

Review Article

Effects of Virtual Training Programs for Parents on the Skills of Children With ASD: A Systematic Review

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ABSTRACT

Access to virtual training for parents and/or caregivers of children with autism spectrum disorder (ASD) has emerged as both a need and an understudied area. This review aims to analyze the effects of virtual parent training programs on the skills of children with ASD. After examining 721 articles, 61 were selected as directly relevant; of these, only 10 studies met the eligibility criteria and were included in the final review. The results indicate that virtual training programs for parents lead to significant improvements in their children's social, behavioral, cognitive, linguistic, and communication skills. These findings are particularly relevant to recommending the implementation of virtual training, expanding access to resources, and providing support for families residing in rural areas or those with time constraints that make it difficult for them to attend these programs in person.

Keywords:

Autism Spectrum Disorder; Autism; Parents; Caregivers; Virtual Training

Efectos de los programas de entrenamiento virtuales para padres sobre las habilidades de menores con TEA. Una revisión sistemática

RESUMEN

El acceso a entrenamientos virtuales para padres y/o cuidadores de menores con trastorno del espectro autista (TEA), se ha planteado como una necesidad y como un área poco estudiada. Esta revisión tiene como objetivo analizar los efectos de los programas de entrenamiento virtuales para padres sobre las habilidades de menores con TEA. Tras examinar las bases de datos Pubmed, Web of Science y Scopus, considerando los elementos esenciales de la lista de verificación y diagrama de flujo que establece la declaración (PRISMA; Page et al., 2021), se obtuvieron 721 artículos, de los cuales se seleccionaron 61 artículos pertinentes; cuando se evaluaron según los criterios de elegibilidad, solo 10 estudios se incluyeron en esta revisión final. Los resultados de esta revisión indican que los programas de entrenamiento virtuales para padres generan mejoras significativas en las habilidades sociales, conductuales, cognitivas, lingüísticas y comunicativas de sus hijos con TEA. Estos hallazgos son de especial relevancia para recomendar la implementación de entrenamientos virtuales, ampliando el acceso a recursos y apoyo para las familias que residen en zonas rurales o que tenga limitaciones de tiempo que dificultan su asistencia presencial a estos programas de formación.

Palabras clave:

Trastorno del Espectro Autista; Autismo; Padres; Cuidadores; Entrenamientos Virtuales

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INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition observable from early childhood. It presents with behavioral manifestations that significantly impair social interaction and communication. Autism Spectrum Disorder also presents with atypical and repetitive behaviors and interests, expressed heterogeneously across individuals (Rojas et al., 2019).

These characteristics may make it challenging to communicate wants and needs effectively, initiate social interactions, and respond appropriately in conversation (American Psychiatric Association [APA], 2013). As a neurodevelopmental disorder, ASD presents with a highly variable symptom profile. Lewis et al. (2007) note that language performance in ASD ranges from above-average to severe impairment. Similarly, Whitehouse et al. (2008) indicate that language impairment varies in degree, ranging from severe (complete absence of language) to apparent absence of deficits. Other areas that pose challenges for people with ASD are social communication and self-regulation—particularly emotional regulation, which negatively impacts participation and performance in academic and social settings (Nowell et al., 2019).

According to data reported by the World Health Organization (WHO, 2022), approximately 1% of children worldwide have a diagnosis of ASD. In Latin American countries, prevalence estimates range between 0.25% and 0.30% based on data from 2011–2013 (Morocho et al., 2021). Over the past 30 years, ASD prevalence has increased continuously and steadily, currently fluctuating between 0.5% and 1% globally. In the Metropolitan Region of Santiago, Chile, ASD prevalence has been estimated at 2%, with a gender distribution of 80% boys and 20% girls (Yáñez et al., 2021).

Rojas et al. (2019) argue that ASD is a growing phenomenon characterized by the accumulation of multiple co-occurring difficulties. A wide range of treatment and intervention approaches has been developed to address this cluster of challenges. Naturalistic interventions stand out among these. This approach comprises a set of psychoeducational procedures to foster communication and language development through natural strategies. Families or caregivers of children with ASD are the ones to implement these techniques within their daily family routine; this constitutes the core of naturalistic approaches (Del Rio, 2006). These interventions encompass three dimensions: environmental adaptation procedures, language adaptation procedures, and specific educational strategies. Psychoeducational interventions directed at parents of young

children with ASD are particularly significant, as they enhance knowledge levels, provide emotional support, and promote increased interaction and awareness in supporting the family's educational role (Sánchez Savignón et al., 2021).

In this context, naturalistic interventions are grounded in social interactionist and ecological theoretical frameworks (Bronfenbrenner, 1986; Bruner, 1977). They are implemented within the family environment and occur spontaneously in everyday life to promote children's communication and language development. For the effective implementation of these interventions, it is essential to arrange daily and repetitive situations—recognized as routines—where the family plays a central role, sharing quality didactic time with children (Dunst & Bruder, 1999).

