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Original Article

Int J Clin Pediatr. 2024;13(1):14-25

Comparative Analysis of Effectiveness of Online Versus Offline Parent-Mediated Therapeutic Intervention in Preschool Children With Autism Spectrum Disorder

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Abstract

Background: Proper management of an autistic child requires a multidisciplinary team of professionals such as a developmental pediatrician, psychologist, special educator, speech-language pathologist, occupational therapist, etc. With the increase in the prevalence of autism spectrum disorder (ASD), there is a lack of trained specialists in providing adequate services to autistic children in underserved countries. During the COVID-19 pandemic, the implementation of online therapy for autistic children was found to be effective in several types of research. Naturalistic developmental behavioral interventions (NDBIs) delivered by parents at an early age are effective in improving long-term outcomes for these children. Therapists-guided online parent-mediated intervention in preschool autistic children may reduce substantial service system demands due to the scarcity of professionals. This research was conducted to compare the effectiveness of online versus in-person parent-mediated interventions in preschool autistic children in resource-limited settings.

Methods: Preschool children (55 online, 65 offline) with ASD from March 8, 2022 to 30 September 30, 2022 were recruited in the Child Development Clinic of a tertiary hospital for the study. The mean changes in cognitive, language, and motor composite scores of the Bayley Scale of Infant Development, third edition (BSID III) and Childhood Autism Rating Scale, second edition (CARS 2) after 3 months of either intervention based on NDBI were compared.

Results: Most children were boys (89 (74.2%)). The mean age of children was 30.58 (± 3.88) months and 31.36 (± 5.06) months for offline and online groups, respectively. There was statistically significant improvement in all three BSID III scores ($P < 0.005$) and a decrease in CARS 2 score ($P < 0.001$) from baseline mean scores after either intervention indicating both interventions to be effective. When compared between interventions, statistically significant mean score changes were not found for cognitive and motor but for language ($P = 0.012$) and CARS 2 scores ($P = 0.034$) favoring in-person therapy in improving communication and autistic symptoms in preschool children with ASD.

Conclusion: The preferred mode of intervention for preschool autistic children was in-person parent-mediated intervention.Therapist-assisted online intervention can be an alternative mode of intervention in countries with fewer specialists capable of managing autistic children.

Keywords: Autism; BSID III; CARS 2; Children; Offline; Online; Parent-mediated

Manuscript submitted April 13, 2024, accepted May 14, 2024
Published online May 23, 2024

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doi: https://doi.org/10.14740/ijcp538

Introduction

Autism spectrum disorder (ASD) is a common neurodevelopmental disorder characterized by a deficit in social communication and interaction with restricted, repetitive patterns of behavior [1]. ASD is a lifelong disorder but it can be diagnosed in children as young as 18 months of age [1]. Early detection and interventions by multidisciplinary teams have been shown to improve long-term outcomes, including communication, cognitive development, social and adaptive behavior, and inhibit early deficits impacting subsequent daily performing skills [2]. Thus, interventions in the preschool period are necessary for children with ASD [3].

Unfortunately, the growing number of ASD cases has been exceeding the services available for children with ASD [4, 5]. The autism and developmental disabilities monitoring network estimates ASD prevalence to be 1 in 36 children aged 8 years in the United States in 2020 [6]. Two years back, it was 1 in 44 children [7]. A recent systemic review by Zeidan et al showed global median prevalence of ASD as 1 per 100 children [8]. There is a large gap between the burden of disease and the availability of effective interventions by specialists such as developmental pediatricians, psychologists, occupational therapists, speech-language pathologists, behavior analysts, or special educators due to a critical shortage of these professionals trained in the interventions for children with ASD [9]. One

way to bridge this gap is to teach parents techniques utilizing teletherapy by ASD specialists in their daily interactions with their children. Parent training using teletherapy was acceptable to parents according to various researches [9-12]. Teletherapy also reduces the financial burdens on the family [9, 11]. Even a systemic review on telehealth and autism by Ellison et al suggested that the services via telehealth were similar or better to than face services [13].

