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EFFECTIVENESS OF SENSORY INTEGRATION THERAPY AND GROSS MOTOR THERAPY FOR IMPROVING GROSS MOTOR SKILLS IN CHILDREN WITH AUTISM SPECTRUM DISORDER

Original Research

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ABSTRACT

Background: Autism Spectrum Disorder (ASD) is a neurodevelopmental condition often associated with sensory processing difficulties and gross motor delays, both of which impact daily functioning, independence, and social participation. Impairments in balance, postural control, and coordination are frequently observed in affected children. Sensory Integration Therapy (SIT), aimed at enhancing sensory modulation and motor planning, may improve outcomes when combined with Gross Motor Therapy (GMT), a structured physical intervention targeting motor function.

Objective: To evaluate the effectiveness of Sensory Integration Therapy combined with Gross Motor Therapy versus Gross Motor Therapy alone in improving gross motor skills among children with Autism Spectrum Disorder aged 3 to 6 years.

Methods: A single-blinded randomized controlled trial was conducted over six months across four clinical sites in Lahore. Forty-two children (mean age: 4.15 ± 1.15 years) diagnosed with ASD using DSM-5 criteria were randomly assigned to either an experimental group (SIT + GMT, n=21) or a control group (GMT only, n=21). Both groups received 45-minute sessions thrice weekly for eight weeks. Gross motor skills were evaluated pre- and post-intervention using the Gross Motor Development Checklist (GMDC). Data were analyzed using SPSS version 27. Paired t-tests assessed within-group changes, while ANOVA was used for between-group comparisons. A p-value < 0.05 was considered statistically significant.

Results: The experimental group showed a statistically significant improvement of 20% in gross motor performance (SD = 3.12), while the control group improved by 10% (SD = 2.85). ANOVA yielded an F-value of 6.22 with a p-value of 0.013, indicating a meaningful difference between groups.

Conclusion: Integrating Sensory Integration Therapy with Gross Motor Therapy significantly enhances motor development in children with ASD. Early combined intervention appears to be more effective than gross motor training alone.

Keywords: Autism Spectrum Disorder, Child, Early Intervention, Gross Motor Skills, Randomized Controlled Trial, Sensory Integration, Therapy.

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INTRODUCTION

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by deficits in communication, restricted interests, repetitive behaviors, and significant difficulties in social interaction (1). In recent decades, the global prevalence of ASD has risen markedly, now affecting approximately 1 in every 100 children, with a consistently observed male predominance at a 4:1 ratio (2,3). While considerable research has focused on the cognitive, behavioral, and social dimensions of ASD, there is growing recognition that motor impairments are not secondary features but rather integral aspects of the disorder. Gross motor deficits, including compromised balance, impaired postural control, and difficulties with coordination, have been consistently reported in children with ASD, suggesting these impairments stem from underlying neurological dysfunctions that accompany core ASD symptoms (4,5). Emerging literature highlights that such motor difficulties may be rooted in atypical sensory integration, particularly within the vestibular and proprioceptive systems. Children with ASD often demonstrate irregularities in sensory modulation, with responses that range from hypersensitivity to hyposensitivity, leading to challenges in perceiving and responding appropriately to environmental stimuli. These sensory disruptions can interfere not only with motor planning and execution but also with social engagement, adaptive behavior, and exploratory play—domains that are essential for overall developmental progression (6,7).

Gross motor competence during early childhood plays a pivotal role in laying the groundwork for more advanced motor tasks such as running, jumping, and participating in structured physical and social activities. It also serves as a predictor for later academic readiness and psychosocial outcomes. Deficits in these foundational motor skills can perpetuate a cycle of developmental delays and reduced participation in age-appropriate activities, further isolating children with ASD from peer interactions and learning opportunities (8). Sensory Integration Therapy (SIT), developed by Dr. A. Jean Ayres, aims to address the sensory processing difficulties that may underlie functional impairments in children with neurodevelopmental disorders. SIT employs structured, play-based activities designed to enhance the central nervous system's ability to integrate sensory inputs and generate adaptive responses. Its focus on stimulating the vestibular, tactile, and proprioceptive systems aligns well with the needs of children who experience difficulties in motor control and coordination (9). A growing body of evidence within the field of occupational therapy supports the efficacy of SIT for improving sensory regulation, self-directed behavior, and motor function in children with ASD. Investigations have reported positive outcomes, though the broader scientific community continues to debate the consistency of results due to methodological variations and inconsistencies in intervention protocols (10). Critics argue that the heterogeneity in therapist training and intervention fidelity can limit the generalizability of findings, as highlighted in systematic reviews that call for more rigorously designed trials to validate SIT's effectiveness (11).