Considering the aforementioned evidence, it is imperative to incorporate naturalistic intervention models as the foundation of parent training programs. One example is the *Improving Parents as Communication Teachers* program (ImPACT), which hundreds of families have implemented across multiple early intervention services. ImPACT is an active parent coaching program designed for parents of children up to six years of age with ASD and other developmental difficulties (Sengupta et al., 2021). Dai et al. (2023) define the program as an Applied Behavior Analysis (ABA)–based method that incorporates multiple techniques to understand problem behaviors. It also seeks to modify the child's conduct. It is noteworthy that both the duration of training (ranging from 1 to 15 sessions, 6 to 15 weeks, or 5 to 14 modules) and the modalities (group or individual telehealth, synchronous or asynchronous) are relevant, as they allow for comprehensive coverage of intervention content (Hong et al., 2018; Sengupta et al., 2021; Vismara et al., 2013).

The active role parents assume in the therapeutic process defines these interventions. Other characteristics include the use of practical strategies grounded in parent–child interaction, and the establishment of clearly delimited intervention goals to ensure skill consolidation (Koegel et al., 2014).

Parent-focused interventions have been examined in multiple studies, demonstrating significant potential to maximize learning opportunities through low-intensity interventions. Positive outcomes have been reported even when parent training occurs via digital platforms, positioning this approach as a viable alternative in contexts with limited professional and economic resources (Rojas et al., 2019). These parent-mediated interventions delivered through digital platforms are considered telehealth. This means that health services are provided through

information and communication technologies (Moffatt & Eley, 2010).

Telehealth is a highly flexible form of intervention, as it can be adapted to meet individual needs, implemented across multiple settings (home, school, and community), teach skills that are functional in daily life, and delivered both individually and in group formats. Moreover, telehealth-based parent training programs have shown positive cognitive adaptation (Turnbull & Turnbull, 2001) and successful reductions in problem behaviors among children with ASD (Lindgren et al., 2016).

Interest in virtual training for parents of children with ASD has increased, as noted by Postorino et al. (2017). This is due to the high costs of intensive behavioral therapy (Brian et al., 2022), sociodemographic barriers associated with living in remote rural areas, limited parental availability, and the COVID-19 pandemic and associated lockdowns. The latter directly affected children with ASD who primarily accessed interventions through in-person services. Nevertheless, one positive outcome of the lockdowns was the substantial increase in virtual interventions, which expanded exponentially during this period (Nadler et al., 2021).

Several studies have demonstrated the effectiveness of parent-mediated interventions delivered via telehealth. These studies have found positive effects of this modality, including significant improvements in communicative skills (Douglas et al., 2018) and in both linguistic and non-linguistic abilities of children with ASD (Law et al., 2018). It should also be noted that this type of intervention directly influences children's behavior through strategies taught to parents by therapists. Among the most commonly employed strategies are modeling, prompt fading, reinforcement, and role-playing (Dai et al., 2023; Ferguson et al., 2023; Law et al., 2018; Lee et al., 2023).

Most parent-mediated intervention programs employ behavioral or naturalistic strategies to improve communication outcomes in young children. This preference stems from the demonstrated efficacy and effectiveness of these approaches, which allow treatment delivery within natural contexts embedded in daily routines. One of the core strategies of ABA is positive reinforcement. When a behavior is followed by a stimulus perceived as pleasant (e.g., a reward), the individual is more likely to repeat that behavior. As the behavior is consistently reinforced through repetition, positive behavioral change is likely to occur (Law et al., 2018).

De Nocker & Toolan (2023) provide strong evidence that telehealth programs for children with ASD are highly acceptable,

comparable to in-person interventions, and increasingly effective in training therapy partners. Additionally, González-Lagos (2021) proposes that telehealth based on the Early Start Denver Model (ESDM) offers a structured, systematic, and empirically validated approach for parents and/or caregivers of young children with autism. This model equips them with tools to support their children in connecting, communicating, and learning through daily home-based activities. Similarly, Hume et al. (2021) demonstrated that telehealth-based naturalistic, behavioral, and developmental interventions grounded in the child-adult relationship enabled access to a greater number of families with limited community resources. These adaptations better align interventions with family lifestyles and routines, resulting in more active and meaningful learning experiences. Consequently, this format should be consolidated not merely as a context-dependent healthcare practice, but also as a valid and accessible alternative intervention for the broader community.

In the same vein, studies by Valentine et al. (2021) and Alfuraydan et al. (2020) have suggested that telehealth is promising due to its clinical effectiveness and potential to enhance diagnostic and follow-up pathways for ASD. These interventions have demonstrated positive clinical and economic impacts for service users, including increased efficiency in service delivery.

