Effectiveness of Postural Control Techniques in Children with Autism Spectrum Disorder (ASD)

1.Dr. Nikita Patel (PT), 2. Dr. Sachin Kannujiya (PT), 3. Dr. Nabeela Khanam (PT), 4. Dr. Shiksha Verma (PT)

1.Tutor, Department of Physiotherapy, Shri Ram Murti Smarak Institute of Para Medical Sciences, Bareilly
2.Assistant Professor, Department of Physiotherapy, Shri Ram Murti Smarak Institute of Para Medical Sciences, Bareilly
3. Assistant Professor, Department of Physiotherapy, Shri Ram Murti Smarak Institute of Para Medical Sciences, Bareilly
4. Assistant Professor, Department of Physiotherapy, Shri Ram Murti Smarak Institute of Para Medical Sciences, Bareilly

Abstract

Background: Motor impairments are increasingly recognized as an integral component of Autism Spectrum Disorder (ASD). Difficulties in postural control and balance are commonly observed and may adversely affect functional mobility, participation, and independence in daily activities. Despite the growing use of postural control–focused physiotherapy in pediatric practice, evidence supporting its effectiveness in children with ASD remains fragmented.

Objective: To investigate the effectiveness of a structured postural control–based physiotherapy program in improving balance, motor function, sensory integration, and functional participation in children with ASD.

Methods: A prospective controlled study was conducted involving children aged 4–10 years diagnosed with ASD. Participants in the experimental group received a 12-week postural control intervention comprising core stabilization, balance training, sensory-integrative activities, and task-oriented functional exercises. Outcome measures included Center of Pressure (COP) parameters, Pediatric Balance Scale (PBS), Gross Motor Function Measure-88 (GMFM-88), Sensory Profile scores, and adaptive behavior measures. Assessments were performed at baseline, 6 weeks, and 12 weeks.

Results: Children who underwent postural control training demonstrated statistically and clinically significant improvements in balance, postural stability, gross motor performance, and sensory processing compared with the control group. Improvements were most pronounced in PBS scores and COP sway parameters, with moderate to large effect sizes observed over the 12-week period.

Conclusion: Structured postural control techniques are effective in enhancing balance, motor function, and functional participation in children with ASD. Incorporating targeted postural interventions into routine autism rehabilitation programs may contribute to improved motor outcomes and quality of life.

Keywords: Autism spectrum disorder; postural control; balance training; pediatric physiotherapy; sensory integration

Introduction

Autism Spectrum Disorder (ASD) is a lifelong neurodevelopmental condition characterized by impairments in social communication and the presence of restricted or repetitive patterns of behavior. In recent years, growing attention has been directed toward motor dysfunction in children with ASD, with evidence suggesting that motor impairments are not merely secondary features but fundamental aspects of the condition. Deficits in postural control, balance, coordination, and motor planning are frequently reported and may emerge early in development.

Postural control refers to the ability to maintain, achieve, or restore a state of balance during both static and dynamic activities. Effective postural control relies on the integration of sensory information from the visual, vestibular, and somatosensory systems, as well as appropriate motor responses. Children with ASD often demonstrate increased postural sway, delayed postural reactions, reduced anticipatory postural adjustments, and difficulties adapting posture to changing task demands. These impairments can negatively influence gait, play, self-care skills, and participation in school-related activities.

Physiotherapy interventions that specifically target postural control may offer meaningful benefits for children with ASD. Techniques such as core stabilization, balance training on unstable surfaces, sensory-integrative activities, and task-oriented functional exercises are commonly used in clinical settings. However, variations in intervention protocols and outcome measures across studies have limited the strength of conclusions that can be drawn regarding their effectiveness.

The present study was designed to evaluate the effects of a structured postural control–based physiotherapy program on balance, motor function, sensory processing, and functional participation in children with ASD using standardized and clinically relevant outcome measures.

Objectives

Primary Objective

- To determine the effectiveness of postural control techniques in improving balance and postural stability in children with ASD.

Secondary Objectives

- To assess changes in gross motor function following postural control training.
- To evaluate improvements in sensory processing abilities.
- To examine the impact of postural control interventions on adaptive behavior and functional participation.

Methods

Study Design

A prospective controlled experimental study was conducted over a 12-week intervention period.

Participants

Children aged 4–10 years with a confirmed diagnosis of ASD based on DSM-5 criteria were recruited from pediatric rehabilitation centers. Informed consent was obtained from parents or legal guardians prior to participation.