Another systematic review done by Nocker et al found a variety of telehealth interventions for children with ASD in different studies that ranged from structured interventions such as applied behavior analysis (ABA) to naturalistic developmentally oriented interventions such as improving parents as communication teachers (IMPACT) online, early start Denver model (ESDM), joint attention, symbolic play, engagement and regulation (JASPER), skills and knowledge of intervention for language learning success (SKILLS), etc. [14]. A study done by Lindgren et al implemented ABA to find out if challenging behavior in young children aged 48 to 52 months with autism and other developmental disabilities can be treated by training parents using telehealth. In this research, three service delivery models which were in-home therapy, clinic-based telehealth, and home-based telehealth were used in 94 children. In all groups, the mean percentage reduction in problem behavior was more than 90%. The conclusion made from this study was that parents can use ABA techniques to treat behavior problems associated with ASD regardless of whether treatment is directed by behavior consultants in person or via remote video coaching to parents. The cost was lowest for home telehealth [11]. Similarly, a randomized clinical trial was conducted by Fisher et al to evaluate a virtual parent training program for teaching early intensive behavioral intervention (EIBI) using ABA skills to 13 young children with an ASD. The parent in the virtual training group showed large improvements in their implementation of EIBI compared to the control group [15]. Rote responding, lack of spontaneity and self-initiated behavior, and inability to generalize learned behavior are some of the possible flaws that may occur in ABA interventions [16]. Recent interventions in autistic toddlers utilize naturalistic approaches and developmental orientations called naturalistic developmental behavioral interventions (NDBIs) [17]. They include a developmental systems approach that prioritizes the generalization of newly learned skills at every stage of intervention by integrating skills in not only social adaptive but all developmental domains including cognition, language, and motor systems in a child's natural settings [17, 18]. Parents of children between 18 and 48 months were randomized to website access to ESDM learning resources for 12 weeks or to monthly website access to alternative resources without ESDM intervention resources with 1.5 h of video conferencing sessions in both groups in a study conducted by Vismara et al [19]. Children's social communication skills improved for both groups regardless of parent fidelity in this research. A pilot study by Hao et al used NDBIs which are SKILLS based on the IMPACT program, to compare the efficacy of parent training for 15 children between 1 and 10 years with ASD delivered in clinic and via the internet each. The study measured parents' intervention fidelity and children's initiations, responses, lexical diversity, and morphosyntactic complexity in children's natural environment. The findings indicated significant improvements in parents' fidelity and children's language after intervention. There was no significant difference between the two therapy delivery groups on any outcome measures indicating that teletherapy can be as effective as in-person therapy [20]. Sengupta et al did research during the pandemic to find the feasibility and acceptability of synchronous online parent-mediated early intervention based on NDBIs, online project IMPACT in 12 children aged 1 to 6 years with autism in India. They found significant improvement in parent fidelity to intervention and the social communication skills of children [21].

Specific model-based interventions as described above are difficult to execute due to a lack of trained personnel to teach specific or complex intervention strategies of the model, the requirement of expensive and advanced tools or technology such as virtual private networks for web-based modules, etc. They need to be modified to be feasible and culturally accepted converting these modules to center-based parent-mediated in low-resource settings [21-25]. There are published researches on parent-mediated online and in-person direct intervention in children with autism but few comparative researches on parent-mediated online and in-person intervention in preschool children aged 24 to 42 months from resource-limited settings [21-24]. Thus, this comparative prospective study was carried out to compare the effectiveness of online versus in-person parent-mediated therapeutic intervention in preschool children with ASD using a center-based model of NDBIs in resource-limited settings.

Materials and Methods

The study was conducted from March 8, 2022 to September 30, 2022 at the Child Development Clinic (CDC), Institute of Child Health, in Sir Ganga Ram Hospital (SGRH), New Delhi after Institutional Ethics Committee approval (# EC/01/22/1999). This study was conducted in compliance with all the applicable institutional ethical guidelines for the care.

The research team consists of a senior consultant developmental pediatrician, a consultant psychologist for supervising the research, a pediatrician on developmental-behavioral fellowship training (pediatric resident) for recruitment of children, clinical psychologists, and therapy interventionists (occupational, behavioral therapists, speech therapists, and special educators). Preschool children with ASD aged 24 to 42 months, confirmed with the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM 5) [26] by the developmental pediatrician or consultant psychologist were recruited. Children with dysmorphism, medical, and genetic conditions such as chromosomal abnormalities, neurological conditions such as epilepsy, severe hearing or visual impairment, head injury, serious neonatal illness such as hypoxic-ischemic encephalopathy, meningitis, low birth weight were not included as these children may need additional interventions simultaneously such as increase in dose of anti-seizure drugs for uncontrolled seizures, proper use of hearing and visual aids, etc. which may interfere with child's therapies and might be potent confounders during analysis of effectiveness of online and in-

person intervention for ASD. Parents refusing to give consent for their child's participation, or one parent of the recruited child not able to participate in all therapy sessions were also excluded. The sample size calculated was 65 in online and offline intervention groups each to detect a 20% difference in improvement between the two groups with 80% power and with an effect size of 0.50 based on a previous parent-mediated intervention study conducted in a resource-limited setting in autistic Indian children [22]. Written informed consent was obtained from the children's parent before enrollment in the study. A detailed history and physical examination of recruited children was done by the pediatric resident who was supervised by a senior developmental pediatrician and a consultant psychologist. A comprehensive evaluation includes physical, psychological, and developmental assessment which is necessary for appropriate intervention. As NDBIs emphasize the integration of all developmental domains while learning a skill, cognitive, language, and motor domains of development were assessed by a single trained clinical psychologist using Bayley Scales of Infant Development, third edition (BSID III) in each child on the day of enrollment for preintervention cognitive, language and motor composite scores. Similarly, autistic symptoms such as impairment in social-emotional interaction, communication, and behavioral problems including stereotypy or restricted, repetitive patterns of behavior, interests or activities level, and sensory responses were assessed by administration of the standard version of the Childhood Autism Rating Scale, second edition (CARS 2) by another trained clinical psychologist on the same day for pre-intervention CARS 2 scores. The children were then randomized to receive either offline that is in person or online parent-mediated intervention after the group assignment determined by a computer-generated number in sequentially numbered opaque envelopes.

