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OBM Genetics

Original Research

Problems of Motor Development of 6-7 Years Old Children with Autism Spectrum Disorders

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Academic Editor: Fabrizio Stasolla

Special Issue: Rare Genetic Syndromes: From Diagnosis to Treatment

OBM Genetics
2023, volume 7, issue 4
doi:10.21926/obm.genet.2304205

Received: September 21, 2023
Accepted: December 05, 2023
Published: December 11, 2023

Abstract

According to modern research, there is a high risk of motor development disorders in children 6-7 years old with autism spectrum disorders. This determines the relevance of studying the problem of individual differences in motor development of children 6-7 years old with autism spectrum disorders, the need for objective assessment of its level, and the determination of group and individual strategies for correction of motor development. The study identifies and evaluates the motor development problems of 6-7-year-old children with autism spectrum disorders. Materials and methods of the study. Analysis and comparison of the results of observations of the motor development of 27 children 6-7 years old with autism spectrum disorders attending compensatory and combined orientation groups and 100 children of the same age with homotypic product attending general developmental and combined orientation groups of preschool institutions in Belgorod. The following methods were used: theoretical (analysis, generalization, comparison), empirical (observation of the performance

of motor tasks, and methods of mathematical statistics (Student's t-criterion): results and their discussion. The comparative analysis of motor development indicators of 6-7-year-old children with autism spectrum disorders and normotypically developing children shows the reliability of their differences ($p < 0.05$) in qualitative and quantitative indicators. The research confirmed the presence of problems in children with autism spectrum disorders related to the development of balance function (51.85%), impaired regulation of muscle activity, and difficulties in purposeful performance of movements (44.44%). Movement coordination disorders are observed in 55.85% of children: conclusions and conclusion. The study results indicate the relevance of the search for new means of correction of motor development of 6-7-year-old children with autism spectrum disorders at this age stage. The study confirmed the high risk of motor disorder development in children of this nosological group.

Keywords
Preschoolers with autism spectrum disorders; motor development; criteria and indicators; evaluation

1. Introduction

In the conditions of inclusive education, the problem of creating a variable and effective system of physical education for preschoolers with disabilities, focused on the indicators of individual development of the child and their resources, becomes essential [1]. According to the statistics of the World Health Organization and foreign studies, autism spectrum disorders (ASD) occur in one out of 160 children [2]. This group of diseases is considered a neurogenetic disorder of mental development. Deficits in social adaptation, communication, and behavior disorders characterize children with ASD. Significant individual differences in motor development of children with ASD necessitate an objective assessment of its level and determination of strategies for overcoming existing deficits. In modern studies by E.V. Plaksunova, M. Krishtal (Slepian), and M. Huerta, characteristic problems of motor development in children with ASD are noted: disorders of regulation of muscle activity, lack of control of motor actions; difficulties in the formation of purposefulness in the performance of movements and spatial orientation [3-5]. Among the important tasks set in the physical education of children with autism spectrum disorders are tasks aimed at studying the level of physical development, motor activity, and motor experience, which generally is the foundation of motor development [6, 7].

E.V. Plaksunova, A.N. Bhat, and E.Gkotzia suggest recognizing motor disorders as one of the diagnostic criteria or specifiers of ASD [5, 8, 9]. Studying and analyzing the dynamics of motor development of children with ASD allows timely correction of motor development and changes in physical education. This is highly demanded to improve its quality and overcome the problems of motor development of a child with ASD [1, 6].

The study identifies and evaluates the motor development problems of 6-7-year-old children with autism spectrum disorders.

2. Organization and Methods of the Study

In the course of the study, the following methods were used: theoretical analysis and synthesis, abstraction, and concretization; empirical: observation of the performance of physical exercises to investigate the level of motor development: long jump from a place (cm), throwing to a horizontal target (number of times), standing on one leg (sec), tossing and catching a ball (number of times), throwing a stuffed ball at a distance weighing 1 kg from behind the head (cm), endurance running (min), forward bend from standing on a gymnastic bench (cm), flying start (sec), lifting from lying on the back (number of times); methods of mathematical statistics (Student's t-criterion).

The experimental study involved 27 older preschoolers with ASD (18 boys, 9 girls) attending compensatory and combined groups and 100 children with normotypic development hearing municipal budgetary preschool educational institution (MBPEI) No. 12, 15, 36 in Belgorod. It should be noted that according to the data of the «Regional Resource Center for children with ASD and other mental disorders» of Belgorod as of 01.02.2023, the number of preschool children with ASD in the city is 75 people. The sample consisted of children with autism spectrum disorder in the third group, according to the classification of pediatric autism by O.S. Nikolskaya [10].

