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Efficacy of physiotherapy with occupational and speech therapy for improving physical & behavioral status among children with autism spectrum disorder (ASD): an assessor blinded randomized clinical trial

Md. Sherajul Haque[1†], Mohammad Mohinul Islam[2†], Abid Hasan Khan[3†], Nupur Akter[3] and K. M. Amran Hossain[3*]

Abstract

Background Autism Spectrum Disorder (ASD) is characterized by physical, communication, and behavioral challenges that often require comprehensive interventions. This study aimed to evaluate the combined efficacy of physiotherapy, occupational and speech therapies in improving physical and behavioral outcomes among children with ASD.

Materials and methods This assessor-blinded randomized clinical trial was conducted at Proyash (Institute of Special Education), Jashore, Bangladesh, involving seventy children with ASD. Outcomes were assessed using the modified SF-36 for physical status and GARS-3 for behavioral status at baseline and after six weeks of intervention. Data were analyzed using SPSS version 25.0, with descriptive statistics (median and IQR) and inferential tests (Mann-Whitney U and Wilcoxon signed-rank), maintaining a 95% confidence level.

Results The average age of participants was 10.66 ± 3.28 years in Group A and 9.17 ± 2.83 years in Group B. Group A had a higher BMI of 21.86 ± 7.96 kg/m^2 compared to 19.53 ± 4.85 kg/m^2 in Group B. Post-intervention analysis revealed significant improvements in both physical and behavioral outcomes. Between-group comparisons yielded p-values < 0.01 for both measures. Within-group analysis showed significant improvements in Group A ($p < 0.01$), whereas changes in Group B were not statistically significant.

Conclusion The combined rehabilitation program demonstrated significant improvements in physical and behavioral outcomes and showing greater effectiveness overall. These findings emphasize the importance of

†Md. Sherajul Haque, Mohammad Mohinul Islam and Abid Hasan Khan contributed equally as the first author.

*Correspondence:
K. M. Amran Hossain
kma.hossain@just.edu.bd

Full list of author information is available at the end of the article

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customized rehabilitation approaches in enhancing both physical and behavioral health, particularly when tailored to specific participant profiles.

Trial registration CTRI/2024/07/070209 (Prospectively Registered).

Keywords Behavioral status, Physical and emotional health, Rehabilitation, Autism spectrum disorder

Introduction

Autism Spectrum Disorder (ASD) is mainly characterized by core features in two areas: social communication and motor behavior with restricted, repetitive sensory behaviors [1]. At the physical level, it can manifest as impaired coordination and balance, potentially leading to postural stability challenges and an increased risk of injury [2]. Autism prevalence is rising and currently lies between 0.9% and 1.5% [3]. Higher prevalence rates are observed in affluent and high-income countries compared to developing nations, where diagnosis rates remain lower [4]. A recent worldwide ASD prevalence estimate of 0.6% falls far below estimates for Western developed societies, likely due to the shortage of diagnostic services rather than a true difference in ASD incidence [5].

The average age of ASD diagnosis (4 years, 10 months) was later than optimal for children to benefit most from early intervention [6]. According to the Centers for Disease Control and Prevention (CDC)'s Autism and Developmental Disabilities Monitoring (ADDM) Network, an estimated 1 in 44 children aged eight years old were diagnosed with ASD in the United States [7]. Previously, in 2016, the estimate was 1 in 54. Worldwide epidemiological surveys emphasize a rising prevalence in ASD diagnosis over recent years [8].

According to the Child Neurodevelopment and Autism Center at Bangabandhu Sheikh Mujib Medical University in Bangladesh, 7.5 out of every 10,000 children are affected by autism [9]. Early diagnosis of ASD is considered best practice, as early intervention for emotional regulation, communication, cognitive development, behaviors, sensory processing, and social skills support provides children with improved educational outcomes and quality of life [10, 11].

Today, early autism diagnosis before a child turns three years old is possible and has increased [12]. Early diagnosis and treatment with evidence-based services, such as early intensive behavioral intervention, may help optimize health for children with autism and their families [13]. Autism severity is classified into three levels - mild, moderate, and severe based on the individual's ability to perform activities of daily living (ADLs) [14].

The treatment of autism involves a multidisciplinary team composed of professionals such as physiotherapists, occupational therapists, speech therapists, psych ecologists, physicians, and others [15]. Physical therapy should begin early to enhance motor development and daily functional needs [16]. Physical activity can increase aerobic capacity, enhance strength, improve motor control, and improve overall fitness in children with ASD [17]. It can also facilitate routine building, reduce stress and anxiety, increase self-efficacy, and enhance overall psychological well-being [18]. Additionally, participation in activities like jogging, martial arts, and horseback riding has been shown to reduce stereotypical behaviors such as rocking and hand-flapping [19]. Hippo-therapy helps in developing muscle strength, motor coordination, postural correction, and balance, promoting the physical and emotional well-being of children with autism [20]. Hydrotherapy through the physical principles of water, hydrotherapy contributes to motor stimulation, social behavior, sensory development, confidence, self-control, and muscle strengthening [21]. It also helps improve mood, motivation, and reduces autistic movement challenges [22]. Play Therapy is a therapeutic practice that promotes communication, motor coordination, cognitive abilities, and emotional expression in children with ASD [23]. Studies have shown that physical activity helps improve social interaction, reduces aggressive behavior [24], and reduces stereotypical behavior in children with autism spectrum disorder (ASD) [25]. Integrated physical training in children with ASD increases social skills and changes their repetitive and restricted behavior [26].

To date, no study has directly compared conventional therapies (occupational and speech-language therapy) with a combined approach that includes physiotherapy in improving behavioral, physical, and mental outcomes in children with ASD. This study aimed to evaluate the effectiveness of this combined intervention against standard needs-based therapy involving only occupational and speech-language therapy.

Materials and methods

Study design and settings

This assessor-blinded randomized clinical trial was conducted from October 2024 to January 2025 at the outpatient unit of Proyash, Institute of Special Education, Jashore, Bangladesh. Seventy children with ASD were enrolled. The study design, analysis, and reporting adhered to the 25-item CONSORT checklist (Fig. 1) [27].