Parents in online groups were reconfirmed for the ability to use videoconferencing methods with therapists for intervention. Enrollment in the study was continued till 130 preschool ASD children, 65 children in each online and offline parent-mediated intervention group were in the study. Reassessment of enrolled ASD children was done after 3 months of in-person or online parent-mediated invention by the same two clinical psychologists using BSID III and CARS 2 scales respectively for post-intervention cognitive, language, and motor composite and CARS 2 scores. Clinical psychologists who did BSID III and CARS 2 before and after intervention were blinded to the mode of intervention and therapy interventionists (behavioral therapists, occupational therapists, speech therapists, and special educators). Therapists involved in either intervention were also blinded to clinical psychologists who did BSID III or CARS 2 before and after parent-mediated intervention.

Assessment tools

BSID III

BSID III is recognized internationally as one of the most comprehensive and standardized tool to assess development of infants and toddlers, aged 16 days to 42 months [27]. As this study comprises preschool children with ASD from 24 to 42 months, all recruited children were subjected to developmental assessment using BSID III. This assessment tool has been validated to be used in Indian children [28]. It takes 90 min to administer this tool for children aged 13 months and older. The BSID III assesses five domains: cognitive, language, motor, social-emotional, and adaptive behavior skills [27]. The Bayley-III has been identified as a useful instrument in the assessment of cognition, language, and motor domains of children with ASD [27, 29-31]. It is a viable research instrument that can track the effect of intervention on children's performance. So, it was used to assess the effectiveness of NDBIs that emphasize improvement in all developmental domains in this research. Cognitive, language, and motor composite scores equivalent to < 85 were taken as a delay in development [27, 32].

CARS 2

The CARS 2 is a 15-item rating scale used to identify children more than 24 months with autism and distinguish them from those with developmental disabilities. It is empirically validated and provides concise, objective, and quantifiable ratings based on direct behavioral observation. The qualified psychologist or clinician rates the individual on each item, using a four-point rating scale. It takes only 5 to 10 min to record the reply form but ratings are based on the frequency of the behavior in question, its intensity, peculiarity, and duration. Total scores can range for CARS 2 from a low of 15 to a high of 60. Scores below 30 indicate that the individual is in the non-autistic range, scores between 30 and 36.5 indicate mild to moderate autism, and scores from 37 to 60 indicate severe autism [33]. The CARS 2 demonstrates agreement with DSM 5 criteria [26, 34] and the Autism Diagnostic Observation Schedule (ADOS-2) for the assessment of autism [35]. CARS was established as accurate, reliable and valid instrument in India in 2010 [36], and then, in 2022, CARS 2 has been shown to have similar identification power to diagnose ASD when compared with Indian questionnaires such as Indian Autism Screening Questionnaire (IASQ) and the Indian Scale for Assessment of Autism (ISAA) in Indian children [37]. The change in CARS score has been used to evaluate efficacy of different interventions in various researches. Juneja et al concluded that a parent-based behavioral intervention program for Indian autistic children was effective based on significant reduction in CARS score (P = 0.001) after 6 months of intervention [22]. Similarly, greater decrease in CARS score (P = 0.002) reflected overall autistic severity improvement in a pilot randomized controlled trial of home-based developmental, individual difference, relationship based floor time parent training intervention conducted by Pajareya et al in preschool children with ASD [16]. Thus, change in CARS 2 score was used to compare effectiveness of offline and online parent-mediated intervention in preschool children in India with ASD in this study.

Details of intervention

Offline therapy is in-person therapy whereas therapist-guided

online parent-mediated therapy is a teletherapy. The difference between interventions was parent received face-to-face live instructions from a therapist and also therapist demonstrated the intervention strategies by physically interacting with enrolled children in the therapy clinic in the offline intervention whereas in online intervention, a parent was taught targeted therapy techniques verbally via internet-based video technologies such as WhatsApp by a therapist and parent in turn instructing the child to do them in the same time at home.