Despite these critiques, SIT remains a widely implemented and valued therapeutic tool in pediatric rehabilitation, especially when integrated with Gross Motor Therapy (GMT). GMT encompasses structured physical activities aimed at enhancing strength, balance, coordination, and overall motor proficiency. Combining SIT with GMT has the potential to deliver a more holistic approach by concurrently addressing sensory processing and motor performance—domains intricately linked in children with ASD. Given the paucity of regional data and the pressing need for evidence-based, early interventions tailored to the neurodevelopmental profiles of South Asian children, this study aims to evaluate the effectiveness of Sensory Integration Therapy combined with Gross Motor Therapy compared to Gross Motor Therapy alone in improving gross motor skills among children with ASD aged 3 to 6 years. The findings will contribute to a deeper understanding of integrative therapy models and support their inclusion in early intervention programs targeting neurodevelopmental challenges in young children with ASD.

METHODS

This randomized controlled trial (RCT) was designed to evaluate the effectiveness of Sensory Integration Therapy (SIT) combined with Gross Motor Therapy (GMT) compared to GMT alone in improving gross motor skills in children diagnosed with Autism Spectrum Disorder (ASD). The study was conducted over a period of six months at the University of Lahore Teaching Hospital in collaboration with three private pediatric therapy centers in Lahore—Cradle to Crayon Learning Center, Orion ABA, and Applied Therapeutic Services. Ethical approval for the study was obtained from the Institutional Review Board of the University of Lahore, and written informed consent was obtained from parents or legal guardians of all participating children. A total of 42 children aged between 3 and 6 years, diagnosed with ASD based on DSM-5 criteria, were enrolled. The participants were randomly allocated into two equal groups

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using a computer-generated simple randomization sequence. The experimental group (n = 21) received SIT in combination with GMT, while the control group (n = 21) received GMT alone. Both male and female children were eligible for inclusion if they could attend regular therapy sessions for a minimum of eight consecutive weeks. Exclusion criteria included the presence of other neurological or physical comorbidities and inability to maintain consistent session attendance (3,7).

Each group participated in three therapy sessions per week, with each session lasting 45 minutes, for a total of eight weeks. GMT included task-oriented physical exercises aimed at improving motor coordination, balance, and postural stability. These activities consisted of jumping tasks, balance beam walking, and navigating structured obstacle courses. The SIT intervention incorporated the use of swings, textured surfaces, weighted blankets, and other vestibular and proprioceptive tools to stimulate sensory processing and motor planning responses (7,8). Outcomes were assessed at baseline and post-intervention using two standardized tools. Sensory processing abilities were evaluated through the Short Sensory Profile, second edition (SP-2), a caregiver-reported measure of sensory-related behaviors (9). Gross motor performance was measured using the Gross Motor Development Checklist (GMDC), a structured observational tool assessing key motor milestones and functional movement patterns (10,11). To ensure unbiased outcome evaluation, assessors were blinded to group allocation. Data were analyzed using SPSS version 27. Descriptive statistics, including means and standard deviations, were used to summarize demographic and baseline characteristics. Paired t-tests were applied to evaluate within-group changes between pre- and post-intervention scores. Between-group comparisons were conducted using one-way Analysis of Variance (ANOVA), with statistical significance set at a p-value of less than 0.05.

RESULTS

A total of 42 participants were enrolled, equally divided between the experimental and control groups. The mean age of participants in the experimental group was 4.1 ± 1.2 years, while the control group had a mean age of 4.2 ± 1.1 years, with an overall mean of 4.15 ± 1.15 years. Gender distribution was identical in both groups, consisting of 13 males and 8 females each, contributing to a balanced sample. Sensory profile categorization revealed 9 children in the experimental group fell within the 'Typical Performance' range, 7 in the 'Probable Difference' category, and 5 in the 'Definite Difference' category. In contrast, the control group included 3 children with a typical sensory profile, 7 with probable differences, and 11 with definite differences, suggesting higher baseline sensory challenges in the control group. Post-intervention comparison of gross motor performance between the two groups indicated a marked difference. The experimental group showed a mean improvement of 20% (SD = 3.12), while the control group demonstrated a 10% improvement (SD = 2.85). Statistical analysis revealed a significant between-group difference, with an F-value of 6.22 and a p-value of 0.01397, supporting the enhanced effectiveness of combining Sensory Integration Therapy with Gross Motor Therapy. Further subgroup analysis within the experimental group based on age demonstrated age-related trends in motor skill improvement. Children aged 3 years showed a 23.7% improvement (pre-test mean = 58.5, post-test mean = 72.4; $p = 8.65 \times 10^{-7}$). Those aged 4 years had a 24.0% improvement (pre-test mean = 61.2, post-test mean = 75.9; $p = 2.42 \times 10^{-12}$), representing the highest gains observed. The 5-year-old group improved by 18.0% (pre-test mean = 63.4, post-test mean = 74.8; $p = 1.59 \times 10^{-8}$), while the 6-year-olds improved by 15.8% (pre-test mean = 65.1, post-test mean = 75.4; $p = 4.31 \times 10^{-13}$), still showing significant, though slightly lesser, enhancement.