At present, a limited number of studies examine the effects of virtual parent training programs grounded in naturalistic approaches in the context of ASD, which justifies the need for a systematic review (Aleixandre-Benavent et al., 2011). Accordingly, the present article aims to synthesize the available evidence on virtual training programs for parents of children with ASD.

Ethical and professional commitment to the discipline, therefore, entails an ongoing responsibility to advance scientific knowledge and to incorporate emerging evidence that strengthens therapeutic and family-centered support strategies. In this sense, naturalistic approaches have become a valid and promising alternative for families, yet require robust empirical support to ensure appropriate implementation, especially in modalities such as telehealth. The sustained increase in autism prevalence over recent decades has expanded the scope of practice for speech-language therapists, who must be equipped with validated tools that respond to current intervention needs by incorporating effective, evidence-based methods.

Considering the aforementioned background, we formulated the following research questions: (1) Do virtual training programs for parents contribute to improvements in the linguistic and

communicative skills of children with ASD? (2) What are the characteristics of virtual programs directed at parents whose effects are measured in children? (3) Are significant changes observed in the cognitive development of children with ASD following the implementation of virtual parent training programs? (4) Are there additional domains that benefit from the implementation of virtual parent training programs?

Accordingly, the present study aims to analyze the effects of virtual parent training programs on children with ASD's linguistic, communicative, social, and cognitive skills.

METHOD

The systematic review was conducted following the essential elements outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist and flow diagram (PRISMA; Page et al., 2021). The review protocol was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO; registration number: CRD42022384250).

Eligibility Criteria

The inclusion criteria were (1) empirical studies addressing virtual intervention programs for parents of children with ASD, and (2) articles written in English or Spanish and published in peer-reviewed journals. The exclusion criteria comprised (1) reviews, meta-analyses, gray literature, opinion articles, dissertations, editorials, book chapters, and conference proceedings, (2) empirical studies addressing parent intervention programs for other neurodevelopmental conditions, and (3) articles published in languages other than English or Spanish.

Search Strategy

The literature search was conducted in April 2023 using the PubMed, Web of Science, and Scopus databases. The following search strategy was applied: (Fathers* OR Mothers* OR Caregivers* OR Parents*) AND (autismspectrumdisorder* OR autisticdisorder* OR autistic* OR Asperger syndrome* OR autism*) AND (parent training* OR parent-mediatedintervention* OR virtual training* OR telemedicine* OR telehealthprograms* OR remotely* OR distanceeducation*).

Study Selection Process

Two authors (DF and BM) independently performed each stage of the study selection and data extraction. Any discrepancies were resolved through discussion and consensus.

All retrieved records were exported to the Rayyan reference management platform. The study selection process is detailed in the PRISMA flow diagram (Figure 1). Randomized controlled trials (RCTs) and clinical trials were eligible for inclusion. The database searches yielded 91 records from PubMed, 242 from Web of Science, and 388 from Scopus, resulting in a total of 721 records. After removing duplicates, 442 unique records remained. These were screened by title and abstract against the inclusion and exclusion criteria, resulting in the exclusion of 379 records. Of the remaining records, 62 articles were initially considered for inclusion; however, two could not be retrieved. Consequently, 61 full-text articles were assessed for eligibility, with a final total of 10 peer-reviewed studies included in the review.

Quality Assessment of Studies

The methodological quality of the included studies was assessed using the Quality Assessment Tool for Studies with Diverse Designs (QATSDD; Sirriyeh et al., 2012). This tool applies to qualitative, quantitative, and mixed-methods studies and consists of 16 items for mixed-methods designs and 14 items for both qualitative and quantitative designs. Each item is scored on a scale ranging from 0 to 3, yielding a maximum total score of 48 for mixed-methods studies and 42 for qualitative and quantitative studies. Higher scores indicate higher methodological quality. When the interpretation of an article was unclear, the assessment was discussed with a second reviewer to reach consensus (see Appendix 1).

Table 1. Search Terms and Limits Used by Database.

	Concept 1: Parents/Caregivers	Concept 2: Autism	Concept 3: Virtual Training
Keywords	Fathers Mothers Caregivers Parents	Autism spectrum disorder autistic disorder Autistic autism spectrum disorder Asperger syndrome Autism	Parent training Parent-mediated intervention Virtual training Telemedicine Telehealth programs Remotely Education Distance
Mesh Terms	[Fathers] [Mothers] [Caregivers] [Parents]	[Autism spectrum disorder] [Autistic disorder] [Autistic spectrum disorder] [Asperger syndrome]	[Telemedicine] [Education Distance]