3. The Results of the Study and Discussion

Among the important tasks set in the field of physical education of children with ASD are the tasks aimed at studying the level of physical development, motor activity, and motor experience, which, in general, is the foundation of motor development. We define motor development as a process of qualitative and quantitative changes in the child's movement system in the process of growth and accumulation of individual experience. Several scientists note that children with ASD have a weak response to adult assistance, difficulties in imitating movements, and an inability to act according to instructions and consciously control their actions (Nikolskaya, 2014; Plaksunova, 2014; Solomko, 2012) [5, 10, 11]. All this causes the need to analyze and evaluate individual indicators of motor development of preschoolers with ASD.

In our previous studies, we tried to define and systematize the requirements for criteria and indicators of motor development of children with ASD, namely, theoretical validity, objectivity, specificity, and measurability [6]. The developed measures and indicators of motor development of children with ASD are presented in Table 1.

Table 1 Criteria and indicators of motor development of 6-7 preschoolers with autism spectrum disorders.

Criteria of motor development of older preschoolers with ASD	Motor development indicators of older preschoolers with autism spectrum disorders
Qualitative assessment: technique of performing test physical exercises taking into account the peculiarities of development	Take the starting position accurately or with a small error, and perform coordinated technical elements (long jump from a place, throwing a stuffed ball at a distance, maintaining balance when standing, throwing and catching the ball, running at a moderate pace).

Quantitative assessment: parametric measurements of the performance of test physical exercises	- tossing and catching the ball (cm) - standing on one leg (sec) - Hitting a horizontal target from a distance of 3 m (number of times) - bending forward from a standing position on a gymnastic bench (cm) - flying start (sec) - long jump from an upright position (cm) - lift from lying on the back (number of times) - throwing a stuffed ball (cm) - jogging duration (min)

Quality of technical execution (facilitated criteria for assessing technique for children with ASD, taking into account their developmental characteristics)		
Levels		
Optimal 7-9 points	Acceptable 4-6 points	Insufficient 0-3 points
Take the starting position accurately or with a small error, and perform the technical elements of throwing in a coordinated manner (maintain the direction of the swing, aim, coordinate the swing and throw, swing, push in jumps, and other types of physical exercises).	Take the starting position, perform elements with technical errors associated with difficulties in the coordinated execution of details, with violations of sensorimotor coordination, insufficient arm swing (maintained the direction of the swing, aiming, coordinated swing and throw), and Allowed inaccuracies in the performance of physical exercises.	There are difficulties or not performing the motor action (do not maintain the direction of the swing, do not aim, do not coordinate the swing of hands and throw, etc.), do not focus on the requirements for the technique of jumping, lose balance, do not coordinate the swing of hands and push.

Parametric indicators of the performance of test physical exercises			
Levels			
test	Optimal 21-24 points	Acceptable 16-20 points	Insufficient 8-15 points
- throwing and catching the ball	- 38 times or more	- 18-37 times	- less than 18 times.
- one-legged stance (sec)	more than 30 sec	-20-29 sec	less than 20 seconds
- horizontal throwing	-with the leading hand 3 out of 3 times	- with leading hand 1-2 out of 3 times	- before the first hit more than 4 times with the lead hand
- forward bend from a standing position	- touching at a level of more than 5.0 cm	- touching at the level of 0.0-5.0 cm	- touching at a level of less than 0 cm
- flying start	2.3-2.5 c	2.6-2.8 c	- 2.9 sec. or more.
- long jump from a standing position	- more than 100 cm	- 92-100 cm	- 91 cm or less.

- torso lift from a prone position	- number of lifts 13-15 times	- number of lifts 10-12 times	- number of lifts 9 times or less
- throwing a stuffed ball (1 kg)	- 211.0 cm or more	- 170.0-210.0 cm	- 169.0 cm or less.
- running duration	more than 7 minutes	5-7 min	Less than 5 minutes).

The level of motor development of preschoolers with autism spectrum disorders was assessed by the criteria and indicators presented in Table 1.

Considering the selected criteria and indicators, the following levels of motor development of preschoolers aged 6-7 with autism spectrum disorders were determined (optimal - 28-33 points, acceptable - 20-26 points, insufficient - 8-18 points).

