

Minds in motion: Integrating Motor skills and Communication for ASD success in Children

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Abstract

Objective: To know the existing interventions for enhancing motor skills and reducing hyperactivity, social and communication needs for children with autism spectrum disorders (ASD)

Methods: Search in PubMed, Scopus, Web of Science databases was conducted with key words (“child” OR “paediatrics”), “Children diagnosed with ASD”, “Sensory Processing” “Sensory Modulation” search for relevant articles. The chosen terms were based on a preliminary review of the most employed terms in studies using tools. The search strategy and the chosen keywords were developed and revised to generate articles which were pertinent to the objectives of the study.

Results: This article reviews recent studies on various interventions aimed at enhancing motor activity in children with ASD, focusing on therapeutic approaches, technology integration, and complementary therapies. Motor Skill Occupational Therapy (MOTION-ASD) combined with Cognitive Orientation Exercise focused on activities designed to improve specific motor skills, including both gross motor skills (large muscle movements like running, jumping, and climbing) and fine motor skills (smaller movements like grasping, manipulating objects, and hand-eye coordination). Various searches also generated articles the effectiveness of joint attention training in improving key communication skills in children.

Conclusion: The purpose of this article was to identify early childhood interventions existing for enhancement of motor skills, social and communication skill of ASD children that contemplates routine and natural contexts. The improvements in motor and social interaction are promising, future research could investigate the effectiveness of such interventions in less structured environments and examine how peer dynamics influence the generalization of skills across different social settings. There is also a need for research with a more rigorous design to contribute to a deeper understanding of how these interventions can be optimized and applied more broadly to benefit children with ASD.

Keywords: Autism spectrum disorder; motor skills; social communication deficits; sensory integration; early intervention; occupational therapy

How to cite this article: Guha R, Joshi SG. Minds in motion: Integrating Motor skills and Communication for ASD success in Children. *Int J Drug Deliv Technol.* 2026;16(61s):1493-1500. DOI: 10.25258/ijddt.16.61s.168

Source of support: Nil.

Conflict of interest: None

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition which occurs prior to the age of 3 yrs that impacts social communication, behaviour, and motor skills. There are yet no scientific evidences which specifies the underlying causes of autism but it is stated in few literature it occurs due to the combination of gene and environmental factors.¹The Ayres Sensory Integration states that brain processes sensory input which produces desired motor and behavioural responses.² India, with population of more than 1.4 billion, prevalence of autism is also increasing. However many barriers like delayed diagnosis, social stigma, and limited diagnostic facilities lead to underreporting. The prevalence of autism in India vary widely, influenced by disparities of various regions, non-standardized diagnostic practices, and a lack of research work in rural areas. Various programmes are ongoing to enhance awareness, improve diagnostic resources, and develop early

intervention programs. Prevalence of autism in India is very challenging, which underscores the need for national surveys and strong healthcare infrastructure to support individuals with ASD and their families. World Health Organization (WHO) estimates that almost 1 in 100 children (1%) is affected with Autism Spectrum Disorder globally. In the year 2023 the Centres for Disease Control and Prevention (CDC) reported the prevalence of ASD is 1 in 36 children. Bundy and Lane have highlighted two main constructs: sensory modulation dysfunction and dyspraxia (sensory discrimination/praxis deficits).³ Sensory modulation dysfunction, also known as sensory reactivity dysfunction, refers to exaggerated (either hyper-reactive or hypo-reactive) responses to sensation which interfere with engagement in daily activities.³ Dyspraxia refers to difficulty planning new motor actions and is thought to be associated with deficits in vestibular, proprioceptive, or tactile discrimination.

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High prevalence of motor, social and communication difficulties have been documented among children with developmental disabilities. Research suggests that approximately 96% of children are with autism spectrum disorder (ASD) experience motor impairments. Development is continually shaped by interactions between child and their environment. So effective interventions should integrate bottom-up approach, the focus is on underlying sensory and motor components with meaningful activities and daily routines. Early identification and intervention play a vital role in improving the outcomes for children with developmental delays and disorders. Cognitive, social, language outcomes can be significantly improved by early initiation of early intervention as mentioned in Indian Council of Medical Research (ICMR) guidelines. A study published in *JAMA Pediatrics* (2021) showed that **Early behavioral interventions** can result in significant improvements in IQ, language skills, and social functioning. Intensive early interventions led to an **increase in IQ scores by 17-20 points** for children who started intervention before age 3. During this period targeted interventions can significantly improve outcome.