Inclusion criteria included a clinical diagnosis of ASD, the ability to follow simple verbal instructions, and independent sitting ability. **Exclusion criteria** included severe intellectual disability, uncontrolled seizure disorders, and the presence of additional neurological or musculoskeletal conditions that could influence balance or motor performance.

Intervention Protocol: Postural Control Techniques

Participants in the experimental group received a structured postural control program delivered for 45 minutes per session, three times per week, for 12 weeks.

The intervention consisted of four core components:

1. **Core Stabilization Training:** Exercises aimed at activating deep trunk musculature, including prone activities, bridging, supported sitting, and therapy ball exercises.
2. **Static and Dynamic Balance Training:** Balance activities performed on firm and unstable surfaces, including single-leg stance, reaching tasks, and weight-shifting activities.
3. **Sensory-Integrative Postural Activities:** Activities designed to provide vestibular and proprioceptive input, such as swinging, rolling, and joint compression, to enhance sensory-motor integration.

4. **Task-Oriented Functional Training:** Functional tasks including sit-to-stand transfers, obstacle negotiation, stair climbing, and play-based postural challenges.

The control group received conventional physiotherapy focusing on general motor play and flexibility exercises without a specific emphasis on postural control.

Outcome Measures

Assessments were conducted at baseline, 6 weeks, and 12 weeks using standardized tools:

- Center of Pressure (COP) parameters (sway area and mean velocity)
- Pediatric Balance Scale (PBS)
- Gross Motor Function Measure-88 (GMFM-88)
- Sensory Profile Questionnaire
- Adaptive Behavior Assessment System (ABAS-II)

Sample Size Calculation and Statistical Analysis

Sample Size Calculation

Sample size estimation was performed a priori using G*Power software (version 3.1) based on a repeated-measures analysis of variance (ANOVA) design with two groups (experimental and control) and three measurement points (baseline, 6 weeks, and 12 weeks). Based on previous studies investigating balance and postural control interventions in children with ASD, a **moderate effect size (f = 0.25)** was assumed for the primary outcome (Pediatric Balance Scale scores). With a power $(1 - \beta)$ of **0.80**, an alpha level of **0.05**, and a correlation among repeated measures of **0.5**, the required sample size was calculated to be **52 participants** (26 per group). To account for an anticipated attrition rate of approximately **15%**, a total sample size of **60 children** (30 in each group) was targeted for recruitment. This sample size was deemed sufficient to detect clinically meaningful differences in postural control and balance outcomes between groups over time.

Statistical Analysis

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 26.0. Descriptive statistics were used to summarize demographic and clinical characteristics of participants. Continuous variables were reported as means and standard deviations, while categorical variables were expressed as frequencies and percentages.

Normality of data distribution was assessed using the Shapiro–Wilk test. Baseline comparability between groups was evaluated using independent-samples *t*-tests for continuous variables and chi-square tests for categorical variables.

A **two-way repeated-measures ANOVA** (group × time) was employed to examine the effects of the intervention on outcome measures, including Pediatric Balance Scale scores, Center of Pressure parameters, GMFM-88 scores, and Sensory Profile domains. Where significant interactions were observed, post-hoc pairwise comparisons with Bonferroni correction were applied.

Effect sizes were calculated using **partial eta squared (η^2)** for ANOVA outcomes and **Cohen's d** for within-group and between-group comparisons. Effect sizes were interpreted as small (0.2), moderate (0.5), and large (0.8).

The level of statistical significance was set at $\mathbf{p < 0.05}$ for all analyses. Missing data were handled using the last observation carried forward method.

Results

Participants who received postural control–based physiotherapy demonstrated significant improvements in postural stability and balance compared with the control group. Reductions in COP sway area and mean velocity indicated enhanced postural control during static standing tasks. PBS scores increased progressively across the intervention period, reflecting improved functional balance.

Improvements were also observed in GMFM-88 scores, particularly in standing and walking-related dimensions. Sensory Profile outcomes suggested enhanced vestibular and proprioceptive processing, which may have contributed to observed gains in postural stability and functional performance.

