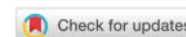


MOTOR DEVELOPMENT AND MOTOR DEFICITS IN CHILDREN WITH AUTISM SPECTRUM DISORDER

Ivan Mihaylov^{1*} 

¹South-West University "Neofit Rilski", Department of Kinesitherapy, Faculty of Public Health, Healthcare and Sports, Blagoevgrad, Bulgaria, e-mail: ivan_mihaylov95@abv.bg



Abstract: Motor development represents an essential component of childhood development and is closely associated with functional independence, participation, and performance in everyday activities. Children with Autism Spectrum Disorder (ASD) frequently present with difficulties in motor coordination, balance, postural control, muscle strength, and fine motor performance, which may affect their overall functional abilities. The aim of the present study was to investigate motor development and identify the predominant motor deficits in children with ASD aged 4 to 7 years. The study included 60 children diagnosed with ASD, who were divided into an experimental group ($n = 30$) and a control group ($n = 30$). A comprehensive assessment of motor functioning was performed using a battery of standardized motor tests evaluating static and dynamic balance, postural control, lower-limb explosive power, hand grip strength, fine motor coordination, spatial orientation, and motor speed. The assessment included the Pediatric Berg Balance Scale, standing long jump, hand dynamometry, fine motor performance assessed through a graphic dictation task, spatial orientation speed, and tapping. The findings demonstrated varying degrees of motor difficulties across several functional domains. The most pronounced impairments were observed in balance and postural control, muscle strength, fine motor coordination, and motor speed. Difficulties in maintaining stable body positions and performing coordinated movements were particularly evident, suggesting reduced efficiency of postural and motor control mechanisms. Reduced grip strength and lower performance in tasks requiring rapid and precise motor responses were also observed. These findings indicate that motor difficulties in children with ASD are multidimensional, involving both gross and fine motor functions. The identified deficits may negatively affect participation in age-appropriate activities and limit functional independence. The results emphasize the importance of comprehensive motor assessment as an essential component of the therapeutic evaluation of children with ASD. Identification of specific motor impairments can provide a basis for individualized intervention planning and support the integration of targeted physiotherapy and occupational therapy strategies aimed at improving balance, strength, coordination, motor planning, and functional performance.

Keywords: autism spectrum disorder, motor development, motor deficits, balance, postural control, muscle strength, motor coordination, physiotherapy, occupational therapy.

Field: Medical Sciences and Health

1. INTRODUCTION

Motor development is a fundamental component of child development and plays an essential role in the acquisition of functional independence, participation in everyday activities, and adaptation to environmental demands. In children with Autism Spectrum Disorder (ASD), motor functioning is increasingly recognized as an important aspect of the overall developmental profile, as motor difficulties may occur alongside the core characteristics of the disorder and may substantially affect participation in daily life. A systematic review and meta-analysis reported a high prevalence of motor impairments among children with ASD, with difficulties affecting multiple components of motor functioning (Kangarani-Farahani et al., 2024). The motor profile of children with ASD is highly heterogeneous and may involve impairments in balance, coordination, postural control, motor planning, muscle strength, and fine motor performance. Recent comparative studies have demonstrated significant differences between children with ASD and their typically developing peers in balance, postural control, and overall motor skills, highlighting the need for systematic and multidimensional assessment of motor functioning (Martín-Díaz et al., 2024). Postural control is particularly important for effective motor functioning, as it enables the body to maintain stability in different positions and during purposeful movement. In children with ASD, difficulties in postural regulation may be associated with reduced balance capacity and less efficient strategies for maintaining body stability. In our previous study, a structured program combining sensory integration with physiotherapy-based balance training resulted in significant improvements in static and dynamic balance, postural stability, and coordination in children with ASD (Mihaylov, 2026). These findings emphasize the importance of postural control as a key component of motor functioning and support the need for a broader assessment of motor abilities encompassing both gross and fine motor skills. In addition to balance and postural control,

