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RESEARCH ARTICLE

EVALUATING THE IMPACT OF EARLY INTERVENTION ON DEVELOPMENTAL OUTCOMES IN CHILDREN WITH AUTISM SPECTRUM DISORDER: A COMPARATIVE STUDY IN BANGLADESH

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ABSTRACT

INTRODUCTION

Autism Spectrum Disorder (ASD) presents a range of developmental challenges, often impacting social, cognitive, and motor skills. Early intervention (EI) is essential in supporting children with ASD by leveraging neuroplasticity during early developmental stages. This study aims to describe developmental profiles of children with ASD receiving early intervention compared to typically developing peers.

METHODOLOGY

A quantitative, comparative study was conducted among 400 six-year-old children, equally divided between ASD (n = 200) and typically developing (TD) (n = 200) groups, selected through purposive sampling from all eight administrative divisions of Bangladesh. Children in the ASD group had received EI since diagnosis before age three. Developmental outcomes were assessed using the Communication DEALL Developmental Checklist (ComDEALL), the Speech and Language Development Chart (SLDC), and the Indian Scale for Assessment of Autism (ISAA). Descriptive and comparative analyses were performed using Python.

RESULTS

The ASD group demonstrated lower acquisition across all domains. Gross motor and fine motor mastery was achieved by only 60% and 40% of ASD children, respectively, compared to 100% in TD peers. Receptive and expressive language skills were acquired by 54% and 46% of ASD participants, with phonology (11%) and pragmatics (20%) particularly underdeveloped. Daily living, cognitive, social, and emotional skills were acquired by less than 52% of ASD children. ISAA scores classified 78% of ASD participants as having severe autism.

CONCLUSION

These findings highlight critical delays in motor, language, and social skills in children with ASD. Tailored EI programs addressing these areas could enhance developmental outcomes and functional independence for children with ASD in resource-limited settings like Bangladesh.

KEYWORDS

autism spectrum disorder, child development disorders pervasive, early intervention education, language development disorders, social skills development

INTRODUCTION

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by impairments in social communication, restricted interests, and repetitive behaviors that affect millions globally, including a growing number of children in low- and middle-income countries (LMICs) such as Bangladesh [1]. ASD requires early, targeted interventions to support optimal developmental outcomes [2]. Research underscores the efficacy of early intervention (EI) in improving language, social interaction, and adaptive functioning in children with ASD by addressing developmental challenges during critical periods of neuroplasticity [3,4].

In high-income countries, EI for ASD is typically provided by specialized healthcare professionals, including speech therapists, behavioral analysts, and developmental pediatricians [5]. However, in LMICs, such resources are scarce and often inaccessible, particularly in rural regions. For instance, a systematic review highlighted that the "treatment gap" for ASD in LMICs remains significant, with nearly 80% of children lacking access to specialized interventions due to financial, logistical, and infrastructural barriers [6]. In response, some countries have adopted task-sharing models, where non-specialists are trained to deliver simplified versions of ASD interventions, which has shown promise in South Asia and sub-Saharan Africa [7]. Studies from these regions report positive outcomes with parent-mediated interventions led by trained community health workers, suggesting the potential effectiveness of these models in resource-constrained settings [8].

A notable example is a South African study where a cascaded task-sharing model was used to train non-specialist health workers in delivering the Naturalistic Developmental Behavioral Intervention (NDBI), an evidence-based ASD intervention [7]. This model showed encouraging improvements in children's social engagement and language development, demonstrating that even simplified interventions can be impactful when specialized resources are unavailable [9]. Similarly, a study in India implemented a parent-mediated intervention where local health workers coached parents on ASD management strategies, resulting in measurable gains in child outcomes and increased parental confidence [10].

Despite these promising findings, Bangladesh still faces unique cultural, social, and structural challenges in implementing EI for ASD [11]. While awareness of ASD is increasing, many families encounter barriers to accessing timely diagnosis and intervention services [12]. Cultural attitudes, stigma, and limited healthcare infrastructure further complicate the delivery of ASD-specific interventions [13–15]. Given these constraints, there is a critical need to adapt existing EI models to Bangladesh's context, potentially by leveraging community-based, culturally sensitive approaches that involve family members and local health workers [16].