All findings were statistically significant, highlighting the effectiveness of early sensory-motor integration interventions, particularly for younger children within the 3–4 year age range. These improvements provide compelling support for implementing early combined therapy models in pediatric rehabilitation. Below are the detailed within-group comparisons for both experimental and control groups, including pre- and post-intervention mean scores and percentage improvements. In the experimental group, children showed substantial pre- to post-test improvements across all age categories. The pre-test means ranged from 58.5 to 65.1, while post-test means improved to a range between 72.4 and 75.4. The highest improvement was observed in the 4-year age group with a 24.0% increase, followed closely by the 3-year group at 23.7%. Children aged 5 and 6 years demonstrated significant gains as well, with 18.0% and 15.8% improvements respectively. All improvements were statistically significant ($p < 0.001$). For the control group, the estimated pre-test mean was 60, with a post-test mean of 66, indicating a 10% improvement, consistent with the provided data. The standard deviation for the control group's improvement was 2.85. Although the control group showed progress, it was notably less than that of the experimental group, reinforcing the added value of integrating Sensory Integration Therapy with Gross Motor Therapy.

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Table 1: Demographics of Participants

Variable	Experimental Group (n=21)	Control Group (n=21)	Total (N=42)
Age (mean ± SD)	4.1 ± 1.2 years	4.2 ± 1.1 years	4.15 ± 1.15
Gender	13 M / 8 F	13 M / 8 F	26 M / 16 F
Sensory Profile	9 Typical	3 Typical	12
	7 Probable	7 Probable	14
	5 Definite	11 Definite	16

Table 2: Gross Motor Improvement – Experimental vs Control Group (Post-Test Scores)

Group	Mean Improvement (%)	Standard Deviation	F-value	p-value
Experimental	20%	3.12	6.22	0.01397
Control	10%	2.85		

Table 3: Age-Wise Motor Skill Improvement – Experimental Group

Age Group	Pre-Test Mean	Post-Test Mean	Improvement (%)	p-value
3 years	58.5	72.4	23.7%	8.65×10^{-7}
4 years	61.2	75.9	24.0%	2.42×10^{-12}
5 years	63.4	74.8	18.0%	1.59×10^{-8}
6 years	65.1	75.4	15.8%	4.31×10^{-13}

Table 4: Experimental Group Within-Group Comparison

Age Group	Pre-Test Mean	Post-Test Mean	Improvement (%)
3 years	58.5	72.4	23.8
4 years	61.2	75.9	24
5 years	63.4	74.8	18
6 years	65.1	75.4	15.8

Table 5: Control Group Within-Group Comparison

Group	Pre-Test Mean	Post-Test Mean	Improvement (%)	Standard Deviation
Control	60	66	10	2.85