Recruitment, randomization and group allocation

The names and contact details of guardians of children with ASD were obtained from the patient data records

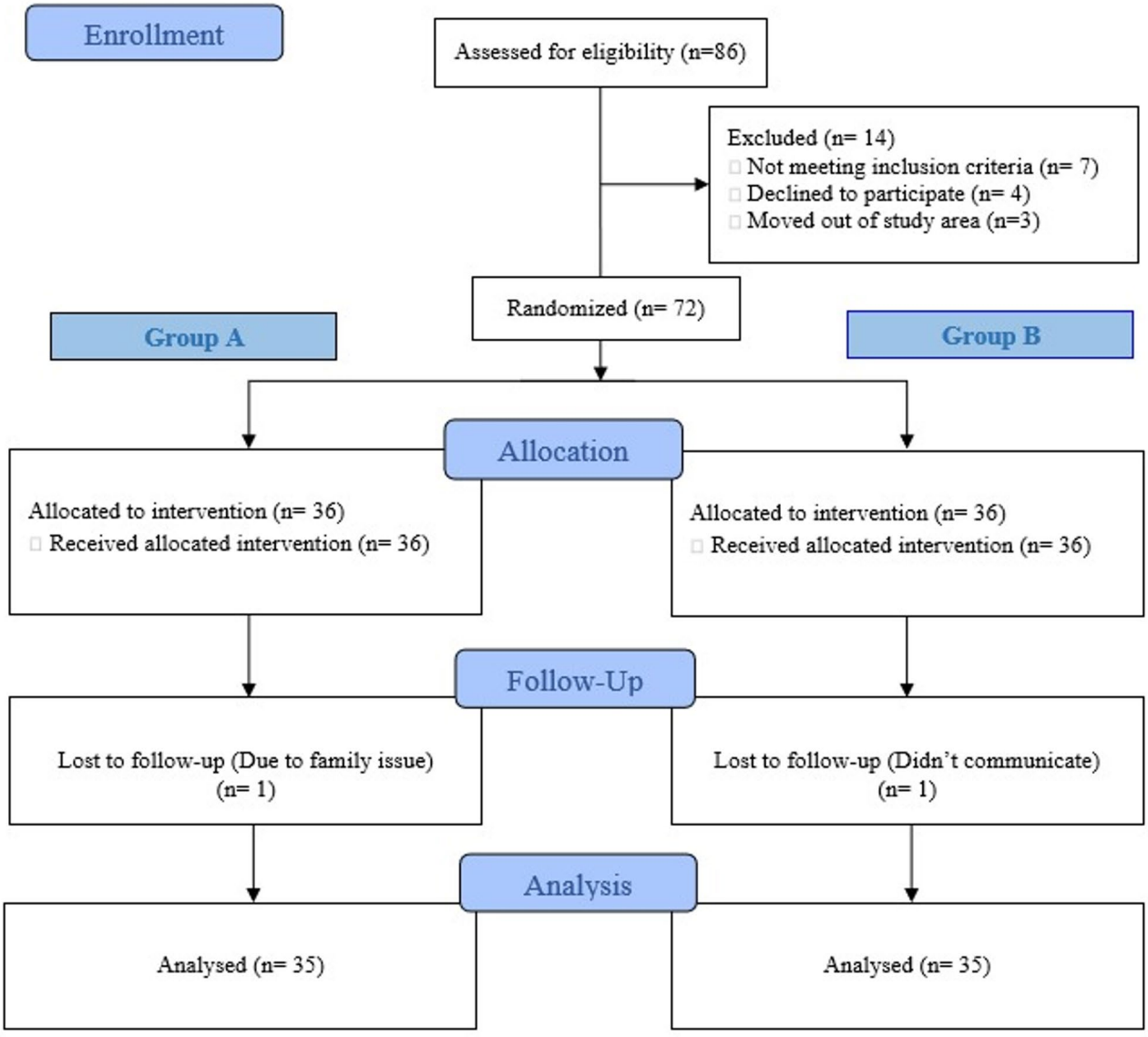

Fig. 1 Consolidated standard of reporting trails (CONSORT) flowchart of this study

of the outpatient department at Proyash, which served as the population frame. Subsequently, potential participants were contacted by telephone to invite them to join the study. Those who expressed interest were screened against the inclusion and exclusion criteria using a questionnaire administered over the phone. The inclusion criteria included: (1) age between 3 and 22 years [28], (2) both boys and girls and (3) diagnosed as children with ASD based on Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-V) criteria [29]. The participants were excluded if they (1) the respondent gave consents but drops out within the first week of enrollment; (2) other neurodevelopmental disorders such as cerebral palsy, down syndrome, and attention deficit/hyperactivity disorder (ADHD) etc.; (3) any self-reported or parent-reported recent (within the past six months) muscle injury or other disease such as muscle sprain, head injury, skin laceration etc [30].

The study samples were chosen through a simple random sampling method, ensuring an unbiased selection process. A secure web-based computerized random assignment sequence was utilized to maintain confidentiality. To further ensure impartial random allocation of participants in either group A or group B, the randomization sequence was generated either by a statistician or through automated technology, preventing any interference from personnel involved in the enrollment process [21].

Sample size

The sample size was determined utilizing ClinCalc software, concentrating on the primary outcome assessed by the Gilliam Autism Rating Scale, Second Edition (GARS – 2) [31]. The sample size was established according to the expected minimum clinically significant differences (MCID) of GARS-2, calculated at 4.7 ± 1.7 (on a 0–10 Hiva scale derived from a 0–126 GARS-2 score). The full sample size, calculated based on a 25% minimum clinical improvement, 1:1 enrollment ratio, 80% power, and an alpha value of 0.05, was 66 [32]. To ensure safety, we recruited 70 children with autism spectrum disorder (ASD), who was divided into two groups, 35 in each group.

Diagnosis of ASD

Screening for autism spectrum disorder (ASD) involves the DSM-5 diagnostic criteria established by the American Psychological Association [33]. The 15-item Childhood Autism Rating Scale (CARS), completed by a licensed psychologist, aids in identifying ASD based on parental descriptions, the Autism Diagnostic Observation Schedule (ADOS), and direct cognitive observations [34]. Key features of ASD include restricted interests, repetitive behaviors, deficits in verbal and nonverbal communication, and challenges in social interaction. These traits appear across socio-economic and cultural contexts, though their expression varies [35]. The severity of symptoms, categorized from Level 1 to Level 3, depends on the degree of hindrance caused by restricted interests and repetitive behaviors [14]. CARS demonstrates high diagnostic accuracy with 98.5% sensitivity and 92% specificity [36].