The study evaluates the impact of early intervention on children with ASD by comparing developmental outcomes between children with ASD who received early intervention and typically developing children. This comparison underscores the importance of tailored early intervention for children with ASD in Bangladesh. By addressing these gaps, the research aims to inform relevant, scalable intervention strategies for underserved populations in Bangladesh.

METHODOLOGY

STUDY DESIGN

This study employed a quantitative, comparative design using purposive sampling to ensure participants met specific criteria essential for addressing the research objectives. The sample consists of 400 children, equally divided between two groups: 200 children diagnosed with ASD who received early intervention and 200 typically developing (TD) children. Each group includes equal gender representation, with 50% male and 50% female participants, though individuals from the third-gender community were not included due to resource limitations. Purposive sampling was chosen to facilitate a focused comparison by selecting participants who closely matched the study's inclusion criteria. While this non-random sampling method is less generalizable, it is suitable for ensuring a balanced and relevant population for examining developmental outcomes across groups.

PARTICIPANTS

The study sample comprised 400 children, divided equally into two groups: Group 1 included 200 children diagnosed with ASD who had received early intervention, and Group 2 consisted of 200 typically developing (TD) children. Gender balance was maintained with 50% male and 50% female participants in each group. Participants were selected from each of Bangladesh's eight administrative divisions—Dhaka, Chattogram, Khulna, Rajshahi, Barishal, Sylhet, Rangpur, and Mymensingh. This selection ensured geographic representation and aimed to include a diverse cross-section of children from different cultural and socio-economic backgrounds across the country. Despite the regional diversity of participants, all assessments and treatments were conducted in Dhaka. Dhaka was chosen as the centralized treatment location because it provides greater access to specialized facilities and trained professionals necessary for administering standardized assessments and early intervention services. This approach allowed for consistent and high-quality data collection while maintaining representation from across Bangladesh.

INCLUSION AND EXCLUSION CRITERIA

Participants were recruited according to predefined criteria to ensure comparability between groups and to minimize potential confounding factors. For the ASD group (n = 200), eligible children were exactly six years old, had received a confirmed clinical diagnosis of ASD before the age of three, and had been consistently engaged in early intervention therapy since diagnosis. The intervention consisted of a structured combination of speech therapy, occupational therapy, and behavioral interventions, delivered by trained professionals at an average frequency of three to five sessions per week, each lasting 45–60 minutes, over a period of at least three consecutive years. To reduce the influence of external variables, only children who were not taking regular medication known to affect cognitive, behavioral, or developmental outcomes (such as antipsychotics, anticonvulsants, or ADHD medications) were included, and those with any co-occurring developmental, neurological, or genetic disorders were excluded. Additional exclusion criteria for this group included irregular attendance at therapy sessions—defined as less than 75% adherence to the planned schedule—and diagnosis of ASD after the age of three.

For the TD group (n = 200), participants were matched to the ASD group by age, sex, and geographic distribution. Inclusion required the absence of any current or past developmental, neurological, psychiatric, or genetic disorders, and none of the children were receiving special education, developmental therapy, or medication that could influence developmental skills. Children identified with developmental delays, special educational needs, or regular use of medication for neurological, psychiatric, or behavioral conditions were excluded. These criteria were applied to ensure that both groups were comparable in demographic characteristics while differing only in the presence or absence of ASD and its associated interventions, thereby allowing for a focused assessment of developmental outcomes.

MATERIALS AND INSTRUMENTS

Three validated and widely used assessment tools were employed to evaluate key developmental areas in both ASD and TD children, namely the Communication DEALL Developmental Checklist (ComDEALL), the Speech and Language Development Chart (SLDC), and the Indian Scale for Assessment of Autism (ISAA) [17–19].

- **Communication DEALL Developmental Checklist (ComDEALL)**: This tool measures developmental skills across eight domains: gross motor, fine motor, activities of daily living, receptive skills, expressive skills, cognitive skills, social skills, and emotional skills. Scores range from 0 (not acquired) to 4 (mastered across all situations), with a color-coded scale from red (not acquired) to dark green (fully mastered.
- **Speech and Language Development Chart (SLDC)**: The SLDC assesses five domains of speech and language development—phonology, semantics, play, syntax-morphology, and pragmatics—indicating the presence or absence of these skills.
- **Indian Scale for Assessment of Autism (ISAA)**: The ISAA, an observational tool, evaluates 40 items across six domains: social relationship and reciprocity, emotional responsiveness, speech-language and communication, behavior patterns, sensory aspects, and cognitive components. Scores on the ISAA categorize the degree of autism from normal (<70) to severe (>153).