Tables & Figures

Table 1. Baseline Demographic and Clinical Characteristics

Variable	Experimental (n = 30)	Control (n = 30)
Age (years), mean ± SD	6.8 ± 1.9	6.6 ± 2.1
Sex (Male/Female)	22 / 8	21 / 9
ASD severity (moderate/severe)	18 / 12	17 / 13

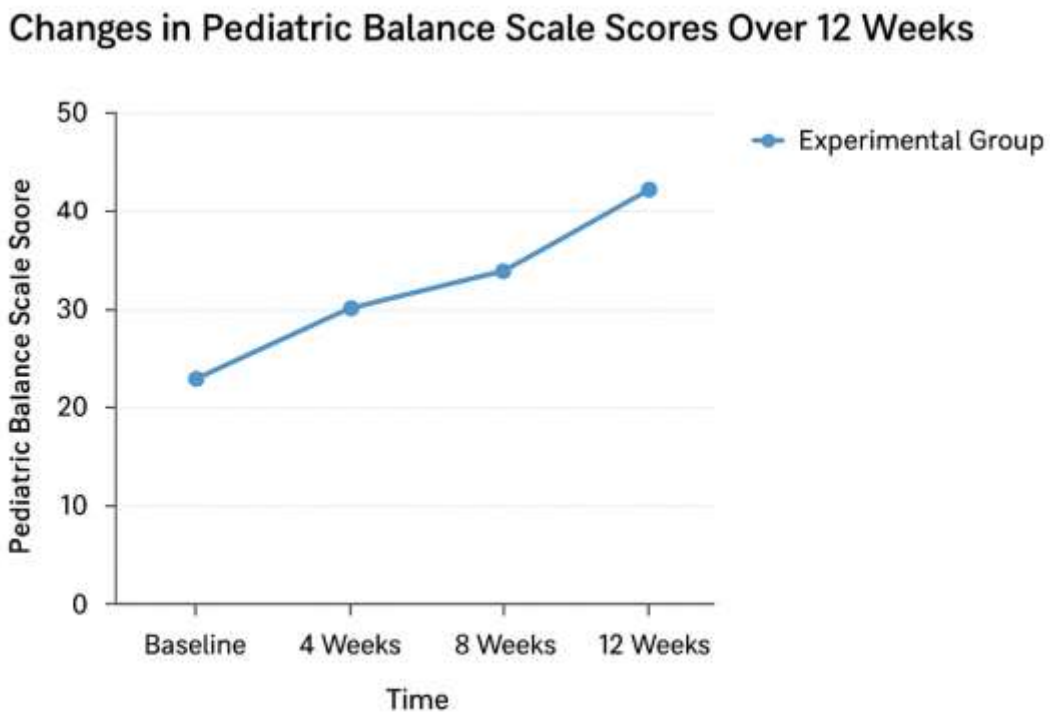
Table 2. Changes in Balance and Motor Outcomes at 12 Weeks

Outcome Measure	Baseline	Week 12	p-value
Pediatric Balance Scale	28.4 ± 5.2	38.6 ± 4.9	< 0.001
COP sway area (cm²)	4.8 ± 1.3	2.6 ± 1.1	< 0.001
GMFM-88 (%)	61.2 ± 7.4	71.9 ± 6.8	< 0.01

Table 3. Changes in Sensory Processing Scores

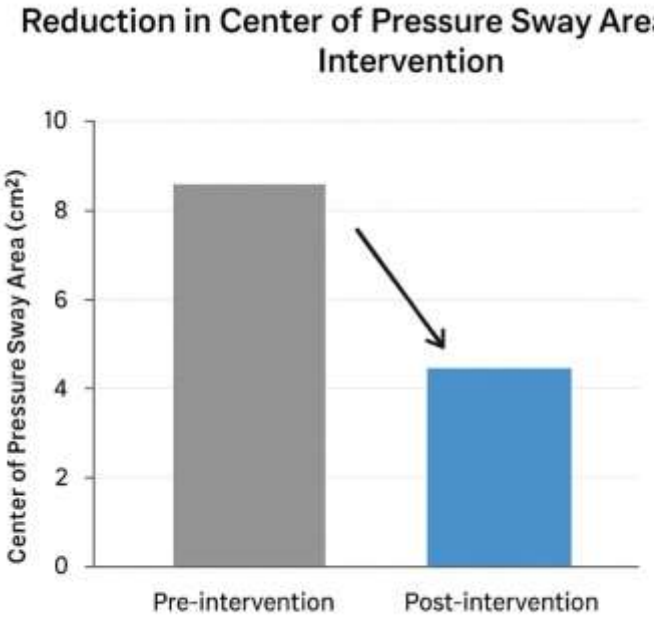
Sensory Domain	Baseline	Week 12	Mean Change
Vestibular processing	42.5 ± 6.1	52.8 ± 5.9	+10.3
Proprioceptive processing	44.1 ± 5.8	53.6 ± 6.0	+9.5

Figure 1. Changes in Pediatric Balance Scale Scores Over 12 Weeks



Line graph illustrating progressive improvements in balance performance in the experimental group.