Intervention

On the first day, an assessor blinded to group assignment conducted additional screening and administered the pre-intervention evaluation. Participants then received multidisciplinary treatment delivered by three postgraduate practitioners from each discipline: physiotherapy, occupational therapy, and speech-language therapy. Each treatment protocol utilized a distinct set of tools and techniques. Each group received interventions three times per week over a six-week period [37].

Group A: Physiotherapy with speech-language and occupational therapy

Physiotherapy intervention Group A received physiotherapy such as balance training on land and in water for 10 min; coordination training for 3 min; hippo-therapy or therapeutic horseback riding for 3 min; proprioception training for 4 min to improve motor function and lower limb strength for 5 min; aerobic exercise to improve sleep, motor skills and muscle strengthening to enhance higher executive performance for 5 min [38–42]. Physiotherapy interventions were carried out daily for 30 min in 1.5-hour daily sessions.

Occupational therapy intervention Sensory integration was customized to each child's unique needs using the ten basic treatment methods outlined in the Credibility Tool [43]. Some of these methods are: (a) arranging space to improve communication; (b) being physically safe; (c) providing alternatives to input sensory; (d) achieving and maintaining proper stimulation levels; (e) providing qualitative challenges by changing activities; (f) ensuring the success of activities; (g) to advise on behavior self-regulation; (h) creating a fun environment; (i) selecting activities together; And (j) Encouraging therapeutic partnership [44]. These ten topics were divided into three main groups: (1) creating sensory opportunities for the child by changing the environment during treatment; (2) providing common challenges and promoting adaptive responses; and (3) Building a rapport between the therapist and the child [45]. Play therapy, balancing training, skill development drills, ball games, pegboard games, and sensory integration exercises are some other interventions that incorporate gross motor function through exercise [46]. Also, cognitive behavioral therapy and community mobility or travel training [47] have been included. Occupational therapy interventions were conducted daily for 30 min in 1.5-hour daily sessions.

Speech and Language therapy interventions Group A underwent Speech and language therapy (SLT) incorporating methods such as Applied Behavior Analysis (ABA), Applied Behavior Consequences (ABC), Relationship Development Intervention (RDA), Cognitive Behavior Intervention (CBI), Picture Communication Exchange Communication System (PECS), Augmentative and Alternative Communication (AAC), social communication interventions (e.g., social story)and visual schedules [48, 49]. Speech and language therapy interventions were ongoing for 30 min in 1.5-hour daily sessions.

Group B: Only occupational therapy and Speech-Language therapy

This group received the same speech and language therapy and occupational therapy treatment protocol for Group A but the treatment duration was 1.5 h per session, and each therapy intervention lasted 45 min, but they did not receive any physiotherapy.

Outcome measurement

A structured questionnaire was developed to collect sociodemographic data, including age, gender, BMI, residential area, birth order, mother's education level, annual household income, history of behavioral intervention,

maternal complications during pregnancy, labor details, delivery type, and postnatal complications [50].

Gilliam autism rating scale III (GARS-3)

ASD children's behavior was assessed using the Gilliam Autism Rating Scale (GARS-3), third edition. The 58-item scale measures Restricted/Repetitive Behaviors (13), Social Interaction (14), Social Communication (9), and Emotional Responses (8). Cognitive Style (seven measures) and Maladaptive Speech (seven items) are used for talkative youngsters. The child's current actions were evaluated with a four-point Likert scale: "not at all like the individual" (0), "not much like the individual" (1), "somewhat like the individual" (2), "very much like the individual" (3), if an item's evaluation is unclear, extended observation or prior behavioral data should be used. The Autism Index demonstrated high reliability, with Cronbach's alpha values of 0.94 and 0.93 for the four- and six-subscale versions, respectively [31].

Modified SF-36

The SF-36 questionnaire is a widely-used tool comprising 36 items that yield eight scores, four of which pertain to physical health: general health, role limitations due to physical problems, physical discomfort, and physical functioning [51]. The remaining scores cover vitality, mental health, role limitations due to affective disorders, and social functioning, with each scale ranging from 0 to 100 [52]. The questionnaire demonstrated strong reliability, with Cronbach's alpha exceeding 0.85 and reliability coefficients above 0.75 across all dimensions [53]. A modified SF-36 was applied to assess activity limitations, physical health challenges, and mental health concerns in children with autism spectrum disorder (ASD) [54].

Data analysis

Parametric tests were applied to analyze interval and ratio data, while non-parametric tests were utilized for nominal and ordinal data. Data normality was assessed using the Kolmogorov-Smirnov test, and a p-value < 0.05 indicated non-normal distribution [25]. Consequently, descriptive statistics, including median and interquartile range (IQR), were employed for sociodemographic analysis. Between-group differences in behavioral and physical performance of ASD children were analyzed using the Mann-Whitney U-test, while within-group analyses for these variables were performed with the Wilcoxon signed-rank test by. The significance level was set at $p < 0.05$. All statistical analyses were performed using SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA).

Results

Following randomization, 70 patients were assigned to one of two groups: Group A ($n = 35$) or Group B ($n = 35$). Each group had equal drops out during the post-assessment period.

Socio-demographic information

The sociodemographic and clinical information are summarized in Table 1. The average age of the participants in Group A was 10.66 ± 3.28 and in Group B 9.17 ± 2.83 years. The body mass index of the participant in Group A was 21.86 ± 7.96 Kg/m2 and in Group B was 19.53 ± 4.85 Kg/m2. In both groups, the male participants number was the maximum, 80% ($n = 28$) in the Group A and 71.40% ($n = 25$) in the Group B and female participants number was the maximum, 20% ($n = 7$) in the Group A and 28.60% ($n = 10$) in the Group B. Most of the participants lived in the urban areas Group A 74.30% ($n = 26$) and Group B 82.90% ($n = 29$) but they were mostly from rural areas Group A 25.70% ($n = 9$) and Group B 17.10% ($n = 6$). Regarding mothers' educational status, most participants 40.00% ($n = 14$) completed graduation in Group A whereas 34.30% ($n = 12$) completed up to SSC education in Group B.