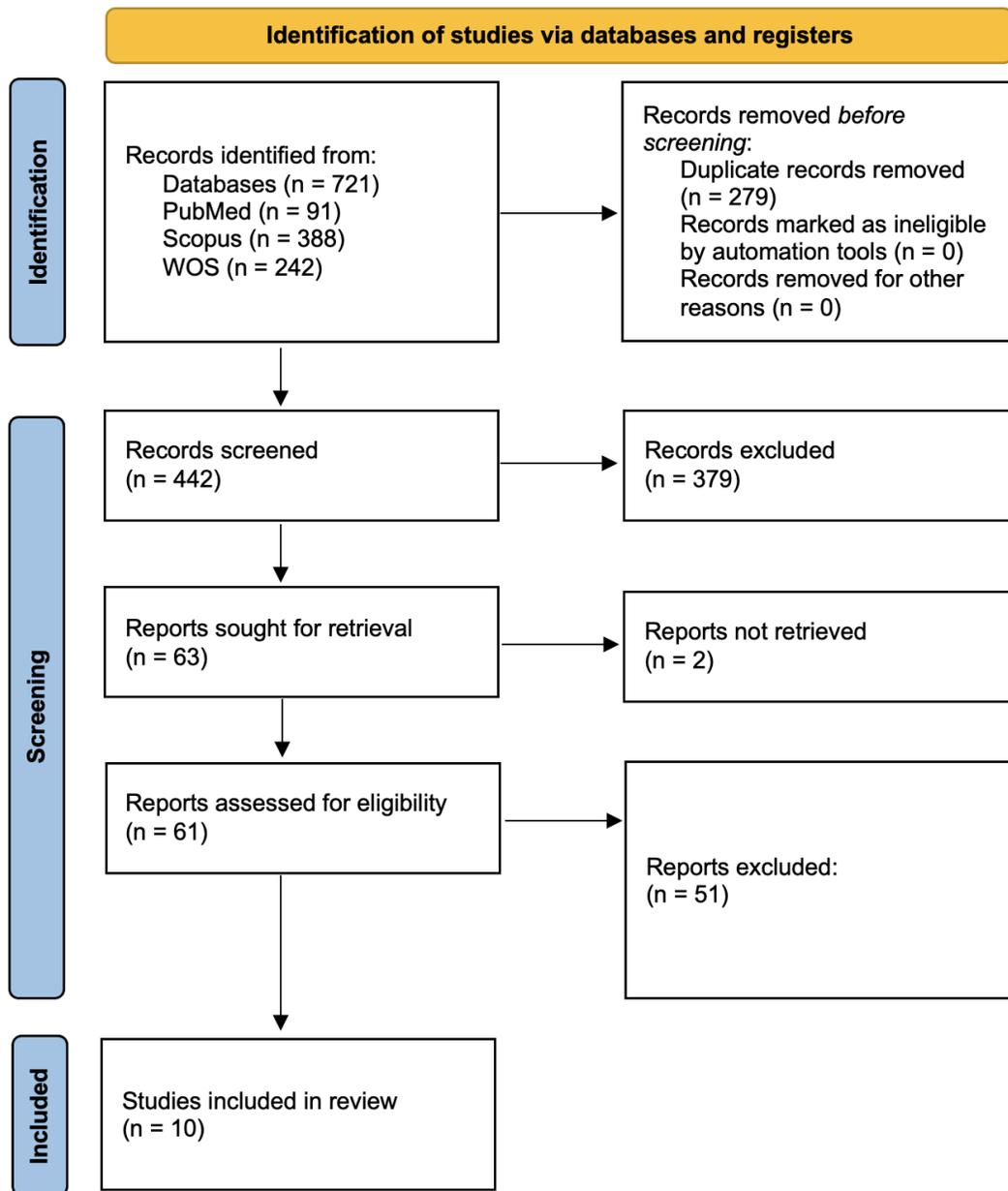


Figure 1. PRISMA 2020 flow diagram, adapted from Page et al. (2021).

RESULTS

The characteristics of the virtual parent training programs and their measured effects on children are presented below (Table 2).

Table 2. Characteristics of Studies Included in the Review.