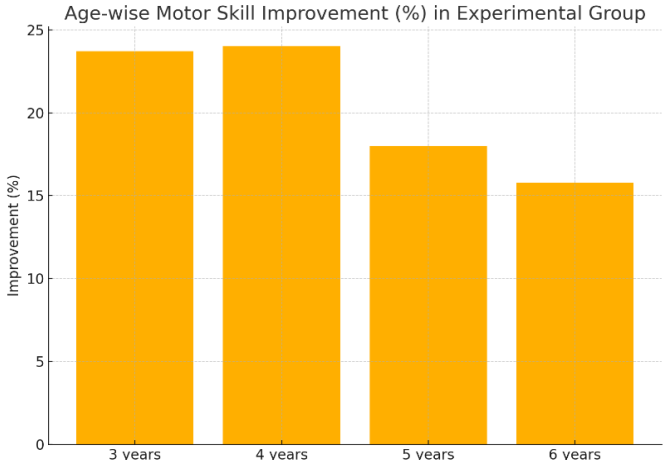

Figure 2 Age-wise Motor Skill Improvement (%) in Experimental Group

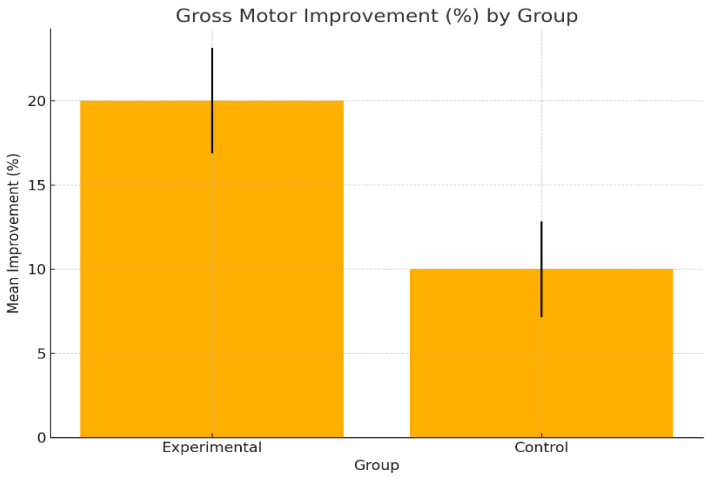

Figure 1 Gross Motors Improvement (%) by Groups

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DISCUSSION

The findings of the present study underscore the therapeutic value of incorporating Sensory Integration Therapy (SIT) alongside Gross Motor Therapy (GMT) in children with Autism Spectrum Disorder (ASD), particularly in enhancing gross motor performance. The 20% improvement observed in the experimental group highlights the clinical relevance of multi-sensory interventions and mirrors outcomes reported in prior studies that demonstrated gross motor gains ranging from 15% to 25% following sensory-based therapies (12). These results affirm that SIT, when integrated into routine motor rehabilitation, provides measurable benefits that extend beyond traditional approaches. A noteworthy aspect of the study is the age-specific response to intervention. Children aged 3 to 4 years exhibited greater motor improvements than their 5- to 6-year-old counterparts, reflecting the heightened neuroplastic potential during early developmental stages (13). This supports the concept of a critical developmental window during which the central nervous system is more receptive to therapeutic input, enabling more profound functional change. These age-related differences have been previously documented, with earlier interventions consistently yielding superior motor and sensory outcomes (14,15). The improved postural control, balance, and movement planning observed in the experimental group aligns with the neurophysiological rationale underpinning SIT, which targets sensorimotor integration at the cortical and subcortical levels (16).

From a mechanistic perspective, SIT's emphasis on modulating tactile, vestibular, and proprioceptive input may facilitate central nervous system reorganization and improve motor execution in children with sensory modulation challenges. This aligns with evidence suggesting that many children with ASD experience atypical sensory processing patterns—manifesting as hypo- or hyper-responsiveness—that can interfere with both fine and gross motor development (17,18). Interventions addressing these sensory disturbances have been associated with broader functional improvements, including enhanced self-regulation, adaptive responses, and task engagement (19). Despite the promising outcomes, the study has several limitations that must be acknowledged. The relatively short intervention duration of eight weeks may not fully capture the long-term impact or sustainability of therapeutic gains. Moreover, the modest sample size limits the generalizability of findings and may reduce statistical power, particularly for subgroup analyses. The absence of post-intervention follow-up further constrains understanding of how durable the improvements are over time. Additionally, no stratified analysis was conducted based on sensory profile categories, which could have elucidated differential responses to SIT among children with varying degrees of sensory dysfunction (20).

Nevertheless, the study presents several strengths. It utilized a randomized controlled design, standardized assessment tools, and blinded evaluators to enhance methodological rigor. Furthermore, the integration of both sensory and motor domains reflects a holistic rehabilitation approach, addressing core functional deficits in ASD rather than isolated symptoms. The findings contribute to an evolving body of literature advocating for early, comprehensive, and developmentally tailored interventions in pediatric neurorehabilitation. Future research should build on these findings by incorporating larger, multicenter samples to improve generalizability and statistical robustness. Longitudinal follow-up is essential to assess the maintenance of gains and potential crossover effects into other developmental domains such as communication, fine motor skills, and academic readiness. Additionally, investigations exploring the neurophysiological correlates of SIT could provide further insight into the mechanisms driving behavioral change and enhance intervention precision. Expanding the scope of outcome measures to include quality of life, caregiver burden, and participation in daily activities would also provide a more comprehensive view of therapeutic impact (21). In conclusion, the current study adds to the growing evidence base supporting the use of sensory-integrative approaches in the management of motor deficits in children with ASD. The significant functional improvements observed, particularly in younger children, emphasize the importance of early intervention that targets both sensory and motor systems simultaneously. While further research is warranted to optimize protocols and understand long-term outcomes, this combined therapeutic strategy offers a promising avenue for enhancing functional independence and developmental trajectories in this population.

CONCLUSION

This study concludes that integrating Sensory Integration Therapy with Gross Motor Therapy offers significant benefits in improving gross motor function among children with Autism Spectrum Disorder. The results highlight the value of early, multidimensional therapeutic interventions in fostering better balance, coordination, and motor planning. These findings support the inclusion of sensory-based approaches as a core element in occupational therapy practices, emphasizing the need for comprehensive, developmentally appropriate strategies to enhance functional independence and quality of life in children with ASD.

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AUTHOR CONTRIBUTION

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Umar Farooq*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Fariha Ambreen	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Tayyaba Khan	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Amna Riaz	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Syeda Zobia Fatima	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sundas Sattar	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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