DATA COLLECTION PROCEDURE

Data were collected through structured, one-on-one assessments conducted in a controlled clinical setting to minimize variability and external distractions. Each child was evaluated individually across multiple developmental domains using three standardized tools: the Communication DEALL Developmental Checklist (ComDEALL), the Speech and Language Development Chart (SLDC), and the Indian Scale for Assessment of Autism (ISAA). Assessments were carried out by a team of six raters, including speech and language therapists, occupational therapists, and special educators, each with a minimum of three years' experience in pediatric developmental assessment. Although no formal external certification was provided for the use of these specific tools, all assessors participated in an intensive, study-specific training program led by senior clinicians with expertise in the instruments. This training covered administration procedures, scoring guidelines, and case-based calibration exercises to ensure consistent application across raters. To further reduce subjectivity, all assessments followed standardized protocols, and regular team meetings were held to review scoring practices. Supplementary information for ISAA scoring was obtained from parents or caregivers through structured interviews, enabling a more comprehensive understanding of each child's abilities in everyday contexts.

ETHICAL CONSIDERATIONS

This study received ethical approval from the Proyash Institute of Special Education and Research (PISER) Review Board under IRB No: 1034/31/Cen/PISERVE. The procedures adhered to the ethical standards set by the Bangladesh Medical Research Council (BMRC) and the principles of the Declaration of Helsinki. Special consideration was given to ethical principles for research involving vulnerable populations, ensuring that the best interests of the children were prioritized throughout the study. Informed consent was obtained from the parents or legal guardians of all participants, ensuring they fully understood the study's purpose, procedures, and voluntary nature. Participation was entirely voluntary, and parents were informed of their right to withdraw at any time without consequences. To protect participant confidentiality, all data were anonymized using unique codes assigned to each participant and securely stored with restricted access. Data collection and management complied with relevant data protection and privacy regulations. Assessments were conducted in a clinical setting, prioritizing the comfort and safety of each child, and ensuring a supportive and ethical research environment.

DATA ANALYSIS

Data analysis was conducted using Python (version 3.11.4 https://www.python.org/) to perform descriptive statistical analysis and create visualizations for presenting the results. The analysis focused on summarizing developmental outcomes across the ASD and TD groups, particularly in areas of communication, socialization, and daily living skills. Python's data analysis libraries, such as Pandas and NumPy, were used to organize and manipulate the dataset efficiently, while Matplotlib and Seaborn facilitated the creation of clear, visually engaging graphs and tables.

The data analysis involved calculating frequency distributions and percentage comparisons for each domain assessed, allowing for a straightforward comparison of developmental progress between the two groups. Visualizations, including graphs, were generated to present data and highlight differences in developmental outcomes between ASD and TD children. Each domain was presented in a distinct graphical format, providing a comprehensive and accessible overview of the findings. All visualizations and data summaries were prepared to ensure clarity for readers, highlighting key contrasts in developmental performance between the ASD and TD groups.

RESULTS

COMDEALL DEVELOPMENTAL SKILLS

The ComDEALL Developmental Checklist assessed gross motor, fine motor, daily living, receptive language, expressive language, cognitive, social, and emotional skills, revealing marked differences between the ASD and TD groups. Gross motor skill acquisition in the ASD group was limited, with only 60% of children showing partial skill mastery compared to 100% of TD children achieving full acquisition. This suggests substantial gaps in physical coordination and mobility for children with ASD. Fine motor skills showed a similar trend, with only 40% of the ASD group displaying consistent skill