The average monthly family income of the participants in Group A was 45 K (35 K to 70 K) BDT and Group B was 40 K (35 K to 50 K) BDT. The firstborn child was Group A 65.70% ($n = 23$) and Group B 54.30% ($n = 19$). In both groups, the maximum number of participants was term baby Group A 88.60% ($n = 31$) and Group B 65.70% ($n = 23$). Most of the participants were C-section delivery in both groups, 91.40% ($n = 32$) in Group A and 85.70% ($n = 30$) in Group B. Regarding clinical characteristics, most of the participants had no birth complications in both groups, 88.60% ($n = 31$) in the Group A and 71.40% ($n = 25$) in the Group B. Birth asphyxia was the most common birth complications in both groups, 8.60% ($n = 3$) in the Group A and 14.30% ($n = 5$) in the Group B. Autism severity level 3 was the most common 60.00% ($n = 21$) in Group A and Autism severity level 2 was the most common 62.90% ($n = 22$) in Group B. The average GARS-3 score of the participants in Group A was 107.09 ± 16.62 and in Group B was 93.80 ± 16.56 and the modified SF-36 total score was 38.66 ± 5.31 in Group A and 42.06 ± 2.41 in Group B.

Physical and behavioral status of the participants

Both group participants were screened for Gilliam Autism Rating Scale scores and Modified SF-36 scores of the participants (Tables 2 and 3). In terms of physical status evaluated by modified SF-36 where the between-group analysis showed significant change was found in between both groups (z value = 5.72, p-value < 0.001). In the case of behavioral status evaluated by GARS-3, also

Table 1 Socio-demographic and clinical characteristics of the participants at baseline

Characteristics	Overall (*n* = 70) % (*n*)	Group A (*n* = 35) % (*n*)	Group B (*n* = 35) % (*n*)	*p*-value
Age (years) Median (IQR)	9 (8 to 12)	10 (8 to 13)	9 (7 to 12)	0.07[a*]
Body Mass Index (Kg/m^2) Median (IQR)	20.15 (16.10 to 23.50)	20.20 (16.50 to 25.40)	19.70 (15.30 to 22.70)	0.27[a]
Gender				
Male	75.70 (53)	80.00 (28)	71.40 (25)	0.38[b]
Female	24.30 (17)	20.00 (7)	28.60 (10)	
Living area				
Urban	78.60 (55)	74.30 (26)	82.90 (29)	0.51[b]
Rural	21.40 (15)	25.70 (9)	17.10 (6)	
Mothers' education				
Up to SSC	20.00 (14)	5.70 (2)	34.30 (12)	0.13[c]
HSC	32.90 (23)	37.10 (13)	28.60 (10)	
Graduation / Bachelor	34.30 (24)	40.00 (14)	28.60 (10)	
Post-graduation	12.90 (9)	17.10 (6)	8.60 (3)	
Monthly family income (BDT) Median (IQR)	45 K (35 K to 60 K)	45 K (35 K to 70 K)	40 K (35 K to 50 K)	0.24[a]
First born child				
Yes	60.00 (42)	65.70 (23)	54.30 (19)	0.74[b]
No	28.00 (28)	34.30 (12)	45.70 (16)	
Birth term				
Pre-term baby (Before 37 weeks)	12.90 (9)	2.90 (1)	22.90 (8)	0.89[c]
Term baby (38–42 weeks)	77.10 (54)	88.60 (31)	65.70 (23)	
Post-term baby (After 42 weeks)	10.00 (7)	8.60 (3)	11.40 (4)	
Type of delivery				
Normal delivery	11.40 (8)	8.60 (3)	14.30 (5)	0.62[b]
C-section delivery	88.60 (62)	91.40 (32)	85.70 (30)	
Birth complications				
Kernicterus	2.90 (2)	-	5.70 (2)	0.53[c]
Birth asphyxia	11.40 (8)	8.60 (3)	14.30 (5)	
Microcephaly	1.40 (1)	2.90 (1)	-	
Low birth weight	2.90 (2)	-	5.70 (2)	
Pneumonia	1.40 (1)	-	2.90 (1)	
No	80.00 (56)	88.60 (31)	71.40 (25)	
Autism severity level				
Level 2	51.40 (36)	40.00 (14)	62.90 (22)	0.81[c]
Level 3	48.60 (34)	60.00 (21)	37.10 (13)	
Total GARS-3 Score Median (IQR)	100 (96 to 112)	105 (95 to 120)	97 (96 to 106)	0.10[a]
Modified SF-36 Total Score Median (IQR)	34 (31 to 42)	32 (30 to 35)	42 (31 to 42)	0.28[a]

(a, Mann-Whitney U Test; b,Fisher's Exact Test; c, Pearson Chi-Square Test; *baseline compatible)

Table 2 Intergroup and intragroup analysis of total GARS-3 scores of the participants

Outcome group	Baseline	After treatment	Within group change scores		Between group change scores	
Total GARS-3 score						
Group A	**Median (IQR)**	**Median (IQR)**	**Z**	**p**	**Z**	**p**
	105 (95 to 120)	71 (60 to 81)	5.16	0.001[**]	5.72	0.001[**]
Group B	97 (96 to 106)	95 (83 to 105)	1.93	0.053		

([**]Significant at 99% Confidence Level; Within-group analysis: Wilcoxon rank test; between-group analysis: Mann-Whitney U test)

Table 3 Intergroup and intragroup analysis of modified SF-36 scores of the participants

Outcome group	Baseline	After treatment	Within group change scores		Between group change scores	
Modified SF-36 score						
Group A	**Median (IQR)**	**Median (IQR)**	**Z**	**p**	**Z**	**p**
	32 (30 to 35)	43 (41 to 44)	5.10	0.001**	3.99	0.001**
Group B	38 (29 to 42)	42 (31 to 42)	0.93	0.354		

(**Significant at 99% Confidence Level; Within-group analysis: Wilcoxon rank test; between-group analysis: Mann-Whitney U test)

showed significant change was found in between both groups (z value = 3.99, p-value < 0.001). This means physiotherapy combined with occupational and speech & language therapy is more effective than only occupational and speech & language therapy interventions for improving behavioral and physical status of the ASD children.

