	0.150	15	21	28	38.25	58	0.37	0.71
Raising the torso to the seat from the lying position, number of times per 60 s	0.944	0.653	14	16.75	24	27.5	36	0.937	0.515	9	10.75	17.5	25.25	33	1.38	0.17
Flamingo exercise, s	0.942	0.601	7.8	16.2	19.6	21.9	30.3	0.922	0.375	0	8.75	10.15	15.075	26.2	2.16	0.03
"Plank" exercise, s	0.949	0.684	2.2	10.4	21	25.95	30.3	0.808	0.018	3	4.975	8.95	15.375	35	1.35	0.18
4.5 m tight-rope walking, s	0.895	0.223	8.5	8.7	11	14.5	17	0.686	0.0006	11.5	11.75	13.25	17.825	30.2	-1.72	0.09
The Romberg Test, s	0.914	0.344	8.2	9.2	23	32.1	43	0.861	0.078	15.6	18	22.65	34.35	37	-0.53	0.59
Standing long jump, cm	0.719	0.002	83	85.95	89.6	104.6	154.6	0.900	0.219	41.5	55.45	87.25	108.125	115.3	0.61	0.54
"4 balls", s	0.917	0.369	5	5.35	6.3	7.815	8.4	0.921	0.367	4.8	5.125	7.665	9.525	10.7	-0.74	0.46
Pushing the medicine ball (1 kg) from the chest, cm	0.838	0.055	151.5	212.25	267	368.25	495	0.940	0.557	52.5	149.25	193	235	372	2.08	0.04
Circle jumping, s	0.760	0.007	6	6.05	6.8	9.35	13.5	0.725	0.002	6	6.1	7.15	9.45	17.7	-0.37	0.71
Right hand grip strength, kg	0.847	0.070	2	2	4	10.5	16	0.602	0.0001	0	0	1.5	3.25	18	1.86	0.06
Left hand grip strength, kg	0.816	0.031	2	3	5	8.5	11	0.580	0.00003	0	0	1.5	2.5	17	2.48	0.01
Tilt forward, cm	0.930	0.482	-3	1.5	13	20	24	0.863	0.084	-3	-2	8	22.25	28	0.33	0.74
Tilt to the right, cm	0.922	0.410	14	19	22	27	28	0.870	0.100	7	9.75	20	23.5	26	1.32	0.19
Tilt to the left, cm	0.978	0.955	18	20,5	23	27	30	0.901	0.258	13	14	18	24	28	1.90	0.06
Bench push-ups, number of times	0.937	0.555	6	10	12	14.5	20	0.886	0.154	0	1.75	6	8.75	20	2.43	0.02
Passing and catching a ball against a wall, number of times per 30 s	0.874	0.135	2	2.5	31	36.5	52	0.954	0.710	2	9	14.5	20.25	26	1.,39	0.16
Two-leg squats, number of times per 10 s	0.900	0.253	4	7.5	9	14.5	15	0.835	0.038	5	6.75	7	7.25	10	2.14	0.03

Notes: EG – experimental group; CG – control group



The author's inclusive physical education program has contributed better than the typical one to the formation of fine coordination of hand muscles, speed and strength of lower limbs, and balance. Since on the completion of the pedagogical experiment, the children from the EG were significantly ahead of the children from the CG according to the results of the "Flamingo" test ($p = 0.05$), writing the letter "O" in 10 s ($p = 0.02$), and two-leg squats ($p < 0.04$).

A comparison of our data with existing data showed that most studies had studied the impact of physical education programs using one type of physical activity. Only some of them dealt with the effectiveness of a program that was comprehensive and used a wide range of tools. For example, the effectiveness of relaxation exercises with dance and music therapy [12], programs containing different types of exercises [13], programs involving coordination and strength exercises [15], and structured motor activities with naturally integrated elements of social interaction [5, 14] were studied. In addition, some studies compared the effectiveness of two different programs: strength and cardio fitness [15], yoga and Chinese gymnastics [16], dance and exercise cycling [17], or even three training programs: author's cycling support therapy, cycling, and complete absence of cyclic loads [33].

We have concluded the inclusive physical education program for schoolchildren with ASD according to the set goal. In our previous studies [22], we found that the duration of the rehabilitation programs for children with ASD is usually short – 8–14 weeks. This substantiated the lower limit of the duration of the program modules, which gives positive changes in the indicators of the psychophysical fitness of children with ASD. Therefore, the training modules had a duration of 8 weeks.

According to our previous data [34], the weekly volume of motor activity in children with ASD (3.31 ± 1.50 days a week) was significantly ($p < 0.05$) lower than for their neurotypically developing peers (4.30 ± 1.88 days a week). Therefore, to increase the volume of motor activity of children with ASD, we developed homework assignments, which involved the performance of physical exercises of the corresponding module of the standard variable component. Homework exercises were suggested to be performed accompanied by one of the parents.