When carrying out diagnostic tasks to study motor development, specific difficulties arose in all children with ASD. One verbal instruction was not enough when performing a movement. Preschoolers with ASD who participated in the study needed visual reference points, i.e., demonstration of movement performance by a teacher or another child, without which they could not independently cope with the task, as well as verbal, gesture, physical, and stimulus cues.

During the performance of the exercise «Throwing and catching the ball» by preschoolers with ASD, the optimal level of movement development was revealed in 14.8% of children; in 40.7% of children, the acceptable level was determined, the insufficient level was demonstrated in 44.5% of children.

Children with an optimal level of development of the ability to toss and catch a ball correctly took the initial position. They performed the movements considering the requirements for technique (throwing the ball up and down with two hands, catching it with two hands without pressing it to the body, controlling the trajectory of the ball's movement in space with their eyes, etc.). No adult's help in performing the test was needed.

Preschoolers with ASD who mastered the action with the ball at an acceptable level threw and caught the ball several times (2-4 times). However, there were difficulties with the quality of some elements (catching) (hands pressed against the body, hands not taking the position of «readiness» to catch the ball, lost trajectory of the ball in space). After losing the ball, interest in physical exercises decreased. Speech instructions did not stimulate the child.

Children with ASD, who had an insufficient level of development of the ability to toss and catch a ball, performed only a separate action – «toss the ball» without taking into account the adult's instructions. The adult's verbal instructions and demonstration of the technique did not improve the quality of its performance. Children constantly lost the ball. There was no interest in resuming the action.

During the performance of the exercise «Keeping balance while standing» by preschoolers with ASD, the optimal level of the quality of the exercise performance was revealed in 7.4% of children, the acceptable level in 40.7% of children, and the insufficient level in 51.9% of children.

Children with optimal static balance development understood and accepted the task, correctly assumed the starting position «Heron,» and held their balance. They demonstrated control of body position in space. The child received the adult's help performing the test and reacted to the verbal instructions.

Preschoolers with ASD, who demonstrated an acceptable level of static balance development, performed exercises with the help of an adult and took the initial position. They kept their balance independently for a short period.

Children with ASD who had an insufficient level of static balance development refused or did not accept the task. The adult's «verbal instructions, gestures, and physical prompts» did not change the character of its performance.

During the performance of the physical exercise «Long jump from a place» by preschoolers with ASD, the following results were obtained: 11.1% of children with ASD demonstrated the optimal level of long jump development; 40.7% of children - the acceptable level, and 48.2% of children - the insufficient level.

Children with the optimal level of long jump development took the correct initial position and performed technical elements of the jump accurately or with a small error. At the stage of jump completion, the child kept his balance independently or with a bit of help from an adult. The child accepted the adult's help performing the exercise and responded to verbal instructions.

Preschoolers with ASD, who demonstrated an acceptable level of development of the long jump, took the correct initial position, orienting on «cues.» When performing the jump, technical errors were observed, connected with difficulties in the coordinated execution of elements of the jump technique, violations of control of motor actions, and insufficient swing of hands. At the stage of jump completion, the child kept his balance with the help of an adult and landed hard on the whole foot.

Children with ASD with insufficient quality in performing the long jump performed the motor action without being oriented to its technique and did not complete the swing. They did not respond to the adult's verbal instructions and prompts. This hurt the indicators of jumping distance.

When performing the exercise «Throwing a stuffed ball,» the optimal level of development of throwing at a distance from behind the head was revealed in 7.4% of children, the acceptable level in 37.01% of children, and the insufficient level in 55.59% of children.

Children with an optimal level of development of throwing at a distance from behind the head correctly accepted the starting position, accurately or with a small error, performed technical elements of the movement (maintained the direction of the swing, aimed, coordinated the swing and throw, etc.).

Preschoolers with the established permissible level of throwing a stuffed ball at a distance took the correct starting position, focusing on the verbal instructions and «prompts» of an adult. When performing the throw, children made technical errors associated with impaired sensorimotor coordination, insufficient swing, etc.

Children with ASD who had an insufficient level of throwing development for distance performed the motor action without being guided by its technique, did not coordinate the swing and pitch, and dropped the stuffed ball instead of throwing it. As a result, the throwing distance was minimal.

When running at a moderate pace, more than half of the children (55.6%) coped with it independently. The rest of the children (44.4%) had to take the teacher by the hand and stimulate them to start performing the task, to run together with the children, setting the pace and rhythm of movement. In the running, these children had stereotyped hand movements (swings), impulsiveness, and rhythm violations.

Thus, there is heterogeneity and specificity of quality and synchronization of motor action performance by children with ASD.