Therapists, method of intervention, and adherence to therapy

Therapists delivering the intervention in both groups were equally qualified and trained to follow a common written institutional intervention protocol for preschool children with ASD. A multidisciplinary team of professional specialists comprising a senior consultant developmental pediatrician, psychologists, special educators, occupational, behavioral therapists and speech-language therapists was involved during therapies. A designated coordinator under the guidance of the senior developmental pediatrician and consultant psychologist was responsible to assign different therapists (a special educator, an occupational, a behavioral, and/ or speech-language therapist) according to need of child. The coordinator would fix date, time and duration of a particular therapy after discussing with parent of recruited children and therapists. This center-based in-person and online intervention included early interventions for each child using the NDBIs in occupational, speech, behavior, and special education sessions and instructions to be followed at home for both groups. These sessions of NDBIs were based on the principles of behavioral learning and developmental theories to achieve target developmental milestones [17, 21]. The behavioral teaching techniques used were modeling, shaping, chaining, prompting, and reinforcement. Targeted developmental milestones for both intervention strategies were to teach motor imitation, joint attention behaviors (index pointing, gaze switching, showing), and social amenities (smiling, saying simple words like please, thank you) based on the child's interests in the natural environment [17, 18]. Natural antecedents and contingencies were utilized to reinforce targeted behavior. Socialization skills were imparted through play-based activities using child-preferred materials with family members and neighbors, e.g., turn taking, requesting, waiting, sharing, and also through social skill training. Activities included in interventions were sorting games using household utensils, vegetables, etc., ball play, play using toy cars, clay, colored stones, and balloons, water play, painting, and coloring. Parents were encouraged to read books, and stories and show pictures to enhance visual learning capabilities. Simple gestures like nodding of the head for yes/no, signs, and symbols were taught to severely autistic children who were non-verbal. In both interventions, a parent was taught different techniques to manage challenging behavior, increase communication skills, and teach new skills in a non-structured individualized manner utilizing child-directed teaching strategies by a therapist. The parents were trained to elicit compliance and develop independent skills such as dressing, and mealtime routines [22]. The aim of the interventions was also to increase parental sensitivity and responsiveness to child communication and reduce mistimed parental responses by working with the parent. Incremental development of the child's communication was helped by the promotion of a range of strategies such as action routines, familiar repetitive language, and pauses. In both intervention groups, the therapists had basic teaching objectives and an individualized plan of intervention strategies for each child based on his/her needs and interaction with his/her natural environment. Parents were also encouraged to integrate and modify different learned strategies in a natural environment [14, 20]. These naturalistic teaching strategies ensured that learning activities were meaningful and generalized. Any difficulty during therapy was resolved by regular meetings between team members and parents as needed based on feedback therapy sessions obtained during the study. Monthly discussions among team members were based on the institutional protocol.

Offline in-person mediated intervention group

The child was taught planned intervention by the specialist in the presence of either parent in an offline in-person mediated intervention group in the therapy clinic.

Online parent-mediated intervention group

Each session occurred via videoconferencing (WhatsApp). The time for therapy sessions was pre-planned by an assigned time coordinator 2 - 3 days before the session. On the day of a therapy session, the therapist in the therapy clinic did a video call and then shared his/her screen with the parent. The therapist would demonstrate the planned intervention online to one of the parents who would teach the skill to a child in the same moment at home. The program relied on parents as therapists for the child, with the specialists demonstrating to them various activities as described below to be incorporated into their daily activities.

Duration of therapy

Children and their parents in each group were randomized to receive 5 - 6 h per week of online or offline intervention for 3 months by therapists in each session according to an institutional common protocol and the needs of the child. Parents in both groups were further asked to do at least 45 - 60 min of daily practice with the child. Parents were informed to reflect on their role in enhancing interaction and to identify new intervention goals.

Documentation, outcome measures, and statistical analysis

A proforma was used for documenting all the information about each enrolled child such as socio-demographic parameters, complaints on the first visit, physical examination, dates,