In within-group analysis showed significant change in both outcome parameters of only group A, for behavioural status, Z value = 5.16, p-value < 0.001 and for physical status, Z value = 5.10, p-value < 0.001. These results suggest that the addition of physiotherapy contributed to significant improvements in Group A participants with ASD.

Discussion

This study was carried out to determine the efficacy of combination therapy in improving the physical and behavioral status of children with autism spectrum disorder (ASD), addressing a worldwide concern among this population. Multiple studies discussed various therapeutic modalities, including physiotherapy, occupational therapy, and speech and language therapy, to address the physical and behavioral conditions of children with ASD. Nevertheless, no research has directly contrasted the effectiveness of physiotherapy with occupational and speech and language treatment approaches. The study objectives were met, and Group A demonstrated statistically significant improvements across all measured outcomes compared to Group B. The study involved participants from two groups, Group A and Group B, with varying body mass indexes and living conditions. Male participants were the most common, with 80% in Group A and 71.40% in Group B.

In a study by Lins et al. [51] most participants lived in urban areas, while rural areas had a smaller percentage. Most mothers completed graduation in Group A, while in Group B, 34.30% completed up to SSC education. Most participants had no birth complications, with birth asphyxia being the most common. Autism severity level 3 was the most common in both groups. The GARS-3 scores were similar between the two groups. The study's results correspond with extensive studies on autism prevalence and related demographic patterns. The high proportion of male participants (80% in Group A, 71.4% in Group B) aligns with the commonly noted male-to-female ratio in autism diagnoses, which is frequently described as hereditary and diagnostic influences [44]. The urban concentration of participants aligns with literature suggesting elevated ASD diagnosis rates in metropolitan regions, where healthcare access and knowledge are superior. In contrast, rural areas experience delayed diagnoses due to resource limitations and dependence on schools for screening.

Higher maternal education in Group A compared to Group B underscores the role of socioeconomic factors in early ASD detection and intervention [45]. Despite this, similar GARS-3 scores and autism severity across groups suggest that such factors may not significantly affect severity as assessed by standardized tools [36]. The observed reduction in stereotyped behaviors following exercise aligns with existing evidence supporting the benefits of physical activity on motor function and engagement in children with ASD [29]. The cited study revealed that a 48-week intervention significantly enhanced motor and verbal stereotypes and responsiveness. These findings align with previous research indicating aerobic activities (e.g., running, cycling, and ball sports) [48] and structured regimens such as combination workouts and martial arts techniques (e.g., Kata) significantly diminish stereotyped tendencies. Aerobic and organized exercise therapies seem to modulate sensory reactivity and promote motor coordination, hence improving social engagement and diminishing repeated behaviors [39].

This corresponds with the neurophysiological advantages of exercise, such as enhanced brain plasticity and executive functioning. The results endorse the use of physical activity in therapy interventions for ASD to mitigate both behavioral and motor deficiencies [31]. Bahrami et al. [55] conducted a study examining the impact of an exercise program (Kata methods) on children with ASD, finding a consistent reduction in stereotypic behaviors in 42.54% of individuals within the exercise group.

Ferreira et al. [24] demonstrated that ball training interventions reduced stereotyped behaviors in children with high-functioning ASD. In the present study, participants in Group A; who received combined physiotherapy, occupational, and speech-language therapy showed greater improvement than those in Group B. Physiotherapy targeted balance, coordination, proprioception, lower limb strength, and aerobic fitness. Occupational therapy

focused on play-based activities, skill development, sensory integration, cognitive-behavioral training, and community mobility. Speech-language therapy employed methods such as Applied Behavior Analysis, Relationship Development Intervention, PECS, augmentative communication, and social storytelling.

The inclusion of aerobic exercises also promotes overall fitness and may have beneficial effects on both physical health and emotional regulation, which is particularly important given the often-observed comorbidities of ASD, such as anxiety and hyperactivity [56]. Cognitive-behavioral training in the context of occupational therapy has been shown to support emotional regulation and adaptive behaviors, leading to improved participation in daily activities and social interactions [57]. Moreover, the inclusion of social stories in speech-language therapy aims to improve social understanding and interaction, which is often a significant challenge for children with ASD [48].

This study had several strengths, including its focus on a combined intervention of physiotherapy, occupational therapy, and speech therapy, which highlights a holistic approach to addressing physical and behavioral challenges in children with ASD. The use of validated tools like the modified SF-36 and GARS-3 enhances the reliability of the findings, while the assessor-blinded randomized clinical trial design minimizes bias. Furthermore, the statistical rigor with descriptive and inferential analyses supports the credibility of the results, emphasizing the effectiveness of tailored rehabilitation programs.

However, the study has some weaknesses. It was conducted in a single institute, limiting the generalizability of the findings to other geographical or clinical settings. The relatively short intervention period of six weeks may not fully capture long-term developmental or behavioral changes. Additionally, while improvements were significant, details about the specific contribution of each therapy type to the overall outcomes remain unclear, which could have added more depth to the analysis.

Conclusion

This clinical trial examined the significant impact of a comprehensive approach, incorporating physiotherapy, occupational therapy with speech and language therapy, on enhancing the physical and behavioral conditions of children diagnosed with autism spectrum disorder (ASD). The study demonstrated that children with ASD experienced significant improvements in physical outcomes following a six-week physiotherapy-based intervention. Balance, coordination, and motor skills were all improved as a result of the fundamental exercise routine that was followed by the youngsters. According to the findings of the research that was carried out, the fundamental exercise programs produced favorable results in terms of the children's motor abilities, along with their balance and coordination. As a result of the fact that both of these physical therapy procedures are simple and basic, they can be simply implemented at home, which means that parents may significantly improve their children's physical well-being. This comprehensive intervention revealed the potential of holistic treatment strategies in managing autism spectrum disorder (ASD) by addressing several developmental aspects. It enhanced motor skills and physical functioning, promoting improved communication and social behaviors.

Abbreviations

ASD	Autism Spectrum Disorder
ABA	Applied Behavior Analysis
ABC	Applied Behavior Consequences
DSM – 5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
GAR – 3	Gilliam Autism Rating Scale – Third Edition
ICD – 10	International Classification of Diseases, Tenth Revision
OT	Occupational therapy
PECS	Picture Communication Exchange Communication System
PT	Physiotherapy
RDI	Relationship Development Intervention
SF – 36	Short Form – 36
SLT	Speech and Language Therapy

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Author contributions

MSH and AHK contributed to finalizing the methodology, overseeing project administration, resource acquisition, software procurement for data analysis, and drafting the original manuscript. MMI and KMAH provided supervision, reviewed, and edited the manuscript. AHK carried out investigations, validated the study, and managed visualization efforts. NA assisted in organizing supplementary files. All authors reviewed and approved the final manuscript.