Table 2 presents a comparative analysis of parametric indicators of test physical exercise performance. Presents the results of comparative analysis of parametric indicators of test physical exercise performance.

Table 2 Parametric indicators of test physical exercise performance by preschoolers 5-7 years old with autism spectrum disorders and neurotypical ones.

test	level	**Groups of children Normotypical (n = 100)**	**With ASD (n = 27)**	**p**
Throwing and catching the ball	*Optimal (3 points)*			
	%	27	22.22	
	index	40.59 ± 0.35 times	39.5 ± 0.56 times	
	Acceptable (2 points)			
	%	48	33.33	
	index	26.77 ± 0.86 times	22.78 ± 1.04 times	
	Insufficient(1 point)			
	%	25	44.44	
	index	13.32 ± 0.61 times	12.92 ± 0.89 times	
	Group average			
	average point	2.02 ± 0.07	1.78 ± 0.15	
	index	27.14 ± 1.09 times	22.11 ± 2.08 times	
	level	acceptable	insufficient	
One-legged stance	*Optimal (3 points)*			
	%	15	18.52	
	index	32.0 ± 0.71 sec	36.40 ± 0.60 sec	
	Acceptable (2 points)			
	%	47	48.15	
	index	23.69 ± 0.85 sec	24.66 ± 0.41 sec	
	Insufficient(1 point)			
	%	38	33.33	
	index	15.0 ± 0.91 sec	16.68 ± 0.41 sec	
	Group average			
	average point	1.85 ± 0.14	1.77 ± 0.07	
	index	22.33 ± 1.28 sec	23.39 ± 0.71 sec	
	level	acceptable	acceptable	
Horizontal throwing	*Optimal (3 points)*			
	%	16	11.11	
	index	3.0 ± 0.0 times	3.0 ± 0.0 times	
	Acceptable (2 points)			
	%	41	37.04	
	index	1.49 ± 0.08 times	1.20 ± 0.13 times	

	Insufficient (1 point)			
	%	43	51.85	
	index	0.0 ± 0.0 times	0.0 ± 0.0 times	
	Group average			
	average point	1.73 ± 0.07	1.59 ± 0.13	
	index	1.09 ± 0.11 times	0.78 ± 0.19 times	
	level	insufficient	insufficient	
Forward bend from a standing position	*Optimal (3 points)*			
	%	19	14.81	
	index	6.53 ± 0.29 cm	7.00 ± 0.71 cm	
	Acceptable (2 points)			
	%	43	33.33	
	index	2.58 ± 0.17 cm	2.78 ± 0.40 cm	
	Insufficient (1 point)			
	%	38	51.85	
	index	-2.76 ± 0.39 cm	-4.86 ± 0.97 cm	
	Group average			
	average point	1.81 ± 0.07	1.63 ± 0.14	
	index	1.30 ± 0.39	-0.56 ± 1.05	
	level	insufficient	insufficient	
Flying start	*Optimal (3 points)*			
	%	15	14.81	
	index	2.35 ± 0.03 sec	2.50 ± 0.0 sec	
	Acceptable (2 points)			
	%	42	37.04	
	index	2.70 ± 0.06 sec	2.77 ± 0.02 sec	
	Insufficient (1 point)			
	%	43	48.15	
	index	3.24 ± 0.04 sec	3.27 ± 0.08 sec	
	Group average			
	average point	1.72 ± 0.07	1.67 ± 0.14	*
	index	2.88 ± 0.04 sec	2.97 ± 0.08 sec	
	level	insufficient	insufficient	
Long jump from a standing position	*Optimal (3 points)*			
	%	14	18.52	
	index	109.86 ± 1.01 cm	103.60 ± 0.98 cm	
	Acceptable (2 points)			
	%	42	40.74	
	index	95.88 ± 0.38 cm	92.73 ± 0.27 cm	
	Insufficient (1 point)			
	%	44	40.74	