Title	Author, Year	Design	Objective	Participants
1. The effectiveness of using telehealth to train parents of children with ASD to use naturalistic teaching to increase mands, tacts, and intraverbals	Ferguson et al. (2023)	Randomized controlled trial (RCT)	To determine whether parent training delivered via telehealth provides naturalistic strategies to increase child communication across multiple verbal operants.	
2. Use of behavior modeling training in a mobile application-based parent training program to improve functional communication in young children with ASD	Law et al. (2018)	RCT	To examine the effectiveness of the Map4Speech application, which provides parents of children with ASD with behavioral and functional communication intervention strategies.	3 children with ASD
3. Preliminary findings from a telehealth approach to parent training in autism	Vismara et al. (2013)	RCT	To examine parents' intervention skills and evaluate children's verbal language and joint attention initiations following parent intervention.	8 children under 48 months of age with ASD
4. Online communication training for parents of children with autism	Douglas et al. (2018)	RCT	To evaluate the effects of online parent communication training on the frequency of communication opportunities parents provide to their children with ASD.	3 children with ASD aged 2–5 years
5. Self-paced, video-based learning: Parent training and language skills in Japanese children with ASD	Hong et al. (2018)	RCT	To evaluate an asynchronous training package designed to teach parents to implement incidental teaching strategies.	2 children with ASD aged 4–5 years
6. Improving social interactions for young children on the autism spectrum through parent-mediated LEGO® play activities	Lee et al. (2023)	RCT	To investigate the effects of a parent-mediated LEGO®-based intervention on parent-child interactions in young children on the autism spectrum.	4 children with ASD aged 3–6 years
7. An initial trial of OPT-In-Early: An online parent training program for caregivers of autistic children	Dai et al. (2023)	RCT	To test the effects of OPT-In-Early on (1) parent knowledge change, (2) strategy use, and (3) parental self-efficacy.	63 parent-child dyads
8. Effects of parent training delivered via telehealth: Equity and access to early intervention for rural families	Rooks-Ellis et al. (2020)	RCT	To examine the feasibility of implementing the parent-delivered Early Start Denver Model (P-ESDM) intervention via telehealth.	10 parent-child dyads
9. Evaluation of a stepped-care telehealth program for parents of young children with autism: A proof-of-concept trial	Wainer et al. (2021)	RCT	To determine the acceptability and feasibility of an online stepped-care Reciprocal Imitation Training (RIT) model and explore preliminary differences in key outcomes such as parent fidelity and self-efficacy compared with treatment as usual.	20 families of children with ASD
10. Feasibility and acceptability of a synchronous, parent-mediated online early intervention for children with autism in a low-resource setting during the COVID-19 pandemic	Sengupta et al. (2023)	RCT	To examine the feasibility of parents learning and implementing the ImPACT intervention when delivered online.	12 parents of children with ASD

Table 3. Characteristics of Virtual Parent Training Programs.

No.	Intervention Content	Intervention Modality	Intervention Exercises or Strategies	Session Number and Duration
1	Training in verbal operants (mands, tacts, intraverbals) through play-based scenarios	Online	Prompt fading	Five sessions per strategy; 15 sessions in total
2	Functional communication and Applied Behavior Analysis (ABA) techniques	Online	Use of reinforcers, imitation, modeling, role-playing, and play	Eight stages over approximately 6–7 weeks
3	Parent training in assessment and intervention based on the Early Start Denver Model (ESDM)	Online	Ten topics: attention and motivation; sensory–social routines; joint activities; nonverbal communication; imitation skills; joint attention; speech; narrative ABC; play routines	12 sessions, once per week, 1.5 h each
4	Communication skills	Online	Providing communication opportunities through environmental arrangement; waiting and responding to child communication; implementation of the POWR strategy (AAC-supported)	Six modules of 12 min each
5	Communication and social interaction skills	Online	Environmental accommodations: communication supports (wait time, asking questions, offering choices, modeling gestures, physical prompting)	Two to three weekly sessions (5 min each) over 5 months
6	Social interaction skills, specifically social initiations, responses, and inappropriate interactions	Online	Simulated scenarios, role-playing, guided practice	One session lasting 3–3.6 h
7	ABA and developmental science emphasizing developmentally appropriate skill teaching in natural environments, following the child’s attentional focus or preferred toys to support social interaction, communication, language, and play development in children aged 1–5 years	Online	Evidence-based behavioral principles (e.g., understanding behavioral functions, task analysis, prompting and immediate fading, contingent reinforcement using natural and/or artificial consequences)	14 modules
8	P-ESDM content, including attention and motivation; sensory–social routines; joint activity routines; nonverbal communication; imitation; joint attention; speech development; functional and symbolic play skills; and ABA teaching techniques	Online	Child interest Learning opportunities Sensory–social routines Joint attention Turn-taking Play steps Gestures Simplified language Imitation Symbolic play Vocal play development	12 weeks, 90 min per session
9	Exploration of child social communication, imitation skills, and family quality of life	Online	Modeling: positive reinforcement	15 weeks
10	Parent training to promote social communication, play, and language acquisition	Online	ImPACT communication pyramid strategies	6 weeks

Table 4. Effects of Virtual Parent Training Programs on the Skills of Children with ASD