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Data availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

On May 20, 2024, the Institutional Review Board (IRB) of the Department of Physiotherapy and Rehabilitation at the Jashore University of Science & Technology granted the trial ethical approval (PTR-JUST/IRB/2024/05/222403). On July 8, 2024, the trial was registered prospectively with the Clinical Trial Registry India (CTRI) (CTRI/2024/07/070209). The administrative authority of Proyash Institute of Special Education, Jashore was provided the necessary permission letter to conduct the study in their facility (Ref: 23.01.955.295.04.099.28.11.24). The researcher complied with the ethical principles outlined in the Helsinki Declaration. Informed consent to participate was obtained from the parents or legal guardians of any participant under the age of 16.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Physiotherapy, Japan Bangladesh Friendship College of Physiotherapy & Health Sciences, Dhaka 1216, Bangladesh
[2]Department of Physiotherapy, Bangladesh Shishu (Children) Hospital and Institute, Dhaka 1207, Bangladesh
[3]Department of Physiotherapy & Rehabilitation, Jashore University of Science & Technology, Jashore 7408, Bangladesh

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References

1. Lord C, Elsabbagh M, Baird G, Veenstra-Vanderweele J. Autism spectrum disorder. Lancet. 2018;392(10146):508–20. https://doi.org/10.1016/s0140-6736(18)31129-2.
2. Travers BG, Mason AH, Gruben KG, Dean DC III, McLaughlin K. Standing balance on unsteady surfaces in children on the autism spectrum: the effects of IQ. Res Autism SpectrDisord. 2018;51:9–17. https://doi.org/10.1016/j.rasd.2018.03.008.
3. Zeidan J, Fombonne E, Scorah J, Ibrahim A, Durkin MS, Saxena S, Yusuf A, Shih A, Elsabbagh M. Global prevalence of autism: A systematic review update. Autism Res. 2022;15(5):778–90. https://doi.org/10.1002/aur.2696.
4. Chiarotti F, Venerosi A. Epidemiology of autism spectrum disorders: a review of worldwide prevalence estimates since 2014. Brain Sci. 2020;10(5):274. https://doi.org/10.3390/brainsci10050274.
5. Elsabbagh M, Divan G, Koh YJ, Kim YS, Kauchali S, Marcín C, Montiel-Nava C, Patel V, Paula CS, Wang C, Yasamy MT. Global prevalence of autism and other pervasive developmental disorders. Autism Res. 2012;5(3):160–79. https://doi.org/10.1002/aur.239.
6. Rhoades RA, Scarpa A, Salley B. The importance of physician knowledge of autism spectrum disorder: results of a parent survey. BMC Pediatr. 2007;7:1–0. https://doi.org/10.1186/1471-2431-7-37.
7. Khan AH, Bhuiyan MS, Kabir MF, Hossain MZ, Jahan S, Hossain KA, Rahman E. Effectiveness of proprioceptive neuromuscular facilitation pattern on upper extremity and scapula in patients with adhesive capsulitis: a single-centre assessor-blinded randomised controlled trial (RCT). Trials. 2025;26(1):146. https://doi.org/10.1186/s13063-025-08848-0.
8. Christensen DL. Prevalence and characteristics of autism spectrum disorder among children aged 8 years—autism and developmental disabilities monitoring network, 11 sites, united states, 2012. MMWR SurveillSumm. 2016;65(3):1–23. https://doi.org/10.15585/mmwr.ss6503a1.
9. Faruk MO, Rahman MS, Rana MS, Mahmud S, Al-Neyma M, Karim MS, Alam N. Socioeconomic and demographic risk factors of autism spectrum disorder among children and adolescents in bangladesh: evidence from a cross-sectional study in 2022. PlosOne. 2023;18(8):e0289220. https://doi.org/10.1371/journal.pone.0289220.
10. Brignell A, Chenausky KV, Song H, Zhu J, Suo C, Morgan AT. Communication interventions for autism spectrum disorder in minimally verbal children. Cochrane Database Syst Rev. 2018;11(11):CD012324. https://doi.org/10.1002/14651858.CD012324.pub2.
11. Elder JH, Kreider CM, Brasher SN, Ansell M. Clinical impact of early diagnosis of autism on the prognosis and parent–child relationships. Psychol Res BehavManag. 2017;10:283–92. https://doi.org/10.2147/prbm.s117499.
12. Harstad E, Hanson E, Brewster SJ, DePillis R, Milliken AL, Aberbach G, Sideridis G, Barbaresi WJ. Persistence of autism spectrum disorder from early childhood through school age. JAMA Pediatr. 2023;177(11):1197–205. https://doi.org/10.1001/jamapediatrics.2023.4003.
13. Hyman SL, Levy SE, Myers SM, Kuo DZ, Apkon S, Davidson LF, Ellerbeck KA, Foster JE, Noritz GH, Leppert MO, Saunders BS. Identification, evaluation, and management of children with autism spectrum disorder. Pediatrics. 2020;145(1):e20193447. https://doi.org/10.1542/peds.2019-3447.
14. Waizbard-Bartov E, Fein D, Lord C, Amaral DG. Autism severity and its relationship to disability. Autism Res. 2023;16(4):685–96. https://doi.org/10.1002/aur.2898.