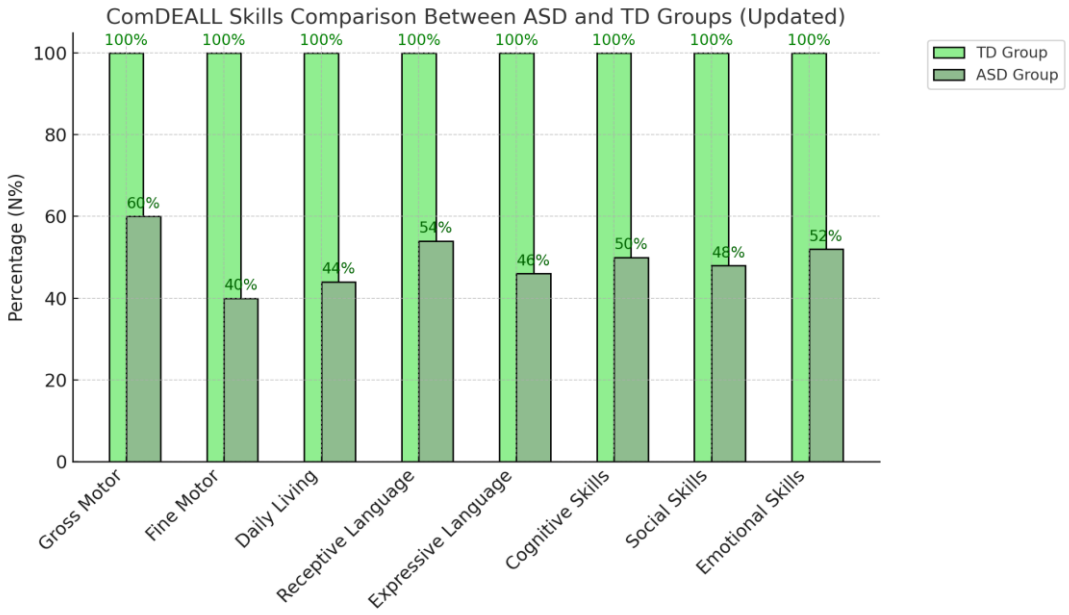
presence, in contrast to full acquisition in TD children. This finding indicates the need for focused support on fine motor activities, such as hand-eye coordination tasks, in EI programs to bridge this gap.

Daily living skills, essential for self-care and routine activities, were notably limited within the ASD group, with only 44% demonstrating adequate skill acquisition. In comparison, all children in the TD group achieved full mastery in this domain. This discrepancy highlights potential challenges in independence for children with ASD and suggests an area where EI could incorporate additional training.

Language skills, assessed via receptive and expressive language metrics, showed similar challenges. Only 54% of the ASD group acquired receptive language skills, and 46% displayed expressive language skills, whereas the TD group achieved 100% acquisition across both metrics. This result emphasizes the need for language-focused interventions within EI programs to support children with ASD in both understanding and producing language.

Cognitive, social, and emotional skills also demonstrated significant gaps. While 50%, 48%, and 52% of children in the ASD group exhibited skill acquisition in cognitive, social, and emotional domains respectively, the TD group achieved 100% in all areas. These results suggest that comprehensive EI programs should integrate cognitive and emotional development support, in addition to social skill-building activities, to address these areas effectively.