*Corresponding author: ivan_mihaylov95@abv.bg



children with ASD may experience difficulties in performing fundamental motor skills. Evidence from a systematic review and meta-analysis indicates that exercise-based interventions can positively influence locomotor skills, object control, and stability, emphasizing the clinical relevance of targeted motor training (Ji et al., 2023). At the same time, these findings highlight the importance of identifying specific areas of motor impairment before intervention in order to tailor therapeutic programs to the individual functional needs of each child. Fine motor skills represent another essential component of motor development, as they are required for the successful performance of numerous daily and educational activities. A large-scale study involving young children demonstrated differences in fine motor performance according to diagnostic profile, with children with ASD exhibiting specific characteristics in manual and visual-motor functioning (Lin et al., 2024). These findings suggest that the assessment of motor development should not be limited to gross motor abilities and balance but should also encompass skills related to movement precision, speed, and coordination. Within this context, comprehensive assessment of motor functioning is particularly relevant to physiotherapy and occupational therapy practice. The combined evaluation of balance, postural control, lower-limb explosive power, hand muscle strength, fine motor skills, spatial orientation, and motor response speed allows for the development of a more comprehensive individual motor profile. Such an assessment may facilitate the identification of specific motor deficits and provide a foundation for planning targeted physiotherapy and occupational therapy interventions. Therefore, the aim of the present study is to assess motor development and identify the predominant motor deficits in children with ASD aged 4–7 years using a comprehensive battery of standardized motor tests evaluating balance, postural control, muscle strength, fine motor skills, spatial orientation, and motor speed.

2. MATERIALS AND METHODS

The present study employed a cross-sectional descriptive-analytical design to investigate motor development and identify the predominant motor deficits in children with Autism Spectrum Disorder (ASD). The analysis was based exclusively on baseline assessment data obtained prior to the implementation of the therapeutic intervention. A total of 60 children diagnosed with ASD, aged 4–7 years, participated in the study. The diagnosis had been previously established according to the diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) by qualified clinical specialists. The participants were subsequently allocated into an experimental group (EG; $n = 30$) and a control group (CG; $n = 30$) as part of a broader intervention study. However, the present analysis includes only the baseline motor assessment performed before the intervention. Therefore, the primary focus of the current study is the motor profile and motor deficits of the total sample ($n = 60$), rather than the effects of the therapeutic intervention. Motor performance was evaluated using a comprehensive battery of standardized motor tests assessing both gross and fine motor abilities. The assessment covered six major functional domains:

- Pediatric Berg Balance Scale (PBBBS) – assessment of static and dynamic balance and functional postural control;
- Standing Long Jump Test – assessment of lower-limb explosive power;
- Hand Dynamometry – measurement of maximal hand grip strength;
- Graphic Dictation Test – assessment of fine motor coordination and visuomotor integration;
- Spatial Orientation Speed Test – assessment of spatial orientation and motor organization;
- Tapping Test – assessment of motor speed and upper-limb movement frequency.

All assessments were administered individually under standardized conditions. The same assessment procedures were applied to all participants in order to ensure consistency and minimize measurement variability.

Statistical analyses were performed primarily for the total sample ($n = 60$) in order to characterize the overall motor profile of children with ASD. Continuous variables were summarized using mean values and standard deviations (Mean $\pm$ SD), while categorical variables were presented as absolute frequencies and percentages. Baseline results were additionally examined separately for the experimental and control groups to assess group comparability prior to intervention. Between-group differences in continuous variables were analyzed using appropriate parametric or non-parametric tests according to the distribution of the data. Differences in categorical variables were examined using the chi-square (χ^2) test. Statistical significance was set at $p < 0.05$.

