

Impact of Sensory-based Therapy on problems with balance in children with Cerebral Palsy -A systematic review

Anjali Gusain¹, Prof. (Dr.) Surendra Kumar Meena^{2*}, Simanta Buragohain³

¹ PG Scholar, Vivekananda Global University, Jaipur, Rajasthan

^{2*} Dean, Faculty of Physiotherapy and Occupational Therapy, Vivekananda Global University, Jaipur, Rajasthan

³ Assistant Professor, Faculty of Physiotherapy and Occupational Therapy, Vivekananda Global University, Jaipur, Rajasthan

*Correspondence Author: Prof. (Dr.) Surendra Kumar Meena

Abstract

Objective: This systematic review and meta-analysis aimed to evaluate the efficacy of Sensory Integration Therapy (SIT) in ameliorating balance dysfunctions in pediatric populations with Cerebral Palsy (CP).

Methods: An exhaustive literature search was conducted through several prominent scientific databases, including PubMed, Web of Science, Google Scholar, and Scopus, until April 2026. The inclusion criteria targeted studies on sensory integration therapy in children under 18 years diagnosed with CP. **Results:** Seven randomized controlled trials were selected, encompassing 203 children with CP. The interventions predominantly utilized SIT, focusing on enhancing sensorimotor integration. The findings reveal that sensory-based interventions significantly boost gross motor capabilities and skills, contributing to improved functional mobility and quality of life in children with CP. **Conclusion:** Sensory-based interventions are efficacious in correcting balance impairments in children with CP. Their integration into comprehensive rehabilitative frameworks is recommended to foster functional autonomy and augment overall developmental outcomes.

Keywords: Cerebral Palsy, Sensory integration therapy, GMFM, Balance, Systematic review

How to cite this article: Gusain A, Meena SK, Buragohain S. Impact of Sensory-based Therapy on Problems with Balance in Children with Cerebral Palsy - A Systematic Review. *Int J Drug Deliv Technol.* 2026;16(61s):1168-1171. DOI: 10.25258/ijddt.16.61s.133

Source of support: Nil.

Conflict of interest: None

1. Introduction

Cerebral palsy (CP) is one of the foremost causes of chronic disability among the pediatric population, associated not only with neuromuscular impairments with abnormal range of postural and movement disorders, but also alteration in sensory processes. These neuromuscular impairments often contribute to sensory processing deficits, which can affect child's motor planning and coordination and result in difficulty in executing day-to-day activities [1]. About 45% children with CP presents with white matter lesion which affects the development of thalamocortical projection responsible for abnormalities in sensory processing mechanisms [2]. During normal development, registration, modulation, and internal organisation of different afferent inputs by the CNS determine the success of performance in the daily task and thereby facilitate the purposefulness of the child [3].

According to population-based research, the global estimated prevalence of CP ranges from 1-4 per 1000 live births, and in India, the estimated prevalence is 2.95 per 1000 children [4]. Spastic CP is the most frequent motor type of CP, comprising 70% to 80% of children. As per the clinical classification, spastic CP can be bilateral (diplegia and quadriplegia) and unilateral

(hemiplegia) [5]. Children with spastic CP often experience sensory processing difficulties due to underlying neurological impairments like muscle stiffness and increased muscle tone that affect their motor functions, influencing their functional performance [6]. Children with CP also classified as per their motor functioning skills using Gross Motor Function Classification System (GMFCS) [7]. Pavao et al. conducted a literature review focusing on how alterations in sensory information affect postural stabilization in children with CP. They examined various studies addressing the significance of visual information and proprioceptive input as crucial regulatory factors in the postural control of these children [10]. Studies integrating sensory therapy in rehabilitation protocol for these children showed constructive impression for their efficacy [11]. This draws attention to the implementation of sensory based therapies in rehabilitation of these children. Therefore, the present study was undertaken to thoroughly analyzed the literature on how sensory based interventions impact the balance and posture in children with CP.

2. Materials and Method

*Author for Correspondence: : surendra.meena@vgu.ac.in

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement served as the direction for this meta-analytical systematic review [12].