No.	Assessment Instrument	Program Effects on Child Skills
1	Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP)	Increased communication, with successive gains across each verbal operant
2	Not specified	Increased functional communication Increased verbal expressions Increased spontaneous requesting through pointing
3	Parent-implemented Early Start Denver Model (P-ESDM); MacArthur–Bates Communicative Development Inventories: Words and Gestures	Increased vocalizations Maintenance of joint attention Increased comprehension of words and gestures
4	Not specified	Increased communication
5	Checklist	Increased verbal response
6	Not applicable	Increased social initiations and responses Decreased inappropriate social interactions
7	Direct observation	No effects observed on joint attention, following simple instructions, or imitation
8	P-ESDM	Significant reduction in problem behaviors Significant increase in social reciprocity (e.g., shared enjoyment or affect, use of social smiling, use of gestures) Increased communication Reduction in repetitive behaviors (i.e., decreased resistance to changes in routines)
9	Mullen Scales of Early Learning (MSEL), used to index developmental level at intake CEW Fluency Scale	Improvements in social communication skills, specifically imitation
10	Social Communication Checklist	Improvements in expressive language skills, social communication, comprehension of instructions, social imitation, reciprocity, and social and play participation

Regarding the effects of virtual parent training programs on the skills of children with ASD, a study included in the review (Sengupta et al., 2021) showed improvements both in children's social engagement and in parents' competence in managing difficulties associated with ASD. This study also replicated the positive effects of telehealth-based, parent-mediated communication interventions for children with ASD. Additionally, the study by Law et al. (2018) reported substantial improvements in children's functional communication, with participating children using words, phrases, or gestures more functionally and making more attempts to request preferred objects or activities. Similarly, the study by Rooks-Ellis et al. (2020) revealed a statistically significant reduction in the frequency of problem behaviors following the intervention. Significant pre–post changes were also reported in ASD symptomatology, specifically in the domains of communication, social reciprocity, and restricted and repetitive behaviors.

Three studies included in the review reported significant improvements in social and behavioral skills among children with ASD, following parental participation in online training programs

(Lee et al., 2023; Rooks-Ellis et al., 2020; Sengupta et al., 2021). These studies support the claim that virtual interventions specifically designed to guide parents and/or caregivers are effective, demonstrating positive effects on children's development and strengthening their social and behavioral skills.

Rooks-Ellis et al. (2020) further reported that parents participating in an online training program observed notable gains in their children's communication and social skills. They particularly noted a marked reduction in problem behaviors and an increase in social reciprocity. Similarly, Lee et al. (2023) found that parents trained online demonstrated an enhanced ability to implement behavior management and social skills–promoting strategies. This resulted in increased social initiations and responses and decreased inappropriate social interactions in their children with ASD.

Regarding cognitive skills in children with ASD, one study examined the effects of a parent training program and found significant improvements in cognitive domains, including word and gesture comprehension (Vismara et al., 2013).

Concerning linguistic and communicative skills, eight studies included in the review consistently supported significant improvements in children with ASD following parental participation in parent-mediated intervention programs (Douglas et al., 2018; Ferguson et al., 2023; Hong et al., 2018; Law et al., 2018; Rooks-Ellis et al., 2020; Sengupta et al., 2021; Vismara et al., 2013; Wainer et al., 2021).

These findings provide robust evidence for the effectiveness of parent-mediated intervention programs in enhancing linguistic and communicative skills in children with ASD. For instance, Rooks-Ellis et al. (2020) reported significant improvements in children's communication skills following parent participation in targeted training programs. Likewise, Ferguson et al. (2023) demonstrated promising outcomes in a parent-mediated intervention focused on language development in young children with ASD.

Moreover, studies by Hong et al. (2018), Law et al. (2018), Lee et al. (2023), Sengupta et al. (2021), Vismara et al. (2013), and Wainer et al. (2021) further support the benefits of parent-mediated interventions for the development of linguistic and communicative skills, particularly in increasing verbal responsiveness in children with ASD. In contrast, the study conducted by Dai et al. (2023) did not report improvements in social or behavioral skills following parent training.

Regarding the quality of the studies, QATSDD scores highlighted both methodological strengths and limitations across the reviewed research. Among the strengths, the studies demonstrated solid theoretical foundations that contextualized the research, provided adequate descriptions of assessment instruments, and justified the analytical methods employed. The studies conducted by Wainer et al. (2021), Dai et al. (2023), Lee et al. (2023), and Ferguson et al. (2023) achieved the highest quality scores. Conversely, the primary methodological weaknesses were small sample sizes and limited critical discussion of the study's strengths and limitations.

DISCUSSION

This systematic review aimed to analyze the effects of virtual parent-training programs on the skills of children with ASD. For clarity and coherence, the discussion is organized according to the research questions posed at the beginning of this article.

After a comprehensive review of 721 references, only 10 studies evaluating the effectiveness of parent training programs were included. Although the number of included studies is limited, it is important to highlight that additional research supports the

findings, validating the relevance and efficacy of virtual parent-training programs as an effective intervention option for children with ASD.

This review successfully addresses the first research question, which sought to determine whether these training programs improve children with ASD's linguistic and communicative skills. Evidence indicates significant gains in social, behavioral, cognitive, linguistic, and communicative abilities. Specifically regarding social communication skills, improvements were observed in: (a) verbal expressions; (b) use of more diverse and varied language; (c) increased joint attention, eye contact, and orientation toward their communication partner; (d) increased social interactions; and (e) enhanced receptive and expressive identification of stimuli.