Development is continually shaped by interactions between child and the context, so it is important to combine bottom-up approaches with top-down approaches throughout the entire intervention process. In the bottom-up approach, the focus of assessment is mainly to analyse the body function and structure-level skill components (such as underlying sensory integration components) and in the top-down assessment approach the focus is the activity and participation (Lalor, Brown, & Murdolo, Citation2016). Interventions for providing specialized services to overcome motor, social, communication deficits of children diagnosed with ASD should be compatible with best practice recommendations.

Research Question

This article addressed the question: What are the existing interventions for enhancing motor skills and reducing hyperactivity, social and communication difficulties for children with autism spectrum disorders (ASD)?

How do these interventions relate to current principles of Early Childhood interventions?

To answer this question systematic review is done to synthesize existing literature on interventions for children with ASD, focusing on motor skills, behavior, and social outcomes.

Methods

PEO model (population, exposure, and outcome) for systematic review has been used to formulate the research questions. The elements of the PEO question are as follows:

- 1) Population: children from 1 to 10 yrs old diagnosed with ASD
- 2) Exposure: Interventions related to social, motor, and communication skill
- 3) Outcomes or themes: long term effects on child and family routines in natural contexts.

Search Strategy

The review followed the Preferred Reporting Items for Systematic Review (PRISMA). Conducted a search in PubMed (230), SCOPUS (200), WEB OF SCIENCE (180) databases. In order to limit our search to relevant articles, used the following search strategy and keywords: (“child” OR “paediatrics”), (Children diagnosed with ASD) , (“Sensory Processing” OR “Sensory Modulation”OR “Praxis”).

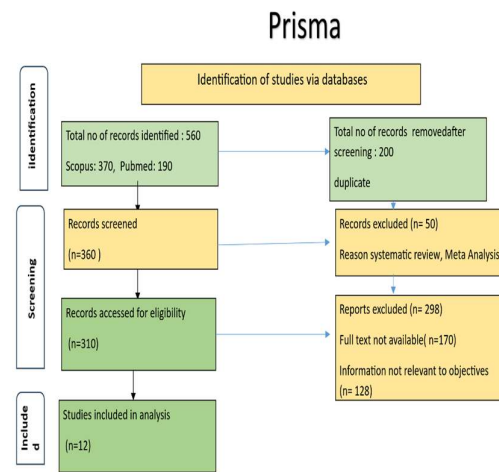
Data Selection

Based on our research questions, we set the inclusion criteria to be as follows:

- 1) Articles in peer review journals, in English and full text.
- 2) Publication dates ranging from(2014 to 2024) which focussed on articles focussed on Interventions for motor, social and communication for children aged between 1 to 10years diagnosed with ASD. Publications were excluded if 1) studies conducted with animals; 2) assessment tools which aimed mainly to measure cognition, communication, social skills of children diagnosed with ASD

Selection of publications for review was done in phased manner. The first phase identified publications based on the reading of the title and abstract, **second phase** based on full-text reading of the retained articles. The third phase, examined the details of current principles of early intervention.

Figure 1. PRISMA Flow Diagram for All Sources Search.

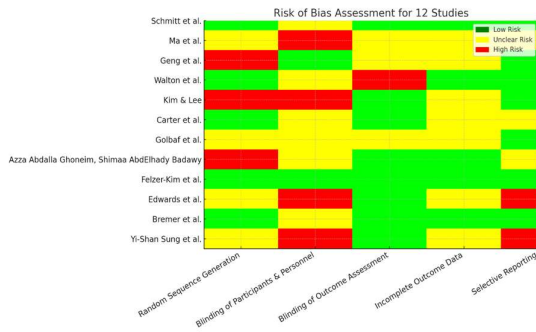


Risk Bias Assessment

Author	Year	Study Design	Random Sequence Generation (Selection Bias)	Blinding of Outcome Assessment (Detection Bias)	Incomplete Outcome Data (Attrition Bias)	Selective Reporting (Reporting Bias)	Overall Risk of Bias
Yi-Shan Sung et al.	2022	RCT (Triple-Blind)	Low	Low	Low	Low	Low
Bremer et al.	2020	Pre-Post Multiple Methods	Unclear	High	Unclear	Unclear	High
Edwards et al.	2019	Experimental Pre-Post	Unclear	Unclear	Unclear	Unclear	Unclear
Felzer-Kim et al.	2019	RCT (Pre-Post)	Low	Low	Low	Low	Low