	index	86.45 ± 0.94 cm	82.36 ± 1.02 cm	
	Group average			
	average point	1.70 ± 0.07	1.78 ± 0.14	*
	index	93.69 ± 0.87	90.52 ± 1.59 cm	
	level	insufficient	insufficient	
Torso lift from a supine position	*Optimal (3 points)*			
	%	16	11.11	
	index	13.94 ± 0.21 times	13.0 ± 0.0 times	
	Acceptable (2 points)			
	%	43	51.85	
	index	10.98 ± 0.13 times	10.21 ± 0.11 times	
	Insufficient (1 point)			
	%	41	37.04	
	index	7.10 ± 0.20 times	6.50 ± 0.40 times	
	Group average			
	average point	1.75 ± 0.07	1.74 ± 0.13	*
	index	9.86 ± 0.27 times	9.15 ± 0.46 times	
	level	insufficient	insufficient	
Throwing a stuffed ball	*Optimal (3 points)*			
	%	21	7.41	
	index	217.95 ± 0.97 cm	215.50 ± 0.50 cm	
	Acceptable (2 points)			
	%	41	48.15	
	index	189.49 ± 1.77 cm	176.31 ± 0.99 cm	
	Insufficient (1 point)			
	%	38	44.44	
	index	161.71 ± 0.79 cm	159.17 ± 0.67 cm	
	Group average			
	average point	1.83 ± 0.08	1.63 ± 0.12	
	index	184.91 ± 2.26 cm	171.59 ± 2.97 cm	
	level	insufficient	insufficient	
Running duration	*Optimal (3 points)*			
	%	15	18.52	
	index	7.95 ± 0.12 min	7.10 ± 0.02 min	
	Acceptable (2 points)			
	%	47	48.15	
	index	5.77 ± 0.07 min	5.67 ± 0.10 min	
	Insufficient (1 point)			
	%	38	33.33	
	index	4.18 ± 0.05 min	4.10 ± 0.12 min	

	Group average			
	average point	1.77 ± 0.07	1.85 ± 0.14	*
	index	5.49 ± 0.13 min	5.41 ± 0.22 min	*
	level	insufficient	insufficient	
Total points	*Optimal (24-27 points)*			
	%	15	7.41	
	average point	26.47 ± 0.24	27.0 ± 0.0	
	Acceptable (19-23 points)			
	%	10	14.81	
	average point	19.90 ± 0.31	20.75 ± 1.03	
	Insufficient (11-18 points)			
	%	75	74.07	
	average point	13.52 ± 0.43	13.43 ± 0.72	
	Group average			
	average point	17.15 ± 1.05	15.52 ± 1.00	*
	level	insufficient	insufficient	

* - reliability of differences according to Student's t-test ($p < 0.05$)

A comparison of motor development indicators of 5-7-year-old children with ASD and normal showed that in all test tasks, ordinary children are ahead of their peers with ASD. The reliability of differences according to students' t-tests was revealed in the mean values of parametric indicators or the mean score for the group in the following tests: flying start, long jump, trunk lift, running duration, and general level of motor development.

Our data confirmed the presence of the following problems of motor development in preschool children with ASD, identified in the works of E.V. Plaksunova, A.I. O.P. Gavrilushkina, N.S. Graschenkova, C.E. Monteiro, Y.S. Sung:

- disorders of formation of motor-coordination abilities,
- regulation of muscular activity,
- significant errors in the technique of performing motor actions;
- expression of stereotyped movements, their impulsiveness [5, 12-15].

These problems negatively affected the quantitative parametric indicators and were the reason for a significant lag of children with ASD in quantitative indicators behind children with homotypic development (Table 2).

4. Conclusions

Scientifically substantiated criteria and indicators of motor development assessment allowed the reveal of individual manifestations of opportunities and deficits of motor development of 6-7-year-old children with ASD to take them into account when designing and developing individual and group physical education strategies, creating separate educational routes.

The research on motor development of 6-7-year-old children with ASD has allowed us to supplement the ideas about individual motor development disorders: impulsive running with

uneven pace, inconsistency of hand movements when throwing and catching a ball, and one-pointed pushing off in a long jump from a place. The analysis of the results of the study confirms the presence in children with ASD of problems related to the development of balance function, impaired regulation of muscle activity, difficulties in the formation of purposefulness and arbitrariness in the performance of movements, and poor coordination of movements.

The research confirms the relevance and significance of the search for new approaches that provide group and individual strategies for motor development of children with ASD and the need to study the influence of motor-play activities on the effectiveness of motor development.

Author Contributions

Lyudmila N. Voloshina: Study Design, Data Collection, Statistical Analysis, Manuscript Preparation. Viktor L. Kondakov: Study Design, Data Collection, Statistical Analysis, Manuscript Preparation. Karina E. Panasenko: Data Collection, Statistical Analysis, Manuscript Preparation. Lyudmila K. Buslovskaya: Data Collection, Statistical Analysis, Manuscript Preparation. Dmitry V. Shcherbin: Data Collection, Statistical Analysis, Funds Collection.

Competing Interests

The authors have declared that no competing interests exist.

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