3. RESULTS

A total of 60 children with Autism Spectrum Disorder (ASD), aged 4–7 years, were included in the baseline assessment. Of all participants, 37 (61.67%) were boys and 23 (38.33%) were girls. The control group consisted of 18 boys (60.00%) and 12 girls (40.00%), while the experimental group included 19 boys (63.33%) and 11 girls (36.67%). No statistically significant difference in sex distribution was observed between the groups ($\chi^2(1) = 0.071$, $p = 0.790$). The baseline assessment revealed motor difficulties across multiple functional domains. The most pronounced impairments were observed in balance and postural control. The mean score on the Pediatric Balance Scale was 27.0 ± 6.4 points out of a maximum of 56, indicating substantially reduced balance performance in the examined sample. Difficulties were particularly evident during tasks requiring the maintenance of a stable body position, changes in the base of support, weight transfer, and the controlled execution of functional movements. Performance on the Standing Long Jump Test also indicated limitations in gross motor functioning. The children achieved a mean jumping distance of approximately 63.5 ± 18.7 cm. In addition to reduced lower-limb explosive power, difficulties in coordinating the preparatory phase, take-off, and landing were observed. Some participants demonstrated insufficient arm–leg coordination and reduced postural stability during landing, suggesting that performance was influenced by both strength and motor coordination. Hand dynamometry demonstrated reduced grip strength, with a mean value of approximately 7.2 ± 2.1 kg for the dominant hand and 6.5 ± 2.0 kg for the non-dominant hand. The difference between the two hands indicated functional asymmetry, while the overall performance suggested limitations in upper-limb muscle strength in a proportion of the assessed children. Fine motor performance assessed using the Graphic Dictation Test was also affected. The mean score for the total sample was approximately 5.4 ± 2.6 points out of 12. Based on the established scoring criteria, 8 children (13.33%) demonstrated a high level of performance, 15 (25.00%) a medium level, 24 (40.00%) a low level, and 13 (21.67%) a very low level. Thus, 61.67% of the participants were classified within the low or very low performance categories. The most frequent difficulties involved inaccurate reproduction of graphic elements, errors in movement direction and sequence, and reduced visuomotor coordination. Difficulties were additionally observed in spatial orientation and motor organization. The children required more time and demonstrated a greater number of errors during tasks involving rapid spatial orientation and organization of an appropriate motor response. These findings suggest reduced efficiency in the integration of spatial information with purposeful motor performance. The Tapping Test revealed limitations in motor speed and the frequency of repetitive movements. During the 10-second testing interval, the children produced a mean of approximately 31.8 ± 7.4 dots with the dominant hand and 27.6 ± 6.9 dots with the non-dominant hand, corresponding to approximately 3.18 and 2.76 movements per second, respectively. Differences between the two hands indicated functional asymmetry, while the relatively reduced movement frequency reflected difficulties in rapid repetitive motor performance. Overall, the baseline assessment demonstrated a multidimensional pattern of motor deficits in the examined children with ASD. The most prominent difficulties involved balance and postural control, lower-limb explosive power, hand grip strength, fine motor coordination, spatial organization, and motor speed. The simultaneous involvement of several motor domains indicates that motor difficulties in ASD extend beyond isolated deficits and may affect the overall efficiency and organization of functional movement.

4. DISCUSSION

The present study identified a multidimensional pattern of motor difficulties in children with Autism Spectrum Disorder (ASD), involving balance and postural control, muscle strength, fine motor coordination, spatial organization, and motor speed. The findings support the growing evidence that motor impairments in ASD are not limited to an isolated motor domain but may affect several components of motor functioning simultaneously. This is consistent with the systematic review and meta-analysis by Kangarani-Farahani et al. (2024), which demonstrated that motor difficulties are highly prevalent among children with ASD and may involve both gross and fine motor abilities. Balance and postural control emerged as particularly affected areas in the present sample. The mean Pediatric Balance Scale score of 27.0 ± 6.4 points suggests substantial difficulties in maintaining postural stability during functional motor tasks. Similar findings were reported by Martín-Díaz et al. (2024), who observed significantly poorer performance in static and dynamic balance and overall motor skills in children with ASD compared with neurotypically developing peers. More recent evidence from the systematic review and meta-analysis by Xu et al. (2025) further indicates that children and adolescents with ASD experience difficulties across several dimensions of balance control, particularly sensory orientation, verticality, and anticipatory postural adjustments.