FIGURE 1: BAR CHART SHOWING DEVELOPMENTAL SKILLS IN ASD AND TD GROUPS



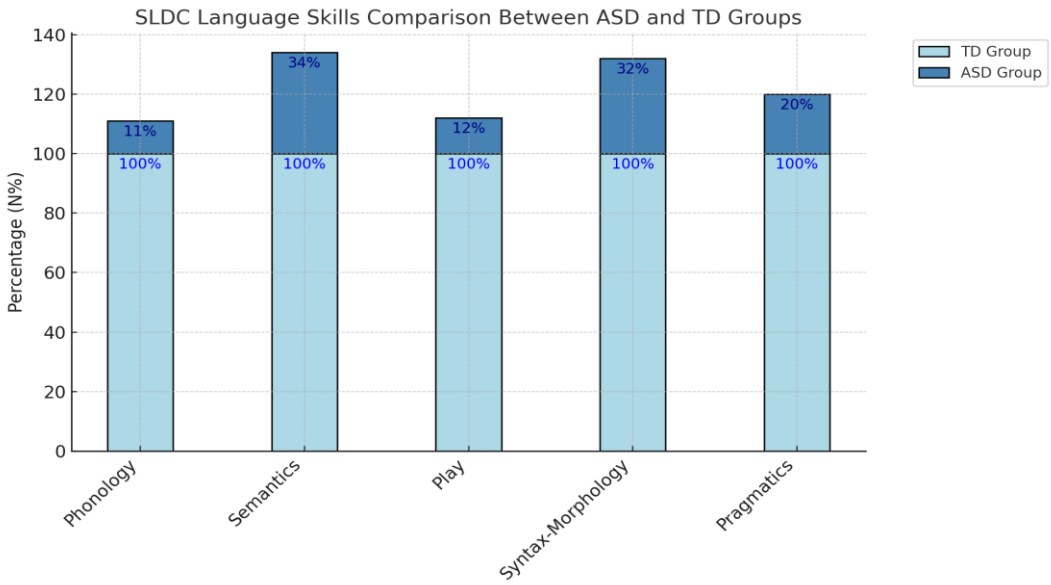
Footnote: This bar chart illustrates the percentage of skill acquisition across eight domains: gross motor, fine motor, daily living, receptive language, expressive language, cognitive, social, and emotional skills. The ASD group shows lower percentages across all skills, highlighting specific areas—such as social and cognitive skills—where additional support through early intervention may be needed.

SLDC LANGUAGE SKILLS

The SLDC further delineated differences in language skills across phonology, semantics, play, syntax morphology, and pragmatics. Phonological skills in the ASD group reached only 11%, indicating limited progress in sound production and discrimination, compared to 100% in the TD group. Pragmatic skills, critical for social communication, were similarly low, with only 20% of ASD children achieving these skills, contrasting with full mastery in TD children. These areas highlight where additional social communication interventions could benefit children with ASD. Higher-level language functions, such as semantics and syntax morphology, were also underdeveloped, with only 34% and 32% of the ASD group demonstrating sufficient skill acquisition, respectively. In contrast, TD children achieved full mastery across these domains, indicating a significant gap. These findings suggest that targeted interventions in vocabulary development and sentence structure could greatly support ASD children's language development. Lastly, play skills were notably limited, with only 12% of children in the ASD group exhibiting age-appropriate play abilities compared to 100% in the TD group. Given that play is

closely linked to social and cognitive development, integrating play-based approaches into EI could potentially improve social skills and creativity.

FIGURE 2: STACKED BAR CHART SHOWING LANGUAGE SKILLS IN ASD AND TD GROUPS

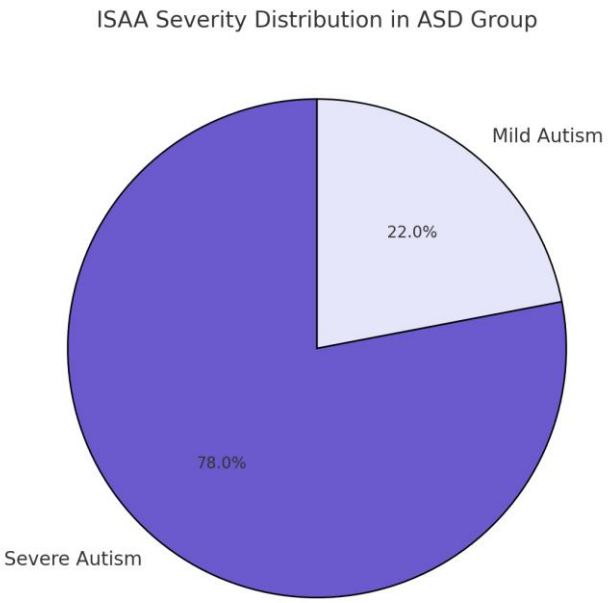


Footnote: This stacked bar chart compares five language skills (phonology, semantics, play, syntax-morphology, and pragmatics) between ASD and TD groups. The TD group achieved 100% acquisition in all domains, whereas the ASD group showed substantial deficits, particularly in phonology and pragmatics, underscoring the impact of language-based interventions.

ISAA SEVERITY DISTRIBUTION

The ISAA provided insights into the severity levels within the ASD group, categorizing children as mild or severe. The majority (78%) were classified with severe autism, with only 22% falling within the mild range. This distribution underscores the variability within ASD and highlights the need for adaptive, individualized intervention strategies. The higher incidence of severe cases suggests that many children with ASD may benefit from more intensive, multifaceted intervention approaches designed to address complex needs.