15. LaFrance DL, Weiss MJ, Kazemi E, Gerenser J, Dobres J. Multidisciplinary teaming: enhancing collaboration through increased Understanding. Behav Anal Pract. 2019;12(3):709–26. https://doi.org/10.1007/s40617-019-00331-y.
16. Sharmin F, Hossain MF, Bari MU, Khan AH, Hossain MA, Ali ME, Datta A, Sabrin SM, Sharmin F, Rashid HO, Karim MR. Effectiveness of task-oriented circuit training on the motor performance of ischaemic stroke patients: a study protocol for randomised clinical trial. BMJ Open Sport Exerc Med. 2025;11(2):e002604. https://doi.org/10.1136/bmjsem-2025-002604.
17. Yu CC, Wong SW, Lo FS, So RC, Chan DF. Study protocol: a randomized controlled trial study on the effect of a game-based exercise training program on promoting physical fitness and mental health in children with autism spectrum disorder. BMC Psychiatry. 2018;18(1):56. https://doi.org/10.1186/s12888-018-1635-9.
18. Chen S, Zhang Y, Zhao M, Du X, Wang Y, Liu X. Effects of therapeutic horseback-riding program on social and communication skills in children with autism spectrum disorder: a systematic review and meta-analysis. Int J Environ Res Public Health. 2022;19(21):14449. https://doi.org/10.3390/ijerph192114449.
19. Ajzenman HF, Standeven JW, Shurtleff TL. Effect of hippotherapy on motor control, adaptive behaviors, and participation in children with autism spectrum disorder: A pilot study. Am J OccupTher. 2013;67(6):653–63. https://doi.org/10.5014/ajot.2013.008383.
20. Alhowikan AM, Elamin NE, Aldayel SS, AlSiddiqi SA, Alrowais FS, Hassan WM, El-Ansary A, Alghamdi FA, Al-Ayadhi LY. Children with autism spectrum disorder exhibit elevated physical activity and reduced sedentary behavior. Brain Sci. 2023;13(11):1575. https://doi.org/10.3390/brainsci13111575.
21. Sattar MM, Khan AH, Kabir MF, Hossain KA, Jahan S, Rahman E, Sharmin F, Bhuiyan MS, Islam A, Hossain MK, Hossain MZ. Effectiveness of massage gun versus myofascial release technique for releasing latent trigger points of the calf muscle: a protocol for randomized clinical trial. Physiother Res Int. 2025;30(2):e70055. https://doi.org/10.1002/pri.70055.
22. Tan BW, Pooley JA, Speelman CP. A meta-analytic review of the efficacy of physical exercise interventions on cognition in individuals with autism spectrum disorder and ADHD. J Autism Dev Disord. 2016;46:3126–43. https://doi.org/10.1007/s10803-016-2854-x.
23. Oriel KN, George CL, Peckus R, Semon A. The effects of aerobic exercise on academic engagement in young children with autism spectrum disorder. Pediatr Phys Ther. 2011;23(2):187–93. https://doi.org/10.1097/pep.0b013e318218f149.
24. Ferreira JP, Ghiarone T, Cabral Junior CR, Furtado GE, Moreira Carvalho H, Machado-Rodrigues AM, Andrade Toscano CV. Effects of physical exercise on the stereotyped behavior of children with autism spectrum disorders. Med (Kaunas). 2019;55(10):685. https://doi.org/10.3390/medicina55100685.
25. Alam MJ, Pratik MI, Khan AH, Islam MS, Hossain MM. Prevalence and level of stress among final-year students at a health science Institute in Bangladesh. Discov Ment Health. 2025;5(1):9. https://doi.org/10.1007/s44192-025-00136-2.
26. Toscano CV, Barros L, Lima AB, Nunes T, Carvalho HM, Gaspar JM. Neuroinflammation in autism spectrum disorders: exercise as a Pharmacological tool. NeurosciBiobehav Rev. 2021;129:63–74. https://doi.org/10.1016/j.neubiorev.2021.07.023.
27. Merkow RP, Kaji AH, Itani KM. The CONSORT framework. JAMA Surg. 2021;156(9):877. https://doi.org/10.1001/jamasurg.2021.0549.
28. Alipour V, Shabani R, Zarrindast MR, Rahmani-Nia F, Nasehi M. Treadmill exercise improves stereotypical behaviors in autistic rats: treadmill exercise improves ASD. Galen Med J. 2022;11:1–7. https://doi.org/10.31661/gmj.v11i.1990.
29. Huerta M, Bishop SL, Duncan A, Hus V, Lord C. Application of DSM-5 criteria for autism spectrum disorder to three samples of children with DSM-IV diagnoses of pervasive developmental disorders. Am J Psychiatry. 2012;169(10):1056–64. https://doi.org/10.1176/appi.ajp.2012.12020276.
30. Haghighi AH, Broughani S, Askari R, Shahrabadi H, Souza D, Gentil P. Combined physical training strategies improve physical fitness, behavior, and social skills of autistic children. J Autism Dev Disord. 2023;53(11):4271–9. https://doi.org/10.1007/s10803-022-05731-8.
31. Samadi SA, Biçak CA, Noori H, Abdalla B, Abdullah A, Ahmed L. Autism spectrum disorder diagnostic criteria changes and impacts on the diagnostic scales-utility of the 2nd and 3rd versions of the Gilliam autism rating scale (GARS). Brain Sci. 2022;12(5):537. https://doi.org/10.3390/brainsci12050537.
32. Akter R, Urme NA, Hossain KA, Hossain T, Ahammad S, Yeasmin MH, Hossain MZ, Parvin R, Hossain MS, Zahid MA. Protocol for a randomized clinical trial comparing the efficacy of structured diet (SD) and regular therapy (RT) for