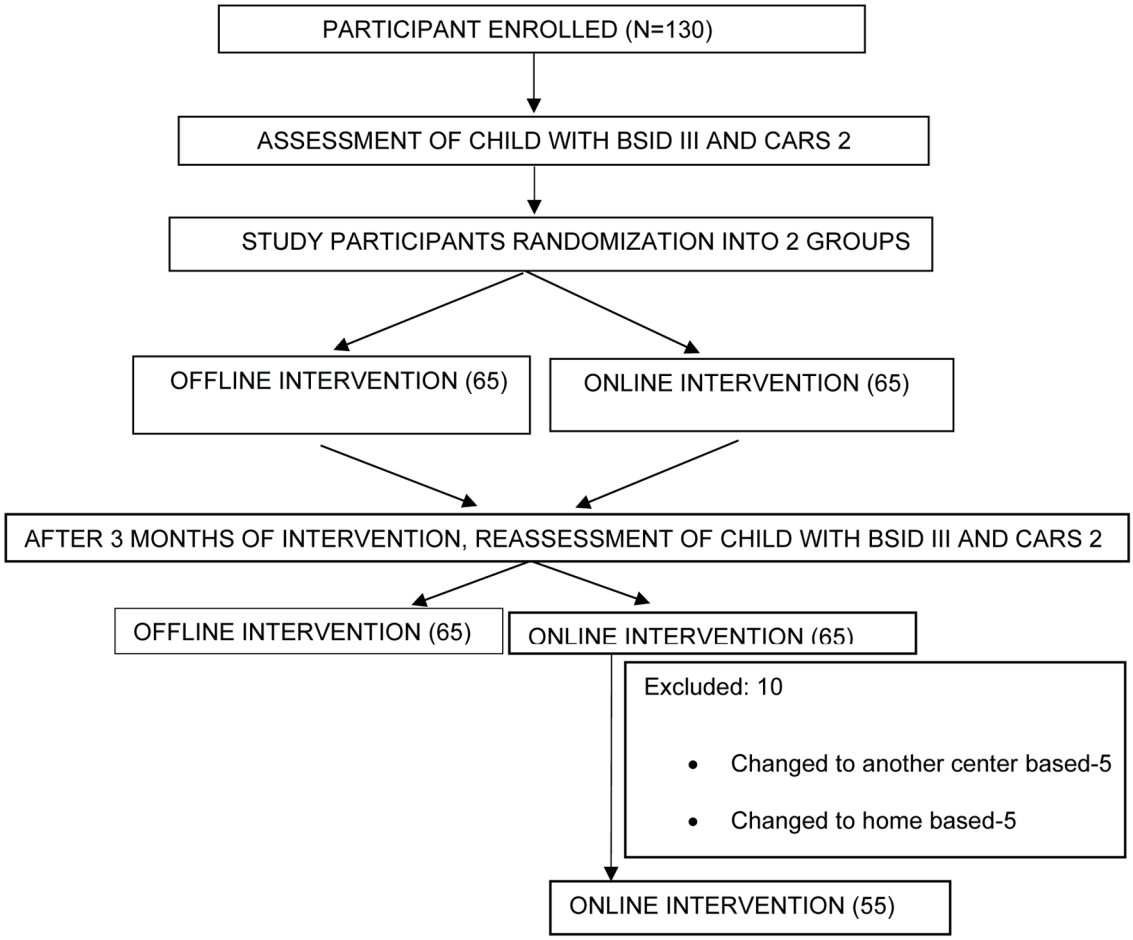

Figure 1. Study flow diagram.

and scores of pre- and post-intervention BSID III and CARS 2 assessments. The efficacy of each intervention was analyzed by individually comparing the improvement in cognition, language, and motor functions of children using mean BSID III cognitive, language, and motor composite scores and autism severity by CARS 2 scores before and after 3 months of intervention. The increment in mean post-intervention BSID III scores and decrement in mean post CARS 2 scores from the baseline pre-intervention scores were used to determine the improvement after either intervention. The comparison of mean scores between pre-intervention and post-intervention in each offline and online group was performed using the paired *t*-test or Mann-Whitney U test. Between the two interventions, the most effective method was decided based on a significant change in the mean score of all three composite scores of BSID III and CARS 2 after intervention using the paired *t*-test or Wilcoxon signed rank test. $P < 0.05$ was considered statistically significant.

Kuppuswamy's socioeconomic scale was used to classify socioeconomic status [38]. Satisfaction to either intervention by a parent was analyzed according to the Likert scale response on a scale of 1 to 5 as strongly dissatisfied, dissatisfied, neutral, satisfied, and strongly satisfied [39]. They were also asked about any difficulties faced during the intervention. Nominal categorical data between the groups were compared using the Chi-squared test or Fisher's exact test as appropriate.

Results

During the study period, all 65 children enrolled in the offline group adhered to intervention whereas in the online group, only 55 children continued to receive 3 months of online therapies which is shown in Figure 1. Table 1 shows the demographic characteristics of the study. As can be seen from Table 1, there was no statistically significant group difference in demographic characteristics of either intervention group. The mean pre- and post-intervention online and offline BSID III (cognitive, motor, and language) composite scores and CARS 2 scores are detailed in Table 2.

BSID III composite scores

BSID III cognitive composite score was improved in 53 (81.5%) out of 65 children and 48 (87.3%) among 55 chil-

Table 1. Demographic Characteristics of the Study Group

	Intervention group		P value
	Offline (n = 65) (%)	Online (n = 55) (%)	
Gender			
Male	49 (75.4)	40 (72.7)	0.740
Female	16 (24.6)	15 (27.3)	
Child's age (months)			
24 - 29	28 (43.1)	21 (38.2)	0.355
30 - 35	31 (47.7)	24 (43.6)	
36 - 42	6 (9.2)	10 (8.2)	
Mean age (months)	30.58	31.36	
Commonest presenting complaint			
Delayed speech	29 (44.6)	26 (47.3)	
Poor response to name	18 (27.7)	12 (21.8)	
Poor eye contact	4 (6.2)	6 (10.9)	
Mother's age at delivery (years)			
20 - 29	10 (15.4)	13 (23.6)	0.376
30 - 35	35 (53.8)	30 (54.6)	
> 35	20 (30.8)	12 (21.8)	
Father's age at delivery (years)			
20 - 29	3 (4.6)	2 (3.6)	0.95*
30 - 35	31 (47.7)	28 (50.9)	
> 35	31 (47.7)	25 (45.5)	
Mother's education			
High school certificate	1 (1.5)	0	0.921*
Intermediate	0	0	
Graduate	32 (49.2)	29 (52.7)	
Post graduate	32 (49.2)	26 (47.3)	
Father's education			
High school certificate	1 (1.5)	0	0.874*
Intermediate	0	1 (1.8)	
Graduate	40 (61.5)	33 (60)	
Post graduate	24 (36.9)	21 (38.2)	
Kuppuswamy's socioeconomic scale			
Lower middle	3 (4.61)	4 (7.27)	0.723*
Upper middle	47 (72.30)	41 (74.54)	
Upper	15 (23.07)	10 (18.18)	
Family structure			
Nuclear	38 (58.5)	26 (47.3)	0.221
Joint	27 (41.5)	29 (52.7)	
Birth order			
1	47 (72.3)	43 (78.2)	0.139*
2	18 (27.7)	10 (18.2)	
3	0	2 (3.6)	

*Fisher's exact test.