FIGURE 3: PIE CHART SHOWING ISAA SEVERITY IN THE ASD GROUP



Footnote: The pie chart shows the distribution of autism severity within the ASD group based on the ISAA scale. A majority (78%) of children are categorized as having severe autism, while 22% fall in the mild range, emphasizing the need for targeted, intensive interventions tailored to individual severity levels.

DISCUSSION

This study highlights the substantial developmental challenges children with ASD face across multiple domains, including motor, language, cognitive, social, and emotional skills. Using the ComDEALL, SLDC, and the ISAA tools, significant delays in skill acquisition were noted in the ASD group compared to TD children. These findings align with existing literature, which commonly observes delays in language, social skills, and motor abilities in children with ASD [20,21].

The ComDEALL results underscore the need for targeted interventions in both gross and fine motor skills for children with ASD. Only 60% of children with ASD showed partial mastery in gross motor skills, and a mere 40% demonstrated consistent fine motor abilities, compared to the full acquisition seen in the TD group. This suggests a foundational gap in physical coordination and dexterity, which may impact other developmental areas, including daily living and social engagement. Studies have similarly found that children with ASD often struggle with motor coordination, which can hinder their ability to participate in peer activities and achieve age-appropriate independence [22,23]. EI programs that incorporate structured motor skill training—such as guided balance exercises, coordinated object manipulation, and fine-motor precision tasks—have been shown to improve physical coordination, postural control, and functional independence in children with ASD. Such interventions not only enhance basic movement patterns but also facilitate participation in daily routines, self-care activities, and peer play, which in turn promote broader social and cognitive development [24,25]. Evidence suggests that targeted motor interventions delivered in early childhood can yield measurable gains in adaptive functioning and overall quality of life, particularly when integrated into multi-domain early intervention programs [26].

The language skills assessed via SLDC were markedly underdeveloped in the ASD group. Phonology and pragmatics were particularly low, with only 11% and 20% acquisition rates, respectively, in contrast to 100% in the TD group. Limited phonological skills indicate a barrier in sound discrimination and production, while reduced pragmatic skills impede social communication—a critical component of interaction. Studies have highlighted that deficits in phonological awareness and pragmatic skills are key characteristics of ASD. In our intervention, phonological training involved structured articulation drills, auditory discrimination activities, and repetitive syllable practice to improve sound production and clarity. Social language development was supported through guided role-play, storytelling, and turn-taking games aimed at enhancing pragmatic communication skills. Given that language development in children with ASD often progresses differently from that in TD children, incorporating EI strategies focused on phonological training and social language use can be beneficial [27,28]. Speech-language interventions that prioritize sound production exercises and social communication skills could support ASD children in achieving greater proficiency in language [29,30].

Daily living skills were another area with a notable discrepancy between groups, with only 44% of the ASD group showing adequate skill acquisition. This emphasizes a potential challenge in fostering independence and self-care in children with ASD, which could impact their quality of life and ability to integrate into social environments. Other studies have found that deficits in daily living skills are common among children with ASD and contribute to challenges in achieving functional independence [31,32]. Structured routines and behavioral interventions within EI programs may bridge this gap, helping children with ASD build competencies in essential daily activities, such as dressing, eating, and hygiene.

Cognitive, social, and emotional domains also showed significant skill gaps in the ASD group, with only half or fewer children demonstrating acquisition compared to the TD group. Deficits in social and emotional skills can contribute to social isolation and behavioral issues, and research indicates that children with ASD often struggle with social reciprocity and emotional regulation [33,34]. In our intervention, social and emotional skills training included cooperative board games to encourage teamwork, the use of emotion recognition picture cards to enhance emotional awareness, and guided peer-interaction activities to practice turn-taking and conversational exchanges in structured settings. Integrating social and emotional skills training, such as cooperative play and emotion recognition activities, into EI programs may help ASD children better understand social cues and manage emotional responses, facilitating smoother social interactions.

