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THE APPLICATION OF KINESITHERAPY COORDINATION EXERCISES IN THE REHABILITATION OF PATIENTS WITH AUTISM SPECTRUM DISORDERS

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Autism spectrum disorders (ASD) are frequently associated with deficits in motor coordination, sensorimotor integration, and movement planning. Kinetotherapy is an essential component of complex rehabilitation, playing an important role in the functional and adaptive development of these patients. The aim of this study is to evaluate the effectiveness of a playful physical therapy coordination exercise, based on throwing a ball at a target, on improving movement accuracy and motor coordination in patients with ASD. The study was conducted on a sample of 21 patients over a period of 4 weeks. The results indicate a significant decrease in the number of attempts needed to hit the target, demonstrating the effectiveness of the physical therapy intervention.

Keywords: *kinetotherapy, autism spectrum disorders, motor coordination, sensorimotor integration, neuroplasticity, sensory disorder, behavioral patterns.*

APLICAREA EXERCIȚIILOR KINETOTERAPEUTICE DE COORDONARE ÎN REABILITAREA PACIENȚILOR CU TULBURĂRI DIN SPECTRUL AUTIST

Tulburările din spectrul autist (TSA) sunt frecvent asociate cu deficite de coordonare motrică, integrare senzorio-motorie și planificare a mișcării. Kinetoterapia reprezintă o componentă esențială a reabilitării complexe, având un rol important în dezvoltarea funcțională și adaptativă a acestor pacienți. Scopul prezentului studiu este de a evalua eficiența kinetoterapiei asupra îmbunătățirii preciziei mișcării și coordonării motorii la pacienți cu TSA, prin intermediul kinetoterapiei, utilizând exerciții de coordonare cu caracter ludic, bazat pe aruncarea unei mingi către o țintă. Studiul a fost realizat pe un eșantion de 21 de pacienți, timp de 4 săptămâni. Rezultatele obținute indică o scădere semnificativă a numărului de încercări necesare pentru atingerea țintei, demonstrând eficiența intervenției kinetoterapeutice.

Cuvinte-cheie: *kinetoterapie, tulburări din spectrul autist, coordonare motrică, integrare senzorio-motorie, neuroplasticitate, tulburare senzorială, modele comportamentale.*

Relevance

Autism is a fundamental disorder that consists of the inability of some individuals to relate to normal situations from the beginning of life. Autos, from Latin, means “alone.” In 1916, Swiss psychiatrist Paul Eigen Bleuler introduced this term in describing the symptoms of schizophrenia [1, 2, 5].

Autism spectrum disorders are associated with deficits in motor coordination, movement planning, and sensory integration, which significantly affect functional autonomy.

Recent studies highlight the essential role of physical therapy in stimulating motor and cognitive functions using structured and playful exercises. Coordination exercises, which involve visual-motor, proprioceptive, and vestibular integration, are recommended for increasing movement precision and forming adaptive motor strategies [1, 3, 5].

The word “autism” was first used in 1940 to establish a diagnosis, and the first description and research papers on autism were written in 1943 by Leo Kanner, an Austrian psychiatrist at Johns Hopkins Hospital in Baltimore [4].

Much later, in 1980, a new diagnosis called “infantile autism” was included in the Diagnostic and Statistical Manual of Mental Disorders (DSM), which was renamed “autistic disorder” in 1987. Scientific progress continued, and in 1994 several subtypes of autistic disorders were described, including Asperger syndrome and pervasive disorder without further specification (DSM-IV), which in 2013, in the fifth edi-

tion of the DSM, were combined into a single diagnosis–autism spectrum disorder. Currently, there is an increasing number of children in this category, as reflected in Table.

Table 1. Statistical data on ASD (autism spectrum disorder) in the Republic of Moldova

Year	Number of patients diagnosed with ASD
2012	144
2013	220
2014	191
2015	277
2016	317
2017	366
2018	460
2019	663
2020	640
2021	772
2023	137
2024	225

Statistical data analysis shows an increase in the number of autism cases during the COVID-19 pandemic, caused in part by the influence of the family environment on their behavior. According to the data presented in the table, it can be seen that the peak in the number of children diagnosed with autism spectrum disorders occurred during the pandemic. The period of isolation saw the largest increase in the number of autism cases [7, 8, 9].

Autism spectrum disorder is frequently associated with alterations in sensory processing and integration mechanisms. These affect both information from the internal environment and external stimuli, impacting the processes of modulation, organization, and interpretation of sensory input.

At a functional level, these characteristics can cause difficulties in coordinating and planning voluntary movements, reflected in imprecise or poorly organized motor execution. Repetitive behavioral patterns and increased rigidity in adapting to environmental changes may also occur [5].

Emotionally and cognitively, difficulties in recognizing and expressing one's own affective states may manifest, as well as limitations in the ability to imitate motor and gestural movements, which influences the process of learning by example and the development of socio-communicative skills.