Table 2. Comparison of Pre- and Post-Intervention BSID III (Cognition, Language, Motor) Composite and CARS 2 Scores in Offline and Online Groups

Intervention	N	BSID III composite scores								CARS 2 scores		
		Cognitive			Language			Motor				
		Median	Mean (SD)	P value	Median	Mean (SD)	P value	Median	Mean (SD)	P value	Median	Mean (SD)	P value
Offline													
Pre	65	65	65.08 (7.31)	< 0.001	50	52.17 (7.97)	< 0.001	73	73.60 (6.69)	< 0.001	36	35.93 (1.94)	< 0.001
Post	65	70	71.08 (8.36)		59	61.05 (11.29)		76	77.45 (7.21)		35.5	33.63 (2.35)	
Online													
Pre	55	60	62.09 (5.58)	< 0.001	50	51.75 (7.29)	< 0.001	70	72.24 (7.75)	0.012	36	35.96 (1.93)	< 0.001
Post	55	65	67.24 (6.19)		53	57.09 (9.11)		73	74.42 (6.45)		34	34.16 (1.72)	

BSID III: Bayley Scale of Infant Development, third edition; CARS 2: Childhood Autism Rating Scale, second edition; SD: standard deviation.

Table 3. Comparison of Change in Mean Pre- and Post-Intervention BSID III Cognitive, Language, and Motor Composite Scores and CARS 2 Score Between Offline and Online Groups

Scores	Change in mean score after intervention		
	Offline intervention (SD)	Online intervention (SD)	P-value
BSID III cognitive	6.00 (4.25)	5.15 (3.73)	0.244
BSID III language	8.88 (8.38)	5.34 (6.42)	0.012
BSID III motor	3.85 (5.49)	2.18 (6.20)	0.122
CARS 2	2.31 (1.44)	1.80 (1.07)	0.034

BSID III: Bayley Scale of Infant Development, third edition; CARS 2: Childhood Autism Rating Scale, second edition; SD: standard deviation.

dren in the offline and online groups, respectively. In the offline intervention group, the pre-intervention mean cognitive composite score improved from 65.08 (± 7.31) to 71.08 (± 8.36) with a change in the mean score of 6 (SD 4.25) after 3 months of intervention as shown in Tables 2 and 3. In the online group, the mean cognitive composite score improved from 62.09 (± 5.58) to 67.24 (± 6.19) with a change in the mean score of 5.15 (SD 3.73) after intervention as shown in Tables 2 and 3.

BSID III language composite score was improved in 55 (84.6%) and 43 (78.2 %) among 65 and 55 children in the offline and online groups, respectively. Language composite scores improved from 52.17 (± 7.97) to 61.05 (± 11.29) with a change in the mean score of 8.88 (SD 8.38) as shown in Tables 2 and 3 after the offline intervention. In the online intervention group, the mean score language composite score improved from 51.75 (± 7.29) to 57.09 (± 9.11) with a change in the mean score of 5.34 (SD 6.42) after the intervention as depicted in Tables 2 and 3.

BSID III motor composite score was improved in 42 (64.6%) out of 65 children and 37 (67.3%) among 55 children in the offline and online groups, respectively. In the offline group, the mean motor composite score improved from 73.60 (± 6.69) to 77.45 (± 7.21) as shown in Table 2 with a change in the mean score of 3.85 (SD 5.49) after 3 months of intervention as shown in Table 3. In the online group, the mean motor composite score improved from 72.24 (± 7.75) to 74.42 (± 6.45) with a change in the mean score of 2.18 (SD 6.20) after intervention as depicted in Tables 2 and 3, respectively.

The individual endpoint composite scores for cognitive and language of children enrolled in the both online and offline groups were significantly improved ($P < 0.001$) after 3 months of either intervention with only a small estimated group difference of P-value of 0.012 in BSID III motor composite score, as shown in Table 2 indicating a favor of the offline parent-mediated intervention group for motor functioning of children.

Table 3 shows the change in mean scores after either intervention in BSID III cognition, language, and motor composite and CARS 2 scores. There was a statistically significant change in BSID language ($P = 0.012$) and CARS 2 scores ($P = 0.034$) but no statistically significant change in the mean score

Table 4. Comparison of ASD Children Based on Pre- and Post-Intervention CARS 2 Severity Scores Between the Offline and Online Groups

CARS 2 severity	Offline intervention			Online intervention		
	Pre, n (%)	Post, n (%)	P-value	Pre, n (%)	Post, n (%)	P-value
Mild to moderate	52 (80.0%)	62 (95.4%)	0.002	40 (72.7%)	52 (94.5%)	< 0.001
Severe	13 (20.0%)	3 (4.6%)		15 (27.3%)	3(5.5%)	
Total (N)	65	65		55	55	

ASD: autism spectrum disorder; CARS 2: Childhood Autism Rating Scale, second edition.

of BSID cognitive (P = 0.244) and motor (P = 0.122) composite scores comparing offline and online intervention. This implies that online intervention can be as effective as offline intervention in improving cognition and motor domain but not for language and autistic features of preschool children with autism.