It is noteworthy that most of the studies analyzed were randomized controlled trials, which increases the validity of the findings. These trials consistently demonstrate positive outcomes in the development of communicative skills in children with ASD, encompassing both linguistic and non-linguistic aspects (Gentile et al., 2022; Law et al., 2018).

Regarding the second research question—what are the characteristics of virtual parent-training programs whose effects are measured in children? The review shows that the programs feature structured training for parents of children with ASD to enhance children's communicative, social, and behavioral skills. These interventions were predominantly synchronous, delivered via platforms such as Zoom, Skype, or Tencent VooV (Ferguson et al., 2023; Rooks-Ellis et al., 2020; Sengupta et al., 2021), or asynchronous and self-guided (Douglas et al., 2018; Hong et al., 2018). Program duration varied from a single intensive session (Lee et al., 2023) to extended programs of up to 15 weeks (Wainer et al., 2021).

Theoretical models and strategies employed were diverse, including the Early Start Denver Model (Rooks-Ellis et al., 2020; Vismara et al., 2013), ImPACT (Sengupta et al., 2021), Applied Behavior Analysis (ABA) strategies, and Naturalistic Developmental Behavioral Interventions (NDBI) (Law et al., 2018; Wainer et al., 2021). Reciprocal imitation approaches, such as RIT (Wainer et al., 2021), the POWR model to facilitate communication during play routines (Douglas et al., 2018), and multicomponent programs such as OPT-In-Early, which include language development, adaptive skills, and reduction of disruptive behaviors (Dai et al., 2023), were also implemented. Strategies instructed to parents included reinforcement, modeling, role-playing, prompt fading, and following the child's interests.

These strategies were applied by caregivers in natural environments and evaluated through video recordings and delayed feedback. Overall, these programs are distinguished by their accessibility, methodological diversity, and focus on empowering caregivers as active agents of intervention.

Regarding the third research question—are significant changes observed in the cognitive development of children with ASD following program implementation? It should be noted that the evidence analyzed is limited. This is because most of the included studies focused on behavior, communication, and language, while cognitive variables were addressed only indirectly or as part of global developmental assessments. The studies by Brian et al. (2022) and Dahiya et al. (2022) report the effectiveness of virtual programs in promoting skill development in children, but do not provide specific analyses of cognitive changes.

There are additional areas that benefit from parent-directed virtual programs. For instance, some studies (Bearss et al., 2018; Dahiya et al., 2022) reported significant reductions in problematic behaviors among children when parents and/or caregivers received training. These findings underscore the importance of adequate caregiver training and its positive impact on the well-being and development of children with ASD.

Additionally, online parent-training programs for children with ASD appear to have a direct impact on children's behavior, mediated by strategies taught by therapists to parents. The most frequently used strategies include modeling (Law et al., 2018), fading of prompts (Dai et al., 2023; Ferguson et al., 2023), reinforcement, and role-playing (Law et al., 2018; Lee et al., 2023). These strategies have demonstrated benefits in behavioral, communicative, and language domains in children, as well as in equipping parents with tools to support them in daily routines. Parent-directed programs are considered a treatment of choice for reducing behavioral problems in children, as they are strongly supported by evidence across multiple comparisons and replications.

Reviews of the studies have yielded similar conclusions regarding the effectiveness of telehealth-based parent training (Ferguson et al., 2023), Map4Speech (Law et al., 2018), online parent communication training (Douglas et al., 2018), P-ESDM via telehealth (Rooks-Ellis et al., 2020), online stepped RIT care (Wainer et al., 2021), and online ImpACT intervention (Sengupta et al., 2021). These studies provide promising results for addressing behavioral and communication challenges in children. Furthermore, all studies emphasize the importance of behavioral principles and social learning when providing parents with

strategies grounded in behavior modification models. Cognitive stimulation strategies are also included in some programs, although they are not specifically analyzed in the analysis of results.

In summary, virtual parent-training programs have been shown to be efficacious in improving children with ASD's communicative, social, and behavioral skills. However, their impact on cognitive development remains unclear, as evidence in this area is scarce. Future research should explicitly investigate these skills.

It is also noteworthy that traditional behavioral therapies are associated with high costs, which limit access for many families. Sociodemographic barriers in remote rural areas represent additional obstacles to accessing specialized in-person therapies. Furthermore, the increasing time constraints faced by parents and caregivers hinder regular participation in face-to-face therapy sessions. Virtual programs provide a viable alternative by addressing these limitations, offering cost reduction, geographic accessibility, and greater scheduling flexibility.