2.1 Literature search

PubMed, Web of Science, Google Scholar, and Scopus databases preprint server were used to identify relevant studies till July 2024 with proper MeSH terms. The MeSH phrases or keywords with Boolean operators were used as following: "Cerebral Palsy" OR "balance" AND "sensory intervention" OR "sensory integration" AND "GMFM" OR "Pediatric balance". This study was carried out in accordance with the PRISMA [12].

2.2 Eligibility criteria

To define the inclusion criteria, the Participants, Interventions, Comparisons, Outcome and Study (PICOS) design model was applied.

Population

We included children with CP, from both sexes, aged less than 18 years. We excluded studies that assessed children with both CP and other neurological disorders in the same group.

Intervention

The main intervention was Sensory Integration Therapy (SIT). Sensory integration is a concept and treatment method that is most commonly utilised to address sensory processing issues in individuals, particularly those with sensory processing disorders. Sensory integration treatment, help people understand and respond to sensory information in their environment more efficiently.

Comparator

The comparator was standard physiotherapy treatment based on the Neuro Developmental Treatment (NDT) principles. We also covered strategies that use physical activities and exercises to maintain, improve, and restore physical, social and psychological well-being of the child [15]. We excluded studies that: did not apply any kind of treatment to the control group; or did not

clearly describe that the control group received standard physiotherapy treatment.

Outcome measures

We included studies that assessed either gross motor function or functional balance using standardized and valid measures.

Study type

The type of study included were randomized and crossover-controlled trials. We excluded studies involving a case report, non-RCTs, abstracts, systematic reviews, literature reviews, and conference papers.

2.2 Quality Assessment

The quality of the pertinent research was assessed using the Physiotherapy Evidence Database (Pedro) scale, a 10-item rating system designed to evaluate the internal validity of randomized controlled trials [16].

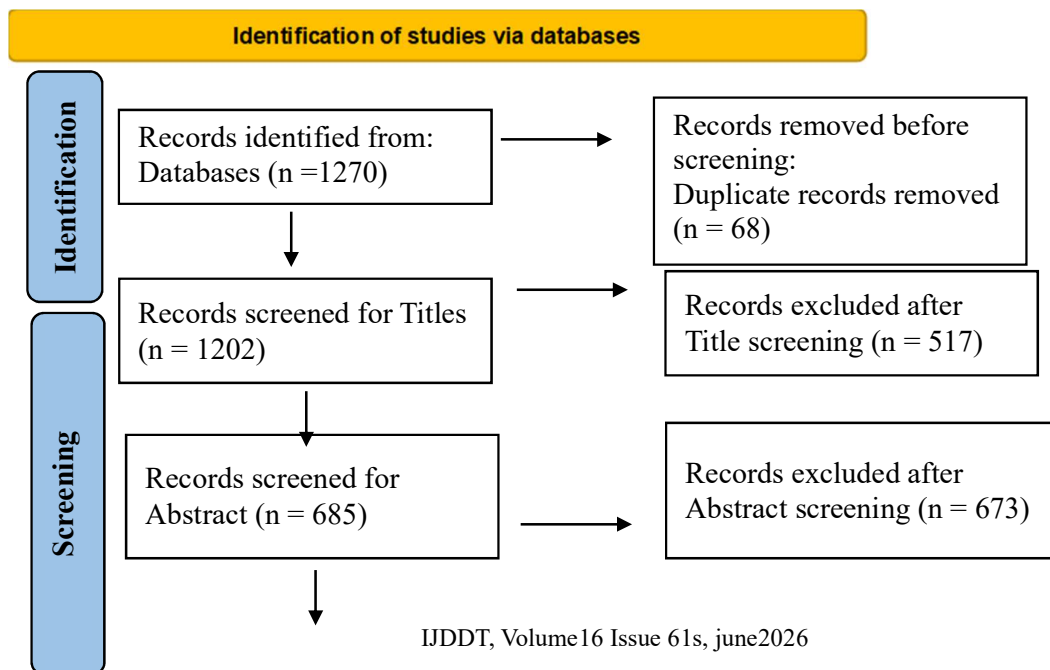
2.3 Data Extraction

The review authors extracted pertinent data from each study group both pre- and post-intervention for use in the outcome measures. Data were represented as means, p-values, standard deviations, and, where accessible, 95% confidence intervals (CI).