CARS 2 scores

CARS 2 score decreased from 35.93 (± 1.94) to 33.63 (± 2.35) as shown in Table 2 with a change in the mean score of 2.31 (SD 1.44) as shown in Table 3 after offline intervention. In the online group, the CARS 2 score decreased from 35.96 (± 1.93) to 34.16 (±1.72) with a change in the mean score of 1.80 (SD 1.07) as shown in Tables 2 and 3 after the intervention.

As shown in Table 4, 52 (80%) and 13 (20%) children in the offline group and 40 (72.7%) and 15 (27.3%) children in the online group had mild to moderate and severe autism in the pre-intervention group, respectively. An almost equal number of children, 62 (95.4%) and 52 (94.5%) had a decrease in post-intervention scores in the offline and online groups, respectively. But the lesser number of children that is three (5.5%) out of 15 (27.3%) children had severe autism after intervention in an online group compared to three (4.6%) out of 13 (20.0%) children who had severe autism in an offline group with a statistically significant value (P < 0.001).

Likert scale response

It can be observed from Table 5 that parents were significantly satisfied (P = 0.001) with the offline intervention as compared to the online intervention. Fifty-eight (89%) parents were satisfied in the offline group with a Likert scale of 4 or more. The difficulties faced by parents on online interventions were difficulty in following instructions as directed by therapists and internet connectivity issues resulting in multiple interruptions during interventions.

Discussion

Diagnosis of ASD is possible as early as 18 months of age [1]. Intervention for children with ASD should begin as soon as possible and include a combination of developmental and behavioral approaches [40]. NDBIs by multidisciplinary teams improve long-term outcomes in all developmental domains such as language functioning, cognitive skills, and social and adaptive behavior, preventing a cascade of effects that result from early deficits affecting later functioning [41]. Autism is increasing due to the increased rate of incidence, awareness among parents, and capability to diagnose the disorder [42]. Incorporating online therapies with parent-mediated intervention may reduce the shortage of specialists required for therapies. This has been tried during the COVID-19 pandemic as well and was found to be feasible [21, 43]. Parent-mediated online interventions coached by therapists result in significant changes in a child's behavior [9, 15, 44]. Compared to clinician-implemented therapy, parent-mediated intervention is suitable for young children, as children's skills are more likely to be maintained and generalized with parental assistance [20]. Moreover, it has a potential role in resource-constraint settings [21-25]. Teaching parents techniques based on NDBIs to manage the behavioral difficulties and sensory issues of an autistic child in natural settings will empower parents to take control of the situation and deal it with ease. This study compares the efficacy of online with in-person that is offline parent-mediated developmentally appropriate naturalistic strategies to teach preschool children with autism. NDBIs prioritizes the integration of all developmental domains in autistic children so the effectiveness of either intervention was analyzed by comparing increased mean BSID III scores (cognitive, language, and motor composite scores) and decreased CARS 2 scores after interventions in this study.

All three cognitive, language, and motor composite BSID III scores were significantly improved with P < 0.05 in offline as well as online parent-mediated intervention after 3 months (Table 2). When compared between online and offline parent-

Table 5. Likert Scale Response to Gauge Satisfaction With Either Intervention

Likert scale	2 (%)	3 (%)	4 (%)	5 (%)	Total	P-value
Offline group	2 (3.1)	5 (7.7)	50 (76.9)	8 (12.3)	65	0.001
Online group	4 (7.3)	20 (36.4)	27 (49.1)	4 (7.3)	55	
Total	6 (5)	25 (20.8)	77 (64.1)	12 (10)	120	

mediated intervention, a statistically significant mean score change (P = 0.012) was seen for BSID III language composite score in the offline group, although it was not seen for motor or cognition composite scores after either intervention (Table 3). Thus, offline intervention improved language domain in preschool children with autism as compared to online parent-mediated intervention group. The study conducted by Hao et al [20] to compare the effectiveness of teletherapy and in-person parent-mediated intervention for 15 children in each group with ASD found significant improvements in the language of children in both groups using NDBIs which was contrary to our study.