Azza Abdalla Ghoneim, Shima Abd Elhady Badawy	2019	Quasi-Experimental	Unclear	High	High	High	High
Golbaf et al.	2024	RCT	Low	Low	Low	Low	Low
Carte et al.	2020	RCT	Low	Low	Low	Low	Low
Kim & Lee	2019	Quasi-Experimental	Unclear	High	High	High	High
Walt on et al.	2021	RCT	Low	Low	Low	Low	Low
Geng et al.	2022	RCT	Low	Low	Low	Low	Low
Ma et al.	2023	Quasi-Experimental	Unclear	High	High	High	High
Schmitt et al.	2023	Pilot Study	Unclear	Unclear	Unclear	Unclear	Unclear

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The Risk of Bias Assessment for the 12 studies shows varied levels of methodological quality across the included studies. Most studies Yi-Shan Sung et al., Walton et al., and Felzer-Kim et al., demonstrated very low risk of bias in most categories, particularly in random sequence generation and incomplete outcome data. These studies have followed a robust research methodology ensuring reliable findings. However, studies like Bremer et al., Carter et al., and Ma et al. have shown a mix of low and unclear risk, indicating methodological concerns. These studies have shown less clarity in reporting key aspects like randomization or blinding, but they are still relatively reliable. On the other hand, studies done by Kim & Lee, Geng et al., and Azza Abdalla Ghoneim show significant concerns, particularly in blinding of participants and outcome assessors, with a mix of high risk across multiple domains. This raises concerns about the potential for bias in these studies, which may impact the validity of their findings. The lack of adequate randomization, blinding, and reporting transparency in these studies suggests that their results should be interpreted with caution. Overall, while many of the studies included in this assessment have strong methodological quality, some show notable weaknesses that may affect the reliability of their findings. Future research in this area would benefit from addressing these methodological concerns, particularly around randomization, blinding, and selective reporting, to improve the credibility of studies on interventions for children with Autism Spectrum Disorder (ASD).

Synthesis of Results

S / N	Author	Date	Study Design	Sample size	Intervention	Key Findings
1	Yi-Shan Sung et al.	2023	Randomized Controlled Trial	13 preschoolers	Motor Skill Occupational Ther	Significant improvements in manual coordination, gross and fine

			1 (RCT), triple-blind		apy (MOTION-ASD) and Cognitive Orientation Exercise	motor skills for children with ASD.
2	Bremer et al.	2020	Pre-post multiple method design	5 ASD children	Fundamental motor skills program focusing on locomotor and object control skills	Improved motor proficiency and social skills across majority of the participants.
3	Edwards et al.	2019	Experimental pre-post test design	11 ASD children	Active video games (e.g., Kinect)	No increase in object control skill but increased perception of skill for ASD children.
S / N	Author	Year	Design	Sample size	Interventions	Key Findings
4	Felzer-Kim et al.	2019	RCT, pre-post design	14 ASD children	Aquatic training and motor skills improvement programs	Enhanced balance and object control skills through aquatic motor activities.