At the same time, there may be dysfunctions in the vestibular system, affecting balance, posture, and spatial orientation, as well as disturbances in body schema representation and effective interaction with the environment.

Thus, the table below shows statistical data on the number of children with ASD between 2000 and 2022 according to the ADDM - Autism and Developmental Disabilities Monitoring Network - a network for monitoring autism and other developmental disabilities [7, 8, 9].

Table 2. ADDM Network - Combining data from all sites in the ADDM network

Surveillance Year	Birth Year	Number of ADDM Sites Reporting	Combined Prevalence per 1,000 Children (Range Across ADDM Sites)	This is about 1 in X children
2022	2014	16	32.2 (9.7 - 53.1)	1 in 31
2020	2012	11	27.6 (23.1-44.9)	1 in 36
2018	2010	11	23.0 (16.5-38.9)	1 in 44

2016	2008	11	18.5 (18.0-19.1)	1 in 54
2014	2006	11	16.8 (13.1-29.3)	1 in 59
2012	2004	11	14.5 (8.2-24.6)	1 in 69
2010	2002	11	14.7 (5.7-21.9)	1 in 68
2008	2000	14	11.3 (4.8-21.2)	1 in 88
2006	1998	11	9.0 (4.2-12.1)	1 in 110
2004	1996	8	8.0 (4.6-9.8)	1 in 125
2002	1994	14	6.6 (3.3-10.6)	1 in 150
2000	1992	6	6.7 (4.5-9.9)	1 in 150

One of the first people to describe these characteristics in patients with autism spectrum disorders was Temple Grandin in her autobiographical book „The Autistic Brain.” Her work was later supplemented by A. Jean Ayres, an occupational therapist who worked with children with autism spectrum disorders. In her research, she described sensory processing disorders in detail and proposed a classification for them [1,2,3].

There are three main types of sensory processing disorders.

The first type is sensory modulation disorder, which is associated with inadequate perception of stimuli by the central nervous system and delayed or insufficient response to sensory stimuli.

The second type – sensory-motor disorders, which manifest themselves in the form of dyspraxia, posture disorders, clumsy and uncoordinated movements. Fine motor skills are often affected, leading to muscle imbalance and decreased movement precision.

The third type – sensory discrimination disorder. In this case, the patient is unable to adequately assess the properties of objects, impact force, weight, hardness, rigidity, which can lead to damage to fragile objects or difficulties in determining the physical characteristics of an object [1, 3, 4, 5].

The role of kinetotherapy in ASD disorders: Physical therapy has a significant impact on the development and functionality of children with autism spectrum disorders, targeting motor, cognitive, and sensory aspects. Physical interventions contribute to the normalization of body weight and posture, promoting the correct alignment of body segments and preventing orthopedic complications.

Through adapted exercises, there is an improvement in coordination and physical endurance, which facilitates the performance of daily activities and participation in group activities.

Kinetotherapy also stimulates neural connections, promoting brain plasticity and sensory-motor integration [5].

Another major benefit is the development of discipline and motor memory through the repetition of motor structures and learning movement sequences, which is essential for learning by example and transferring skills to everyday activities.

Kinetotherapy contributes to the development of gross and fine motor skills, strengthening both general mobility and the precision of manual movements [1, 4].

Sensory-motor and functional assessments performed in kinetotherapy allow the identification of strengths and weaknesses, guiding specific sensory recovery interventions. As a result, there is an increase in independence and quality of life due to the development of self-care skills and autonomy in daily activities.

In addition, physical therapy prepares the patient for complementary therapies, such as speech therapy and ABA programs, facilitating the progressive integration of cognitive and social exercises into a structured setting [1, 7, 9].

Methods and materials

The aim of this study is to evaluate the effectiveness of physical therapy in improving movement precision and motor coordination in patients with ASD, through playful physical therapy coordination exercises based on throwing a ball at a target. The study included a considerable number of patients with ASD who were currently attending the ADIR day clinic.

***Participants*:** The sample consisted of 21 patients with ASD included in the physical therapy rehabilitation program of the ADIR day center for people with disabilities and autism spectrum disorders. The age and severity of symptoms varied, but all participants had moderate motor difficulties. This group of patients was offered a series of specific rehabilitation methods based on physical therapy.

***The kinetotherapy program*.** For this study, a dynamic game called "Skittles" was selected, which consists of throwing a ball with a diameter of 2.5 cm at six skittles placed 4 meters away. The following were selected:

- Variable trajectories: from above, from below, from the chest, from shoulder level.
- Number of repetitions: initially 10 with the dominant limb, then gradually reduced to 5 and 3 repetitions to optimize accuracy.
- The exercise also included the independent arrangement of the pins by the patient, to stimulate praxis and executive functions.