CARS 2 can assess the severity of autism in a child [33]. Outcome measures such as relating to people, imitation, listening response, adaptive behavior skills, verbal and nonverbal communication, behavioral problems including stereotypy or restricted, repetitive patterns of behavior, interests or activities, and sensory issues were also analyzed in the enrolled children using CARS 2 in this study. A decrease in mean scores of CARS 2 indicates improvement after either intervention. There was a statistically significant decrease (P < 0.001) from the baseline mean CARS 2 score after offline as well as online intervention (Table 2). However, when the change in mean CARS 2 score was compared between the two, a statistical difference (P = 0.034) was seen between the offline group and the online group (Table 3). Thus, our study showed that offline parent-mediated intervention was better than online parent-mediated intervention in decreasing CARS 2 scores after 3 months of intervention. However, the research conducted by Lindgren et al showed results contrary to our findings. The mean percentage reduction in problem behavior was > 90% in all three groups that were in-home therapy, clinic-based telehealth, or home-based telehealth after ABA-based treatment with no statistical difference (P = 0.074) [11]. The culturally adapted online parent-mediated project IMPACT based on NDBIs using mixed methods by Guta et al found the program feasible for improving social communication scores in social engagement, expressive language, understanding directions, and social imitation [21]. Similarly, a randomized controlled study done by Vismara et al using telehealth with and without ESDM of NDBIs also found that telehealth parent training for 12 weeks improved imitation in ESDM group but both groups increased their imitation across the time and social communication skills [19]. The researchers in the study thought maturation during the intervention period may have acted as a confounding variable and contributed to overall skill improvement for both groups as both groups increased their rates of imitation at the same rate and older children had improved spontaneous communication [19]. Our study used culturally adapted center-based mixed method NDBI for both interventions. The children in online intervention improved after 3 months of intervention based on CARS 2 and BSID III scores. Further research is required to evaluate interventional or maturational effects on children's development with ASD.

In our study, parents in the offline group were satisfied with their method of intervention with P < 0.001 as compared to parents in the online group. Also, various studies show that parent-mediated intervention reduces parental stress and increases competencies and thus empowerment levels in online therapies as well [13, 44]. The therapy modules need to be changed when the first implemented strategy is not effective in addressing skill deficits and problematic behaviors [15]. In our study, both groups of interventions used a variety of play-based skills in a non-structured individualized manner depending on the child's behavior and interest.

There are limitations of the study. The intervention duration was 3 months, so the outcomes could be different when the duration of the intervention was increased. A wider age range of participants could have given more general data as ASD is a chronic condition with lifelong implications. It was assumed that there were no parent fidelity issues. This study mostly involved participants from middle and upper socioeconomic classes with parents with higher education levels. Therefore, this study cannot be generalized for all socioeconomic groups and education levels. The families with autistic children may benefit more from mixed online and offline, personalized double approach intervention which was not considered as an option for intervention in this study. Effectiveness of online and offline parent-mediated intervention was analyzed based on change in scores obtained in developmental assessment tool which is BSID III and autism rating tool, CARS 2 in this study. However, other assessment tools that measure change in autistic symptoms such as ADOS severity score if used may have different inference of online versus offline intervention. Thus, the results from the current study must be cautiously interpreted due to lack of sensitive and specific assessment tools to compare effectiveness of online versus online parent-mediated intervention in autistic children and warrant further researches.

In conclusion, this study showed that parent-mediated online interventions can be effective in decreasing autistic symptoms but not as effective as in-person intervention. Online intervention may improve accessibility for the management of children with ASD and thus become a viable alternative to parent-mediated in-person intervention in resource-limited settings.

Acknowledgments

The authors would like to thank the patients and their families and acknowledge their participation during the therapies. This work would have not been possible without their contribution.

Financial Disclosure

This research was not funded.

Conflict of Interest

This research was done by Dr. Luna Bajracharya during her 1-year (2021 - 2022) IAP fellowship in Developmental and Behavioral Pediatrics in Child Developmental Clinic, Institute of Child Health, Sir Ganga Ram Hospi (SGRH) in New Delhi,

India. The authors have no potential conflict of interest to disclose.

Informed Consent

Written informed consent was obtained from the children's parent before enrollment in the study.

Author Contributions

PS contributed to conceptualization, protocol development, study design, recruitment of the patients, supervision of therapies, and preparation of initial and subsequent drafts. IM assisted in conceptualization, protocol development, patient enrollment, supervision of therapies, and manuscript review. LB was responsible for protocol development, patient enrollment, data collection, storage and analysis, preparation of the initial and subsequent drafts, figure and table design, and review of the final draft.

Data Availability

The data that support the findings of the study and institutional interventional protocol for preschool children with ASD are available upon request from the corresponding author.

Abbreviations

ABA: applied behavior analysis; ADOS: Autism Diagnostic Observation Schedule; ASD: autism spectrum disorder; BSID III: Bayley Scales of Infant Development, third edition; CARS 2: Childhood Autism Rating Scale, second edition; CDC: Child Development Clinic; DSM 5: Diagnostic and Statistical Manual of Mental Disorders, fifth edition; EIBI: early intensive behavioral intervention; ESDM: early start Denver model; IMPACT: improving parents as communication teachers; IAP: Indian Academy of Pediatrics; ISAA: Indian Scale for Assessment of Autism; IASQ: Indian Autism Screening Questionnaire; JASPER: joint attention, symbolic play, engagement and regulation; NDBIs: naturalistic developmental behavioral interventions; SD: standard deviation; SKILLS: skills and knowledge of intervention for language learning success; SGRH: Sir Ganga Ram Hospital

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