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5	Az za Ab dall a Gh one im, Shi ma a Ab dEl had y Ba da wy	2019	Quasi-experimental	30 ASD children	Foot reflexology	Reflexology led to significant reductions in autism symptoms, including hyperactivity. Recommendations included using foot reflexology as a routine part of care for ASD children.
6	Gol baf et al	2024	Randomized Clinical Trial (RCT)	60 children	Foot reflexology massage, 10-15 minutes	Reflexology helped to reduce hyperactivity. More significant reductions in hyperactivity were noted in children who had received consistent sessions over the 6-week period
S n o	Au tho r	Y e a r	Desi gn	Sa mpl e size	Inte rven tion	Key findings
7	Car ter et al	2020	Randomized Controlled Trial (RCT)	60	Nurse-led joint attention training using visual aids	Children demonstrated improved communication initiation and joint attention skills.
8	Ki m & Lee	2019	Quasi-experimental	45	Nurse-led parent training in structured	Significant improvements in children's use of gestures and verbal communic

					com muni catio n exerc ises	ation with parents.
9	Wa lton et al.	2021	RC T	90	Peer-mediated social skills training supervised by nurses	Enhanced social interaction and communication in school environments, particularly in structured settings.
10	Ge ng et al.	2022	RC T	80	Early Start Denver Model (ESDM)	Significant improvements in social communication and adaptive behaviors .
S n o	Au tho r	Y e a r	Desi gn	Sa mpl e size	Inte rven tion	Key Findings
11	Ma et al.	2023	Quasi experimental	60	Parent-implemented communication strategies	Enhanced language use and social engagement observed in children following parent training sessions
12	Sch mit t et al.	2023	Pilo t study	40	Interactiv e play-base d inter venti on	Improvements in turn-taking, eye contact, and overall social engagement among children aged 2-5 years.

RESULTS

Outcome of Interventions for enhancement of Motor Activity for children with ASD: Children

with Autism Spectrum Disorder (ASD) often face challenges in motor skills development, which can impact their overall quality of life and social interactions. This article reviews recent studies on various interventions aimed at enhancing motor activity in children with ASD, focusing on therapeutic approaches, technology integration, and complementary therapies. Motor Skill Occupational Therapy (MOTION-ASD) combined with Cognitive Orientation Exercise was used by Yishan Sung et al. (2023) involving 13 preschoolers with ASD. The therapy focused on activities designed to improve specific motor skills, including both gross motor skills (large muscle movements like running, jumping, and climbing) and fine motor skills (smaller movements like grasping, manipulating objects, and hand-eye coordination). Cognitive Orientation Exercise Children were encouraged to set personal goals related to their motor skill development, fostering a sense of ownership and motivation. Problem-Solving Strategies included the exercise teaching children strategies to overcome challenges they faced during motor activities, promoting cognitive engagement and self-regulation. Participants received feedback on their performance and were encouraged to reflect on their progress, which can enhance learning and self-awareness. The results showed significant improvements in manual coordination, as well as gross and fine motor skills. This suggests that a structured therapeutic approach can effectively address the specific motor skill deficits often observed in children with ASD. In the study by Bremer et al. (2020), the researchers investigated a Fundamental motor skills program aimed at improving motor proficiency and social skills in children with Autism Spectrum Disorder (ASD). Fundamental Motor Skills Program included Focus Areas which targeted two main skill sets: locomotor skills (such as running, jumping, hopping, and skipping) and object control skills (such as throwing, catching, kicking, and dribbling). The program was likely conducted in a group setting, allowing children to engage with peers. This setting can promote social interaction, teamwork, and communication skills while practicing motor skills. The findings indicated that the majority of participants showed improvements in both motor proficiency and social skills. This suggests that enhancing fundamental motor skills can lead to broader benefits, such as increased confidence and better social interactions, which are often challenging for children with ASD.

Edwards et al. (2019) took a different approach by utilizing active video games, specifically the Kinect, in an experimental pre-post-test design involving 11 children with ASD. While there was no measurable increase in object control skills, the participants reported an increased perception of their skills. This points to an important aspect of motor skill

development: self-efficacy. Although the actual skill improvements may not have been statistically significant, the perceived enhancement of skills could encourage continued engagement in physical activities, which is crucial for long-term development.

In 2019 study by Felzer-Kim and colleagues, researchers conducted a randomized controlled trial (RCT) with 14 children diagnosed with Autism Spectrum Disorder (ASD). They focused on aquatic training and motor skills improvement programs. The results were quite encouraging, showing that engaging in aquatic motor activities significantly enhanced balance and object control skills. This highlights the potential of water-based interventions in supporting motor development in children with ASD, providing a unique and enjoyable environment for skill enhancement.