adolescents with malnutrition having autism spectrum disorder (ASD). PLoS ONE. 2023;18(11):e0292326. https://doi.org/10.1371/journal.pone.0292326.
33. Wiggins LD, Rice CE, Barger B, Soke GN, Lee LC, Moody E, Edmondson-Pretzel R, Levy SE. DSM-5 criteria for autism spectrum disorder maximizes diagnostic sensitivity and specificity in preschool children. Soc Psychiatry PsychiatrEpidemiol. 2019;54(6):693–701. https://doi.org/10.1007/s00127-019-01674-1.
34. Moulton E, Bradbury K, Barton M, Fein D. Factor analysis of the childhood autism rating scale in a sample of two year olds with an autism spectrum disorder. J Autism Dev Disord. 2019;49(7):2733–46. https://doi.org/10.1007/s10803-016-2936-9.
35. Hodges H, Fealko C, Soares N. Autism spectrum disorder: definition, epidemiology, causes, and clinical evaluation. TranslPediatr. 2020;9(Suppl 1):S55–65. https://doi.org/10.21037/tp.2019.09.09.
36. Russell PS, Daniel A, Russell S, Mammen P, Abel JS, Raj LE, Shankar SR, Thomas N. Diagnostic accuracy, reliability and validity of childhood autism rating scale in India. World J Pediatr. 2010;6(2):141–7. https://doi.org/10.1007/s12519-010-0029-y.
37. Haque S, Khan AH, Kabir F, Jahan S, Hossain Z, Rahman E, Akter N, Hossain KA. Study protocol for a Single-center randomized clinical trial: evaluating the effectiveness of combined therapy versus conventional therapy approaches to improve physical & behavioral status among children with autism spectrum disorder. J Health Sci Med Res. 2025;43(4):e20251207. https://doi.org/10.31584/jhsmr.20251207.
38. Gabriels RL, Pan Z, Dechant B, Agnew JA, Brim N, Mesibov G. Randomized controlled trial of therapeutic horseback riding in children and adolescents with autism spectrum disorder. J Am Acad Child Adolesc Psychiatry. 2015;54(7):541–9. https://doi.org/10.1016/j.jaac.2015.04.007.
39. Ansari S, Hosseinkhanzadeh AA, AdibSaber F, Shojaei M, Daneshfar A. The effects of aquatic versus kata techniques training on static and dynamic balance in children with autism spectrum disorder. J Autism Dev Disord. 2021;51:3180–6. https://doi.org/10.1007/s10803-020-04785-w.
40. Belaiba M, Laatar R, Borji R, Ben Salem A, Sahli S, Rebai H. Time limited benefits of physical and proprioceptive training on physical fitness components in children with autism spectrum disorders. Percept Mot Skills. 2024;131(3):785–804. https://doi.org/10.1177/00315125241244484.
41. Wu Y, Ding L, Zhang Q, Dong Y, Tao C, Li Z, Li Z, Lu L. The effect of physical exercise therapy on autism spectrum disorder: a systematic review and meta-analysis. Psychiatry Res. 2024;339:116074. https://doi.org/10.1016/j.psychres.2024.116074.
42. Passarello N, Tarantino V, Chirico A, Menghini D, Costanzo F, Sorrentino P, Fucà E, Gigliotta O, Alivernini F, Oliveri M, Lucidi F. Sensory processing disorders in children and adolescents: taking stock of assessment and novel therapeutic tools. Brain Sci. 2022;12(11):1478. https://doi.org/10.3390/brainsci12111478.
43. Podolan M, Gelo OC. The functions of safety in psychotherapy: an integrative theoretical perspective across therapeutic schools. Clin Neuropsychiatry. 2023;20(3):193–204. https://doi.org/10.36131/cnfioritieditore20230304.
44. Akter MS, Khan AH, Kabir MF, Hossain MZ, Rahman E, Hossain KA, Hossain T, Jahid MI, Yin KN, Jahan S. Effect of pelvic floor muscle exercise with postural advice on improving quality of life among pregnant mothers in bangladesh: a randomized controlled trial. Discov Public Health. 2024;21(1):97. https://doi.org/10.1186/s12982-024-00221-x.
45. Sutapa P, Pratama KW, Rosly MM, Ali SK, Karakauki M. Improving motor skills in early childhood through goal-oriented play activity. Child (Basel). 2021;8(11):994. https://doi.org/10.3390/children8110994.
46. Beck JS, Fleming S. A brief history of Aaron T. Beck, MD, and cognitive behavior therapy. ClinPsychol Eur. 2021;3(2):e6701. https://doi.org/10.32872/cpe.6701.
47. Thompson GA, Abel LA. Fostering spontaneous visual attention in children on the autism spectrum: A proof-of-concept study comparing singing and speech. Autism Res. 2018;11(5):732–7. https://doi.org/10.1002/aur.1930.
48. Hutchins TL, Prelock PA. The social validity of social stories™ for supporting the behavioural and communicative functioning of children with autism spectrum disorder. Int J Speech Lang Pathol. 2013;15(4):383–95. https://doi.org/10.3109/17549507.2012.743174.
49. Pfeiffer BA, Koenig K, Kinnealey M, Sheppard M, Henderson L. Effectiveness of sensory integration interventions in children with autism spectrum disorders: A pilot study. Am J OccupTher. 2011;65(1):76–85. https://doi.org/10.5014/ajot.2011.09205.
50. Khan AH, Bhuiyan SH, Hossain Z. Priming factors related to burn injury among people in Bangladesh. J Health Allied Sci NU. 2024;14(1):102–5. https://doi.org/10.1055/s-0043-1766126.
51. Lins L, Carvalho FM. SF-36 total score as a single measure of health-related quality of life: scoping review. SAGE Open Med. 2016;4:2050312116671725. https://doi.org/10.1177/2050312116671725.
52. Ezzati A, Zammit AR, Katz MJ, Derby CA, Zimmerman ME, Lipton RB. Health-related quality of life, cognitive performance, and incident dementia in a community-based elderly cohort. Alzheimer Dis AssocDisord. 2019;33(3):240–5. https://doi.org/10.1097/WAD.0000000000000324.
53. Bunevicius A. Reliability and validity of the SF-36 health survey questionnaire in patients with brain tumors: a cross-sectional study. Health Qual Life Outcomes. 2017;15(1):92. https://doi.org/10.1186/s12955-017-0665-1.
54. Garriot CC, Villes V, Bartolini AM, Poinso F. Self-perceived health of parents of children with autism spectrum disorders: relation with the severity level. Psychology. 2014;5(19):2189–99. https://doi.org/10.4236/psych.2014.519221.
55. Bahrami F, Movahedi A, Marandi SM, Sorensen C. The effect of karate techniques training on communication deficit of children with autism spectrum disorders. J Autism Dev Disord. 2016;46:978–86. https://doi.org/10.1007/s10803-015-2643-y.
56. Lauritsen MB, Astrup A, Pedersen CB, Obel C, Schendel DE, Schieve L, Yeargin-Allsopp M, Parner ET. Urbanicity and autism spectrum disorders. J Autism Dev Disord. 2014;44:394–404. https://doi.org/10.1007/s10803-013-1875-y.
57. Mohammadzaheri F, Koegel LK, Rezaee M, Rafiee SM. A randomized clinical trial comparison between pivotal response treatment (PRT) and structured applied behavior analysis (ABA) intervention for children with autism. J Autism Dev Disord. 2014;44:2769–77. https://doi.org/10.1007/s10803-014-2137-3.

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