The ISAA severity distribution revealed that 78% of children in the ASD group were classified as having severe autism. This high proportion almost certainly influenced the developmental outcome patterns observed in this study. Children with severe ASD typically present with greater impairments in communication, social interaction, and adaptive functioning, which limit their baseline skill acquisition. As a result, even when enrolled in early intervention programs, progress may be slower and gains smaller compared to those with mild or moderate ASD [35,36]. In our sample, these severe cases often required higher levels of support and more repetition during therapy tasks, leaving less opportunity for advancement across multiple developmental domains within the same timeframe. Furthermore, high severity can impact engagement and attention during structured tasks, reducing the effectiveness of standardized interventions and contributing to the lower percentages of mastery seen in gross motor, fine motor, language, and social–emotional skills. The variability within ASD underscores the importance of adaptive interventions, as studies have shown that autism severity can predict both the type and intensity of support needed in social, cognitive, and behavioral domains [37,38]. For these children, EI approaches need to be flexible, allowing for adjustments in intensity and focus based on each child's unique needs. Studies also suggest that consistent and intensive interventions may improve outcomes for children with severe ASD, underscoring the value of early and personalized therapeutic strategies [39].

In addition to skill-specific interventions, integrating play-based and peer-interaction methods could be advantageous for comprehensive development. Play, as seen with only 12% skill acquisition in the ASD group compared to 100% in TD children, is a foundational activity closely linked to social, cognitive, and language development. This finding suggests that ASD children could benefit from interventions that incorporate structured play, aligning with other studies showing that play-based approaches can promote social engagement and creativity in children with ASD. Play therapy, especially when involving peer interactions, can encourage children to practice social behaviors in a supportive, structured environment, potentially improving social and cognitive outcomes.

STRENGTHS AND LIMITATIONS

This study benefits from a relatively large and geographically diverse sample, with participants drawn from all eight administrative divisions of Bangladesh and balanced for age and gender. Standardized, validated assessment tools (ComDEALL, SLDC, ISAA) were used to measure multiple developmental domains, and evaluations were conducted in controlled clinical settings by trained professionals, which helped minimize environmental variability.

However, several limitations should be considered when interpreting the findings. The purposive sampling strategy, while ensuring representation across regions, may introduce selection bias and limit generalizability to the broader ASD population in Bangladesh. The absence of random assignment between the ASD and TD groups restricts causal inference, as pre-existing differences beyond early intervention could have influenced outcomes. Reliance on parent and caregiver reports for certain measures introduces potential subjectivity, despite structured interview protocols. Additionally, the cross-sectional design precludes assessment of long-term intervention effects, and the chosen assessment tools, although standardized, may not fully capture culturally specific aspects of child development. Importantly, there was variability in the intensity, duration, and composition of early intervention programs across participants, which may have contributed to the heterogeneity of outcomes observed.

IMPLICATIONS AND FUTURE DIRECTIONS

These findings underscore the pressing need for scalable, multi-domain early intervention programs in Bangladesh and other resource-limited settings, with approaches that integrate motor, language, and social–emotional training and are tailored to the severity of each child's needs. The high proportion of severe ASD cases in this study highlights the importance of tiered service models, ensuring that children with greater developmental challenges receive more intensive, specialized support. From a policy perspective, integrating ASD-specific developmental screening into routine maternal and child health services could promote earlier identification, while expanding community-based delivery models would improve access for rural and underserved populations. Strategic investment in training non-specialist providers to deliver culturally adapted, evidence-based interventions could help close the treatment gap and reduce long-term societal costs associated with unmet developmental needs. Future research should adopt longitudinal and randomized designs to evaluate sustained impacts, develop locally relevant intervention protocols that leverage family

engagement and community resources, and examine how autism severity interacts with specific intervention components to inform more personalized, effective treatment strategies.

CONCLUSION

This study highlights substantial developmental challenges in motor, language, cognitive, social, and emotional domains among children with ASD compared to typically developing peers. The findings emphasize the critical need for individualized, multi-dimensional intervention approaches tailored to these specific areas of delay. By targeting each child's unique needs within a structured and adaptive framework, EI programs have the potential to more effectively address the complex developmental needs of children with ASD, as suggested by the observed skill gaps. Further research is needed to evaluate the specific impacts and long-term benefits of EI in ASD populations, especially in low-resource settings, to establish inclusive, scalable intervention models for ASD care worldwide.

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COMPETING INTERESTS:

The authors declare that they have no competing interests.

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