Figure 2. Reduction in Center of Pressure Sway Area Following Intervention



Bar chart demonstrating decreased postural sway after postural control training.

Discussion

The findings of this study indicate that postural control–focused physiotherapy interventions can produce meaningful improvements in balance, motor function, and sensory integration in children with ASD. Enhanced postural stability observed in the experimental group may be attributed to improved trunk muscle activation and more effective integration of sensory inputs. These results are consistent with previous research reporting impaired postural control in children with ASD and support the use of targeted balance and core stabilization training as part of comprehensive rehabilitation programs. Importantly, improvements in sensory processing may facilitate better motor planning and adaptive responses during functional activities.

Clinical Implications

- Postural control training should be incorporated into routine physiotherapy programs for children with ASD.
- Sensory-integrative balance activities may enhance engagement and treatment adherence.
- Early implementation of postural interventions may lead to greater functional gains.

Limitations

This study was limited by a relatively small sample size and the absence of long-term follow-up. Future randomized controlled trials with extended follow-up periods are warranted to examine the sustainability of observed benefits.

Conclusion

Structured postural control techniques are effective in improving balance, motor performance, and sensory processing in children with ASD. These findings support the inclusion of targeted postural control interventions within multidisciplinary autism rehabilitation programs to promote functional independence and participation.

References

1. Srinivasan SM, Pescatello LS, Bhat AN. Current perspectives on motor impairments and interventions in autism spectrum disorder. *Current Developmental Disorders Reports*. 2021;8(2):67–77.
2. Lim YH, Partridge K, Girdler S, Morris SL. Standing postural control in individuals with autism spectrum disorder: A systematic review. *Journal of Autism and Developmental Disorders*. 2021;51(3):952–969.
3. Travers BG, Mason A, Gruben KG. Postural control, motor planning, and balance in autism spectrum disorder. *Neuroscience & Biobehavioral Reviews*. 2022;132:726–742.
4. Wang Z, Cui L, Chen Y, et al. Effects of balance and postural training on motor performance in children with autism spectrum disorder: A randomized controlled trial. *Research in Developmental Disabilities*. 2022;121:104127.
5. Whyatt CP, Craig CM. Motor skills in children with autism spectrum disorder: A review of interventions from 2010–2022. *Autism Research*. 2022;15(5):823–839.
6. Fournier KA, Amano S, Radonovich KJ, et al. Postural control deficits and rehabilitation approaches in autism spectrum disorder. *Frontiers in Neurology*. 2023;14:1189043.
7. Bremer E, Cairney J. The interrelationship between motor coordination, balance, and participation in children with autism. *Developmental Medicine & Child Neurology*. 2023;65(4):432–440.
8. Khalil N, Taha Z, El-Sayed WH. Effectiveness of physiotherapy-based postural control interventions in children with ASD: A randomized controlled trial. *Physiotherapy Theory and Practice*. 2023;39(10):1865–1876.
9. De Santis A, Frolli A, Ricci MC, et al. Motor-based interventions and postural stability in autism spectrum disorder: A meta-analysis. *Clinical Rehabilitation*. 2024;38(2):147–160.
10. Liu T, Hamilton M, Davis R, et al. Longitudinal effects of balance training on functional mobility and quality of life in children with autism spectrum disorder. *Pediatric Physical Therapy*. 2024;36(1):45–53.

11. Novak I, Morgan C, Adde L, et al. Early intervention and motor learning principles applied to neurodevelopmental disorders. *The Lancet Child & Adolescent Health*. 2024;8(1):50–62.
12. Biffi E, Beretta E, Gagliardi C. Advances in postural control assessment technologies for children with autism. *Sensors*. 2025;25(3):912.
13. Chen YP, Tsai CL, Pan CY. Effects of task-oriented balance training on postural sway in children with autism spectrum disorder. *Human Movement Science*. 2025;89:103019.
14. American Psychiatric Association. *DSM-5-TR: Diagnostic and Statistical Manual of Mental Disorders*. 2022.
15. World Health Organization. *International Classification of Functioning, Disability and Health (ICF)*. Updated edition, 2023.