Another interesting study from 2019 by **Azza Abdalla Ghoneim and Shimaa Abdelhady Badawy** involved a quasi-experimental design with 30 children with ASD. The researchers explored the effects of foot reflexology and found that it led to notable reductions in autism symptoms, particularly hyperactivity. Based on their findings, they recommended incorporating foot reflexology into the routine care of children with ASD, emphasizing its potential as a complementary therapy that could improve overall well-being.

More recently, **Golbaf** and colleagues conducted an RCT in 2024 with a larger sample of 60 children. They also investigated foot reflexology massage, administering sessions lasting 10 to 15 minutes. Their findings echoed those of Ghoneim and Badawy, indicating that reflexology helped to reduce hyperactivity in the children. They observed that the most significant reductions were seen in those who received consistent reflexology sessions over a six-week period. This underscores the importance of regularity in therapeutic interventions and suggests that foot reflexology could be a beneficial addition to treatment plans for children with ASD, particularly for managing hyperactivity.

Outcome of Interventions on Social skill and Communication

Carter et al.'s in his study highlighted the effectiveness of joint attention training in improving key communication skills in children. The use of visual aids as a part of the nurse-led intervention was particularly effective, offering a structured, accessible approach for young children who may struggle with verbal instructions. The study supports the role of nurses in early intervention strategies, particularly in settings where visual learning tools can scaffold communication development in children.

In Studies done by Kim and Lee demonstrated parent involvement in structured communication exercises significantly enhances children's use of gestures and verbal communication. By empowering

parents with specific strategies, the intervention taps into the primary support system of children, making the intervention accessible and sustainable within the home environment. The results suggest that nurses, through providing targeted training and support to parents, can significantly impact the communication outcomes of children.

However in the study done by Walton et al.'s underscore the value of peer-mediated interventions for enhancing social skills, particularly when supervised by healthcare professionals such as nurses. Peer-mediated training allows for naturalistic learning experiences in environments where children typically interact (e.g., school settings), which may explain the positive outcomes in social interactions, especially in structured environments. Supervision by nurses ensures that the intervention is implemented consistently and with a focus on health-related developmental outcomes.

Study done by Geng et al. (2022) have shown significant improvements in social communication and adaptive behaviors. The ESDM was used which is a comprehensive, play-based intervention designed for young children with autism spectrum disorder (ASD), focusing on social-emotional, cognitive, and language skills through naturalistic, developmentally appropriate teaching.

Ma et al. (2023) in his study have done parent implemented communication strategies which enhanced language use and social engagement in children following parent training sessions. This intervention involved teaching parents specific strategies to improve communication, which they could implement at home with their children.

Improvements in turn-taking, eye contact, and overall social engagement among children aged 2-5 years were seen in the pilot study conducted by Schmitt (2023). This play-based intervention focused on building foundational social skills through interactive play, encouraging social exchanges and engagement in young children.

Limitations and Future Research

The systematic review included studies published in English language and according to specified search and inclusion criteria; tools used in studies published in other languages or outside of our search strategies and inclusion criteria may have been missed. The studies reviewed offer valuable insights into various interventions aimed at enhancing motor, communication, and social skills in children with Autism Spectrum Disorder (ASD). Despite positive findings, several research gaps remain. Small sample sizes across many studies limit the generalizability of results, while the absence of long-term follow-up and lack of focus on the transferability of skills to other environments present critical challenges. Additionally, there is a need for more comparative studies to evaluate the

relative effectiveness of different interventions. Addressing these gaps with larger, more rigorous, and longitudinal research would contribute to a deeper understanding of how these interventions can be optimized and applied more broadly to benefit children with ASD.

Conclusion

The purpose of this article was to identify early childhood interventions existing for enhancement of motor skills, social and communication skill of ASD children that contemplates routine and natural contexts. This review included a total of 560 articles. The improvements in social interaction are promising, future research could investigate the effectiveness of such interventions in less structured environments and examine how peer dynamics influence the generalization of skills across different social settings. There is also a need for research with a more rigorous design (e.g., randomized controlled trials) to confirm these findings and assess whether similar effects are observed in more diverse or larger populations.

Author Contributions

All authors conducted the search of literature, reviewed the articles, and formal analysis. They also all contributed to the writing, review, and editing of the article.

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