



EFFICACY OF BALANCE TRAINING ON CENTER OF PRESSURE (COP) METRICS IN AUTISTIC POPULATION: A NARRATIVE REVIEW

Mariam Mohsin^{*1}, Tehreem Mukhtar², Minahil Sajjad³, Laraib Shabir⁴, Armish⁵,
Muhammad Khalid⁶

^{*1}Physiotherapist, MS Rehabilitation Sciences, Superior University, Lahore,
Email: *1mariamohsin25@gmail.com

²Assistant Professor Superior University, Lahore, Email: 2tehreemkukhtar01@gmail.com
ORCID: <https://orcid.org/0000-0002-8213-7742>

³MS Neurorehabilitation, Superior University, Lahore. Physiotherapist,
Email: 3manhyalsajjad@gmail.com

⁴MS Pediatric Rehabilitation, Superior University, Lahore, Email: 4laraibf125@gmail.com

⁵Physiotherapist, Superior University, Lahore, Email: 5armishchaudhary420@gmail.com

⁶Lecturer frontier institute of modern sciences Mansehra, Email: 6Khaliddoctor115@gmail.com

ARTICLE INFO:

Keywords:

Autism Spectrum Disorder;
Balance Training; Postural
Control; Center of Pressure
(CoP); Physical Therapy.

Corresponding author:

Mariam Mohsin,

Physiotherapist, MS
Rehabilitation Sciences,
Superior University, Lahore,

Email:

mariamohsin25@gmail.com

Article History:

Received: November 28, 2025

Accepted: January 12, 2026

Published: January 29, 2026

ABSTRACT

Background: Children with Autism Spectrum Disorder (ASD) frequently present with postural and balance impairments. Physical therapy interventions focused on these balance and posture deficits are crucial for increasing functional independence and improving social participation among autistic children.

Objective: The objective of this narrative review is to synthesize controlled intervention literature from the past five years, 2020–2025 (1-5) regarding balance training for autistic children and youth focusing on Center of Pressure (CoP) metrics as outcome variable.

Methods: A total of 5 controlled trials, including randomized controlled trials and quasi-experimental designs, were included in this narrative review analysis.

Findings: Multiple balance focused interventions including psychomotor programs, virtual reality, short session of hippotherapy and therapeutic horseback riding showed consistent improvement in CoP measures and other parameters associated with posture and balance in children and youth with autism.

Conclusion: Structured, individualized balance intervention programs support autistic population in their balance improvement and rehabilitation. Despite the positive correlation seen in all these experiments, study heterogeneity and limited number of strictly experimental studies focused on CoP metrics for postural sway in autistic children in the given time period are clear limitations which must be considered for future studies.

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by social communication issues and repetitive behaviors with an estimated prevalence of 1 in 40, characterized by impairments in communication, social reciprocity, and repetitive behaviors(6). The symptoms may also include motor impairments, especially common among autistic children and youth are balance and postural control deficits which negatively impact their daily participation (1, 2). A meta-analytic review of 15 balance intervention studies in children and adolescents with ASD reported a large positive effect of balance-focused interventions on standardized balance performance scores, indicating that balance is a motor skill highly responsive to targeted training in autistic population, although methodological differences across studies warrant cautious interpretation (7). These deficits may stem from altered sensory integration, vestibular dysfunction, or poor neuromuscular coordination in them. Furthermore, meta-analytic evidence indicates that exercise-based interventions, including structured balance and motor training, produce meaningful improvements in balance and related motor outcomes in children with ASD, highlighting the potential efficacy of therapeutic physical activity in this population (8). In this regard, the outcome variable of Center of Pressure (CoP) measures from force plate analysis provide objective, quantitative data on postural sway and serve as primary outcome measures in research studies focused on

3. RESULTS

Table 1 summarizes the characteristics and findings of the 5 controlled trials included in this review.

Table 1: Summary of Controlled Trials on Balance Training in ASD Measuring CoP

Authors & Year	Sample	Intervention	Duration	Outcome	Key Findings
----------------	--------	--------------	----------	---------	--------------

balance training. From the perspective of physiotherapy practice, center of pressure (CoP) parameters provides clinically meaningful insights into posture and balance impairments, which are commonly targeted areas during neurorehabilitation of pediatric population(1). Beyond the traditional clinical setups, multisensory interventions such as hippotherapy using horse movements, have gained attention due to their ability to provide rhythmic, three-dimensional pelvic motions that mimic pelvic movements during normal human gait cycle. This may eventually help in stabilizing postural sway in children with ASD. (3, 5)

2. METHODS

A structured literature search was conducted across databases including PubMed, Scopus, and Google Scholar using keywords such as "autism," "balance training," and "postural control" and "CoP" using Boolean operators "And" and "Or". Initially, total 13 studies were screened, that included case reports, observational studies, clinical trials, both experimental and quasi-experimental studies and systematic reviews. After applying the strict **inclusion criteria** of including only experimental studies a total of 5 intervention-based studies, 2 experimental (2, 4) and 3 quasi-experimental studies (1, 3, 5) published between the duration of 2020 and 2025 were included in the narrative review. These studies focused on pediatric population or youth with ASD populations. Studies that did not include CoP metrics as outcome variable to assess postural sway were excluded.