Limitations and Future Directions

Most studies on virtual parent-training programs for children with ASD have small sample sizes, and withdrawal rates often influence program effectiveness and the reliability of outcomes (Lozano Rodríguez & Valero Aguayo, 2017). In this review, the total sample included 127 parents and/or caregivers, which may be considered adequate for drawing the current conclusions.

Another limitation is that the assessment was primarily conducted through questionnaires and rating scales, with parents serving as judges, evaluators, and co-therapists. This may limit the accuracy of reported changes, highlighting the need for future studies to incorporate more objective, direct observational data and meta-analytic approaches (Lozano Rodríguez & Valero Aguayo, 2017).

Additionally, it is difficult to determine whether families will continue applying the strategies taught after program completion. Longitudinal studies are recommended to evaluate whether behavioral and parental changes are maintained.

The results of this systematic review focus exclusively on children with ASD aged 7 or younger, due to the complexity and heterogeneity of participants and techniques across the included studies. Future research should extend to older age groups. Furthermore, only three databases were used in this study; expanding the search scope would likely capture a broader range of relevant studies. Moreover, this review was unable to examine

other domains, such as sensory and motor skills, highlighting the need for a more comprehensive approach in future research.

Despite these limitations, virtual parent-training programs remain relevant. This study provides a generalized framework of reasonable adjustments that have proven to be effective for children with ASD. The findings are particularly relevant for recommending virtual training programs. These programs would facilitate access to resources and support for families residing in rural areas or facing time constraints that hinder their in-person participation.

It is noteworthy that the cited studies were primarily conducted in North America, where greater attention has recently been given to the accessibility of virtual parent-training programs for children with ASD. Similar attention is needed for studies targeting parents of adolescents with ASD, both to advance research and to address common clinical concerns.

CONCLUSIONS

Parents of children with ASD actively seek qualified professionals for intervention and support once a diagnosis is confirmed. However, intervention programs may be hindered by in-person attendance requirements, high costs, insufficiently trained staff, and poor coordination of healthcare services. These barriers can make the intervention experience challenging and, at times, distressing for both autistic children and their caregivers.

This systematic review provides insight into common adjustments made to virtual training programs for parents of children with ASD, which may improve the quality of life for both parents and children. Positive outcomes have been observed in behavioral management and communication needs. Key program adjustments include efficient communication, simulations to familiarize parents with intervention environments, and strategies to support children across various domains. Additionally, the review highlights the need for professionals to be adequately trained to provide family-centered services for parents of children with ASD.

Finally, further research is needed on virtual training programs for parents of children with ASD, incorporating outcome measures beyond parent-reported data to increase objectivity. Longitudinal studies are also necessary to determine whether behavioral and communicative changes are sustained after the intervention concludes.

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Appendix 1. Study Quality Assessment Using the QATSDD Tool

QuADS Criteria	Sengupta et al. (2021)	Wainer et al. (2021)	Rooks-Ellis et al. (2020)	Dai et al. (2023)	Dai et al. (2023)	Lee et al. (2023)	Hong et al. (2018)	Douglas et al. (2018)	Vismara et al. (2013)	Law et al. (2018)	Ferguson et al. (2023)
1. Explicit theoretical framework	3	3	3	3	3	3	2	2	2	2	3
2. Statement of aims/objectives in main report	3	3	2	3	3	3	3	0	0	3	3
3. Clear description of research setting	3	3	3	3	3	3	3	3	3	3	3
4. Evidence of sample size considered for analysis	3	3	3	3	3	3	3	3	3	3	3
5. Representative sample of the target group of a reasonable size	2	2	2	3	3	2	2	2	2	2	2
6. Description of data collection procedure	3	3	3	3	3	3	3	3	3	3	3
7. Justification for choice of data collection tool(s)	3	3	3	3	3	3	2	3	3	3	3
8. Detailed recruitment information	3	3	3	3	3	3	3	3	3	3	3
9. Statistical assessment of the reliability and validity of measurement tools	3	3	0	0	3	0	0	2	2	3	3
10. Alignment between research question and data collection method	2	3	0	0	3	0	0	2	3	2	3
11. Alignment between research question and content/format of data collection tool (e.g., interview program)	3	0	3	3	0	2	3	0	0	0	0
12. Alignment between research question and analysis method	0	3	0	0	3	0	0	2	3	2	3
13. Adequate justification of analytical method	0	3	3	3	3	2	2	2	2	2	3
14. Assessment of the reliability of the analytic process	2	0	3	3	0	2	3	0	0	0	0
15. Evidence of participant involvement in design	3	3	3	3	3	3	3	3	3	3	3
16. Critical discussion of strengths and limitations	2	3	3	2	2	3	2	2	2	3	3
Score	38	41	37	38	41	35	34	32	34	37	41
Quality %	79.2%	85.4%	77.1%	79.2%	85.4%	72.9%	70.8%	66.7%	70.8%	77.1%	85.4%