Following our program, children with ASD performed yoga and martial arts exercises at every lesson. Scientists proved that such tools have a positive effect on stereotypic movements, communication skills, and social interaction of children [9, 10] and increase the degree of their

psychophysical fitness for learning [25, 26]. At the beginning of the study, the indicators of 12-year-old children with ASD corresponded to the norms of 6-year-olds [22]. There was a significant improvement in the results of the test exercise of writing the letter "O" for 10 s, which indicates an increase in the level of psychophysical fitness of children with ASD for learning. Improvement of balance while standing on one and two legs under the influence of yoga and martial arts was observed by other researchers [3]. Thus, our results confirmed the data [3, 9, 10, 26] on the positive impact of yoga and martial arts on the indicators of psychophysical fitness of children with autism spectrum disorders for learning.

Researchers proved the positive effects of gymnastics and fitness tools on the rehabilitation of children with ASD. For example, the influence of gymnastic exercises on self-control [16, 18], speech development, and indicators of physical fitness [18] of children with ASD was observed. In addition, cardio and strength fitness programs significantly increased the level of physical fitness of children with ASD, primarily improving aerobic endurance and muscle strength [15]; the use of exergaming reduces the number of actions during stereotyped behavior improves cognitive functions [17]. In the author's program, 14 hours were devoted to gymnastics. The data was confirmed by a significant increase in the indicators of psychophysical fitness [15–18] on the effectiveness of these tools and the feasibility of their inclusion in a comprehensive physical education program to improve the psychophysical fitness of schoolchildren with ASD.

Program with priority use of elements of sports games, increased motor activity [35], and also had a positive effect on psychophysical qualities of children with autism spectrum disorders: hand and body coordination, strength, and agility [7, 35], and improved the executive function [7]. The program developed by us, which contained a large number of sports games tools in the standard variable component: basketball (15 hours), volleyball (15 hours), football (26 hours), and sports games and relays in the additional variable component confirmed the data on [7, 35] positive changes in indicators of psychophysical fitness of children with ASD under the conditions of using games.

Hydrotherapy was shown to have a positive effect on the technical skills of people with ASD (for example, on the formation of new skills) [19–21], increasing the level of physical fitness, in particular, leg and hand strength, flexibility, cardiorespiratory endurance, balance, and agility [19, 21]. The researchers [19, 20] demonstrated the positive impact of water exercises on the behavior and interaction of people with ASD with the environment, reducing



their hyperactivity, anxiety, and stereotypes. Exercising in the aquatic environment had a positive effect on various quality of life indicators, including indicators of physical, emotional, social, and school functioning [35]. Our program included a module (16 hours) on swimming. Being convinced of the higher efficiency of the author's program, which combined swimming with other types of physical activity, we confirmed the data of other scientists [6, 7, 19–21, 35] that exercising in the aquatic environment in combination with other means of physical education have a positive effect on indicators of psychophysical fitness, various manifestations of quality of life of children with ASD, in particular indicators of their physical, emotional, social and school functioning.

An additional invariant component of the physical education curriculum included imitations of horseback riding (fitball jumping) and trampoline jumping. The use of these tools in each lesson helped improve the psychophysical development of children with ASD. Thus, we confirmed the data [5, 8, 36] on the positive impact of hippotherapy classes for improving motor skills, socialization, increasing motor activity, and improving communication skills [5] of children with autism spectrum disorders. Imitation of horseback riding and trampoline jumping, similarly to animal therapy [37, 38], helps improve the children's psycho-emotional state. Parents of children with ASD considered trampoline jumping a promising type of physical activity [39].

Limitations

Some of the classes were held at home because of the Covid-19 pandemic. We assume that the improvements could be greater if the curriculum was fully implemented.

Conclusions

An inclusive physical education program for schoolchildren with ASD was drawn up. The characteristic differences of the program made up by the authors were the following: focusing on the harmonious psychophysical development of schoolchildren with ASD; the content of the study material of the additional variable component of the program and homework assignments for these schoolchildren corresponded to the content of the standard variable component (for all pupils in the class) – athletics (20 hours), football (24 hours), gymnastics (14 hours), swimming (13 hours), basketball (15 hours) and volleyball (15 hours), football (24 hours), and contained tools with proven effectiveness for children with ASD (mobile games, aqua fitness, tennis, martial arts); additional invariant component of the curriculum (it was implemented in each lesson regardless of its focus) included asanas, katas, imitation of horseback riding, elements of meditation, and breathing exercises.

It was proved that the inclusive physical education program helps to improve the psychophysical fitness of schoolchildren with ASD. Analysis of indicators of psychophysical fitness proved significantly higher efficiency of the authors' program compared to the traditional one, especially in the formation of shoulder extensors (pushing medicine ball (1 kg) from the chest, bench push-ups) and hand flexors (dynamometry of the right and left hands); fine coordination of hand muscles (writing the letter "O" in 10 s), speed-strength of leg muscles (two-leg squats in 10 s), and balance ("Flamingo" exercise). This allows us to recommend the inclusive physical education program of children with ASD for usage during physical education classes in general secondary education establishments.

Conflicts of interest

Authors do not have any conflicts of interest to declare

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