After mastering the exercise with the dominant limb, the activity was also performed with the non-dominant limb, to develop bilateral coordination and activate additional neuromotor circuits.

The ball is thrown using various kinematic trajectories: overhead throw; underhand throw; chest throw; shoulder throw.

This variability allows for: diversification of motor programs; adaptation of the exercise to the individual characteristics of the patient; stimulation of neuroplasticity mechanisms.

Structure and progression of the physical therapy program

Stage I – Stabilization of the motor pattern

- 10 repetitions with the dominant hand;
- emphasis on distance, posture, and movement control;
- simple, clear visual and verbal feedback.

Stage II – Increasing accuracy

- gradually reducing repetitions to 5, then to 3;
- focusing on accuracy of execution,
- optimizing the sensorimotor scheme.

Stage III – Developing praxis

- The patient arranges the pins themselves;
- Initially, the standard pattern is used;
- Later, variations in arrangement are allowed, maintaining the distance;
- Planning, anticipation, and spatial organization are stimulated.

Stage IV – Training the non-dominant limb by repeating the exercise with the non-dominant hand, strengthening bilateral coordination, and stimulating interhemispheric interaction.

Specific aspects for patients with ASD

The exercise is playful, which facilitates engagement and sustained attention, while its clear and repetitive structure provides predictability, reducing anxiety.

The activity simultaneously stimulates the visual, proprioceptive, vestibular, and tactile systems. The high level of sensory engagement contributes to behavioral and emotional regulation.

***Development of motor praxis*.** Patients were given the opportunity to arrange the pins independently. Initially, a standard placement pattern was used, and later variations were allowed, provided that the fixed distance was maintained. This approach contributed to the development of motor planning, visual-spatial analysis, and elements of executive functions.

***Bilateral training*.** After achieving an adequate level of performance with the dominant limb, the exercise was also performed with the non-dominant limb, contributing to the development of bilateral coordination and strengthening interhemispheric interaction.

Results. As we can see in Figure 1, in the first week, the children with ASD included in the study needed 10 repetitions to complete the task, while in the following week they needed only 6 attempts. The average reduction in the number of attempts indicates significant progress in the development of motor coordination.

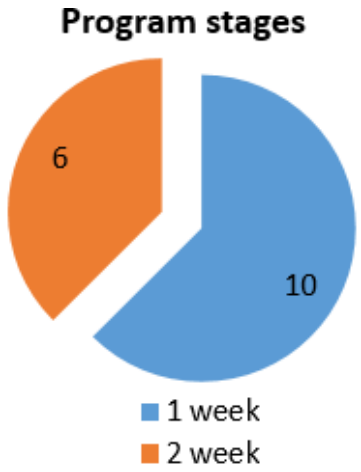


Fig. 1. Coordination performance dynamics in the first 2 weeks

In Table 3, we can see a decrease in the number of attempts to a single one, in 23.8% of the 21 people with ASD, which indicates a very good performance of the coordination capacity resulting from the physical therapy program we proposed. At the opposite end of the spectrum are the 14.3% of individuals with ASD who succeeded in 5 repetitions, which demonstrates a weaker adaptability to the prescribed effort. At the same time, 52.4% of patients succeeded in reaching the target on the first or second attempt.

Table 3. Coordination performance dynamics in the fourth week (n-21)

Number of attempts	Number of patients	Percent (%)
1	5	23,8 %
2	6	28,6 %
3	8	38,1 %
4–5	3	14,3 %
Total	21	100 %

***Discussion*:** The physical therapy program focused on coordination exercises, developed in this study, showed positive effects on motor performance and sensory-motor response organization in people with ASD. The authors observed a gradual decrease in the number of attempts required to complete the task, indicating an improvement in motor control and accuracy in the execution of coordination movements.

The intervention engaged visual-motor integration mechanisms and required higher-level processes such as action planning, trajectory anticipation, and movement self-regulation based on feedback in individuals with ASD. Through these components, the program contributed to strengthening praxis and optimizing executive functions.

The playful dimension of the activities encouraged the active involvement of participants, reducing anxiety and increasing compliance with the intervention. At the same time, the bilateral use of limbs stimulated interhemispheric coordination and supported the adaptive processes associated with neuroplasticity.

Conclusions

1. Bowling is an effective physical therapy tool for patients with autism spectrum disorder, integrating motor, sensory, and cognitive development into a game.
2. The progressive adaptation of the task and the active involvement of the patient with ASD facilitate motor learning, functional autonomy, and an improved quality of life by strengthening coordination and precision of movement.
3. The skittles coordination exercise supports sensory-motor integration and motor precision and is recommended for inclusion in complex physical and functional rehabilitation programs.
4. By correlating the force of the throw with the distance to the pins, the exercise simultaneously addresses multiple types of sensory processing, contributing to the correction of motor and sensory disorders identified in patients.

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