3. Results

3.1 Study Selection

In the initial search, 1,270 studies were found and after removing duplicates (n = 68); 1,202 studies were screened on the basis of title. After the titles screening (n = 517); 685 studies in total were subjected to abstract screening. Further screening based on the abstracts (n = 673); 12 studies were determined to be relevant. Furthermore, 12 studies' full texts were obtained; following a thorough assessment, 7 studies were determined to be pertinent for the quantitative analysis in accordance with the goals and objectives of the current investigation. Figure 1 displays the PRISMA flow chart that includes the systematic screening and selection of studies [19-25]. There were 203 children with CP included in the study for further analysis. Table 1 compiles the characteristics of the included studies.



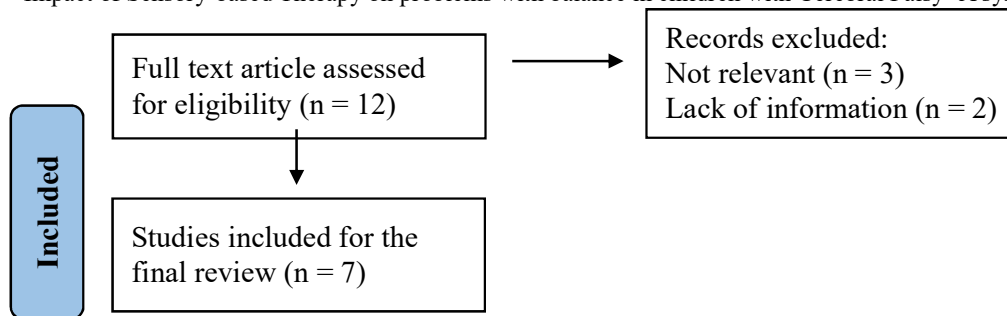


Figure 1. Prisma Chart

3.2. PEDro Quality assessment

The methodological quality of seven studies was assessed using the PEDro criteria, which encompass aspects such as eligibility criteria, randomization, allocation concealment, baseline comparability, blinding of subjects, assessors, and therapists, dropout rates, intention-to-treat analysis, between-group analysis, and measurement of variability. The results obtained from PEDro scores ranging from 6 to 9 for the included studies (Table 2). Highest score was observed in three studies [22-24] and lowest was also detected in three studies [19, 21, 25].

3.4.2 Pediatric Balance Scale (PBS)

For the PBS, three randomized trials were analyzed, including a total of 100 participants. The MD for functional balance improvements was 6.28, with a CI from 0.74 to 11.81, demonstrating a significant positive effect of the interventions (Figure 3). The results provide strong foundation for recommending these therapies as part of comprehensive rehabilitation programs aimed at improving motor functions and overall quality of life for children with CP.

4. Discussion

The main objective of this systematic review and meta-analysis was to verify if SIT with standard physiotherapy treatment improves gross motor function and functional balance of children with CP when compared with standard physiotherapy alone. We included seven studies in the meta-analysis. SIT showed significant improvement to standard physiotherapy alone for the gross motor function and functional balance in children with CP. Furthermore, improvement was observed in other parameters as well, such as gait, muscle strength, posture, trunk abdominal strength, sensory function, but these were outside the scope of this systematic review and meta-analysis.

4.2 Effect on Functional Balance

Out of the included seven studies only three studies examined the effect of SIT on functional balance using PBS. Studies conducted by Raipure et al. (2023) [19] and Malwade et al. (2020) [21] showed significant difference between SIT and standard physiotherapy treatment on PBS parameters. In the study conducted by Reddy et al. (2021) [20] showed no significant difference on PBS between the SIT and the standard physiotherapy treatment.

5. Conclusion

SIT though is not a new rehabilitation approach but its efficacy in children with CP is a recent rehabilitation approach. SIT showed superior results in children with CP, particularly in enhancing balance and motor skills, likely due to its focus on integrating sensory inputs, which enhances neural plasticity and improves motor planning. Physiologically, these therapies contribute to better proprioceptive feedback, muscle tone normalization, and motor control, leading to significant functional gains. The findings suggest that incorporating SIT into rehabilitation programs can optimize motor outcomes and overall quality of life for children with CP.

6. Declarations

Funding: This research received no funding.

Conflicts of Interest: The authors declare no conflict of interest.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

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