These findings suggest that impaired balance in ASD may reflect broader difficulties in the organization and integration of sensory information required for efficient postural regulation. The relationship between sensory processing and postural control appears particularly relevant during early childhood. Ferreiro-Pérez et al. (2024) demonstrated alterations in the use of sensory information for postural control in preschool children with ASD, emphasizing the importance of sensory processing for maintaining stability during functional activities. This relationship is also consistent with our previous findings, in which a structured program combining sensory integration and physiotherapy-based balance training was associated with improvements in static and dynamic balance, postural stability, and coordination in children with ASD (Mihaylov, 2026). Taken together, these observations support the inclusion of postural control and sensory-motor integration as important components of motor assessment and intervention planning in children with ASD. The observed limitations in lower-limb explosive power and hand grip strength further demonstrate that the motor profile of children with ASD extends beyond balance deficits. Reduced muscle performance may influence the execution of activities requiring jumping, propulsion, stabilization, object manipulation, and sustained physical effort. Martín-Díaz et al. (2024) similarly identified strength as one of the motor domains showing pronounced differences between children with ASD and neurotypically developing participants. These deficits may have functional implications for participation in play, physical activity, self-care, and other age-appropriate daily activities. Fine motor difficulties represented another important component of the motor profile. Reduced performance in the Graphic Dictation Test indicated difficulties in precise movement control, visuomotor integration, and the organization of sequential hand movements. Lin et al. (2024) also identified distinctive patterns of fine motor performance among young children with ASD, supporting the need to include fine motor assessment as part of a comprehensive evaluation. Such difficulties may be particularly relevant during the preschool and early school years, when drawing, writing preparation, object manipulation, dressing, and other activities increasingly require accurate and coordinated hand movements. The findings related to spatial orientation and the Tapping Test additionally suggest difficulties in the speed and organization of motor responses. Reduced frequency of repetitive movements and differences between the dominant and non-dominant hands may reflect limitations in rapid motor execution and functional asymmetry. When considered together with deficits in balance, strength, and fine motor coordination, these findings reinforce the view that motor difficulties in ASD should be approached as a complex functional profile rather than as isolated impairments. From a clinical perspective, comprehensive motor assessment may therefore provide valuable information for individualized intervention planning. Physiotherapy interventions may target postural control, balance, muscle strength, coordination, and gross motor performance, whereas occupational therapy can further address fine motor abilities, visuomotor integration, motor planning, and the transfer of acquired skills to meaningful everyday activities. A systematic review by Date et al. (2024) indicates that different sensorimotor interventions may improve aspects of postural balance control in individuals with ASD, although heterogeneity across intervention protocols and outcome measures limits the generalizability of current evidence. This highlights the importance of individualized assessment and clearly defined therapeutic objectives. Overall, the present findings support the inclusion of systematic motor assessment in the clinical evaluation of children with ASD. Early identification of deficits in balance, postural control, strength, coordination, and motor speed may facilitate the development of more targeted physiotherapy and occupational therapy programs aimed not only at improving isolated motor abilities but also at promoting functional independence and participation in everyday activities.

5. CONCLUSION

Children with Autism Spectrum Disorder demonstrate a multidimensional pattern of motor deficits affecting both gross and fine motor functioning. The most prominent difficulties involve balance and postural control, muscle strength, fine motor coordination, spatial organization, and motor speed. These findings highlight the importance of comprehensive motor assessment for the early identification of functional limitations. Individualized physiotherapy and occupational therapy interventions targeting the identified deficits may contribute to improved motor performance, functional independence, and participation in everyday activities.

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