Authors & Year	Sample	Intervention	Duration	Outcome	Key Findings
Hassen et al., 2023 (1)	30	Psychomotor training	9 weeks	CoP area/velocity	Improved static postural control
Caldani et al., 2020 (2)	20	Postural training (VR)	4 weeks	CoP Area	Improved postural stability
Coccia et al., 2025 (3)	120	Hippotherapy (HPOT)	30-min session	CoP Displacement	Immediate reduction in sway
Falivene et al., 2025 (4)	20	Immersive VR (GRAIL)	5 weeks	CoP; MABC-2	Reduced sway; improved motor skills
Vives-Villarraig et al., 2025 (5)	9	Horseback riding	3-9 months	CoP velocity	Improved postural control

4. DISCUSSION

This review highlights the efficacy of different types of balance training including land-based psychomotor training, virtual reality, and horseback riding in improving balance control and function mobility in children and youth with ASD. Results across these studies consistently show a positive correlation between these interventions and Centre of Pressure measures. These findings are consistent with the preliminary case-report evidence of Jabouille et al., who demonstrated that highly individualized or tailored balance training programs can lead to substantial reductions in postural sway even within short intervention periods, despite very small sample sizes, highlighting the responsiveness of balance control systems in children with ASD (9). The findings from Coccia et al. (2025) are particularly notable due to the immediate reduction in CoP displacement following only a single 30-minute short hippotherapy session. This suggests that the vestibular and proprioceptive input provided by the horse's movement can rapidly modulate the sensory-motor systems responsible for

balance in the autistic population(3). There was a visible decrease in postural sway and improved motor control in some. The objective nature of CoP metrics is vital for the accurate assessment of the efficacy of such balance targeted rehabilitative protocols(4).

Limitations: The current evidence is limited by number of experimental studies available with CoP as variable outcome to measure postural sway in children with ASD during the time interval from 2020-2025 and many studies have very short follow-up periods. A recent systematic review of postural balance control interventions in individuals with ASD noted that while a wide variety of sensorimotor and physical activity programs appear to benefit postural control, the overall evidence is limited by small sample sizes, methodological variability, and a lack of large-scale randomized trials, indicating the need for more rigorous studies with population-specific outcome measures to strengthen the evidence base for balance interventions in this population (10). Furthermore, the 5 studies included in this narrative review show a heterogeneity in

protocols and types of intervention, which highlights the need for standardized intervention guidelines in future studies.

5. CONCLUSION

Balance training is an essential part of postural rehabilitation and balance training for children and youth with ASD. Evidence from latest controlled trials (2020–2025) shows marked improvements in CoP metrics, functional mobility, and overall social participation in autistic population. While immediate balance improvements were observed in hippotherapy protocols, further research is required to determine if these gains in CoP stability are maintained long-term or if frequent 'booster' sessions are necessary to sustain the improvement in postural control. (3, 5) Future research should prioritize large-scale, well-controlled trials using standardized protocols to establish definitive clinical guidelines.

REFERENCES

1. Ben Hassen I, Abid R, Ben Waer F, Masmoudi L, Sahli S, Driss T, et al. Intervention Based on Psychomotor Rehabilitation in Children with Autism Spectrum Disorder ASD: Effect on Postural Control and Sensory Integration. *Children (Basel)*. 2023;10(9).
2. Caldani S, Atzori P, Peyre H, Delorme R, Bucci MP. Short rehabilitation training program may improve postural control in children with autism spectrum disorders: preliminary evidences. *Sci Rep*. 2020;10(1):7917.
3. de Fátima Coccia V, Rodacki ALF, Pavão SL. Immediate effects of a 30-min hippotherapy session on center of pressure displacement in children with autism spectrum disorder: A quasi-experimental study. *J Bodyw Mov Ther*. 2025;44:190-9.
4. Falivene A, Scaccabarozzi G, Busti Ceccarelli S, Molteni M, Klingels K, Verbecque E, et al. Virtual Reality-Based Postural Balance Training in Autistic Children: A Pilot Randomized Controlled Trial. *Journal of Clinical Medicine*. 2025;14(16):5616.
5. Vives-Vilarroig J, Ruiz-Bernardo P, García-Gómez A. Effects of Horseback Riding on the Postural Control of Autistic Children: A Multiple Baseline Across-subjects Design. *J Autism Dev Disord*. 2025;55(2):510-23.
6. Kogan MD, Vladutiu CJ, Schieve LA, Ghandour RM, Blumberg SJ, Zablotsky B, et al. The Prevalence of Parent-Reported Autism Spectrum Disorder Among US Children. *Pediatrics*. 2018;142(6).
7. Djordjević M, Memisevic H, Potic S, Djuric U. Exercise-Based Interventions Aimed at Improving Balance in Children with Autism Spectrum Disorder: A Meta-Analysis. *Percept Mot Skills*. 2022;129(1):90-119.
8. Li H, Zhang R. The effect of exercise intervention on balance and executive function in children with autism spectrum disorder: a meta-analysis. *BMC Sports Science, Medicine and Rehabilitation*. 2025;17(1):80.
9. Jabouille F, Billot M, Hermand E, Lemonnier E, Perrochon A. Balance rehabilitation for postural control in children with Autism Spectrum Disorder: A two-case report study. *Physiother Theory Pract*. 2023;39(3):658-66.
10. Date S, Munn E, Frey GC. Postural balance control interventions in autism spectrum disorder (ASD): A systematic review. *Gait & Posture*. 2024;109:170-82.