

Efficacy of Parental Training In Addressing Developmental and Behavioural Difficulties Associated With Excessive Digital-Media Exposure: A Controlled Study

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Abstract

Virtual autism is a new developmental problem linked to high screen time and low interaction with peers in the early years that results in autism-like symptoms. There has been growing evidence that excessive exposure to digital media during infancy and toddlerhood might have a negative impact on language, social communication, emotional regulation, attention function, and sensory processing. In the present controlled study, the effectiveness of a parental training program to reduce virtual symptoms of autism in young children exposed to high levels of screen time was explored. The total sample was 40 children aged 2-5 years who exhibited autism-like symptoms in relation to excessive digital exposure, which were split into two groups: the experimental group (n = 20) and the control group (n = 20). The experimental group was assigned to a structured intervention parental training program that emphasized screen reduction, responsive caregiving, communication enhancement, play-based interaction, emotional engagement, and healthy media practices for a period of 12 weeks, and the control group received developmental guidance as usual. Developmental screening, behavioral observation, interviews with parents, and symptom severity ratings of communication, social interaction, attention, emotional regulation, and screen dependency were all used for assessment. The statistical analysis of data, with the help of paired t-tests and independent t-tests, showed that there was significant improvement in communication skills, eye contact, social responsiveness, emotional regulation, and reduction of screen dependency for children in the experimental group compared to the control group. Findings reinforce the role of parent-mediated intervention and healthy media use in developmental outcomes of children with virtual autism symptoms. The research pointed out that it is important to identify children in early stages; awareness of parents, media hygiene education, and multi-disciplinary intervention methods are necessary to protect the neurodevelopment of children in the digital era.

Keywords: Virtual autism, screen exposure, parental training, early intervention, child development, digital media, autism-like symptoms.

1 Introduction

Smartphones, tablets, television, and devices with internet connectivity are everywhere in children's everyday lives today and have become a part of modern childhood. While digital media can offer educational, recreational and communication opportunities, issues have been raised about developmental effects of exposure to digital media in early childhood. Language, cognition, social competence, emotional regulation, and adaptive behaviour are all important areas of development that begin to be shaped in early childhood, when language acquisition, cognition, social skills, emotional development, and adaptive behaviour are heavily dependent on reciprocal caregiver-child interactions, play, exploration, imitation, and everyday social interactions (National Research Council & Institute of Medicine, 2000). Research has consistently highlighted difficulties in executive functioning among children with autism spectrum disorder (ASD), particularly in domains such as working memory, inhibitory control, and cognitive flexibility (Jagruth, 2025).

Screen exposure may have a developmental effect on children that is not only dose-dependent but content-driven, context-driven, and/or time-driven, and caregiver-driven. According to the World Health Organization (WHO, 2019), children under the age of two should have limited screen time, and those ages 2-18 should have no more than 2 hours a day. The WHO additionally suggests that children should get plenty of sleep, physical activity, playtime, and non-screen interactions. In a systematic review and meta-analysis of 42 studies with 18,905 children, Madigan et al. (2020) concluded that increased screen time was correlated with poorer language outcomes, while educational content and co-viewing by caregivers were correlated with better language outcomes. The results indicate that screen exposure needs to be seen in relation to the developmental context

as a whole, and not as time spent on a screen. In parallel, emerging research on early childhood digital-media exposure suggests that prolonged screen use may be associated with developmental differences in socio-communication and play. Mallikarjuna et al. (2025) reported that toddlers exposed to more than two hours of screen media per day demonstrated lower levels of eye contact, joint attention, and symbolic play than children with comparatively lower exposure. These findings suggest a possible association between excessive screen exposure and aspects of socio-communicative and functional play development, while also highlighting the importance of appropriate parental guidance and balanced digital-media practices during early childhood. Similarly, Vidhupriya et al. (2025) reported associations between higher early screen exposure and language difficulties, social withdrawal, and repetitive behavioural characteristics. Their regression analysis identified daily screen duration and limited parental engagement as significant predictors of reported virtual-autism-related symptoms. Collectively, these findings underscore the importance of examining children's digital-media exposure within the broader context of parental interaction, developmental opportunities, and early psychosocial experiences, while avoiding the assumption that screen exposure alone establishes an autism diagnosis.

Other developmental research quantifying screen use has also identified relationships with developmental indicators. In a cross-sectional study of preschool children, Hutton et al. (2020) reported that increased screen-based media consumption was linked to decreased white-matter organization in pathways connected with language, literacy, and executive functions. However, findings from a cross-sectional design do not provide evidence of causality, and family and child factors can also affect screen use and developmental outcomes. Therefore, any such conclusions should be interpreted as correlations that need to be studied longitudinally.

These issues are especially relevant if children exposed to high levels of digital media exhibit delayed communication, less social interaction, less eye contact, attention issues, and inability to manage emotions or overreliance on digital media at a young age. In clinical and popular literature, the term "virtual autism" was introduced to refer to the autism-like features found in excessive computer use and social isolation. But "virtual autism" is not a diagnosis listed in the DSM-5-TR, and there is currently no evidence of a link between overuse of screens and autism spectrum disorder (ASD). When children demonstrate developmental or autism-like qualities, then developmental assessment is needed, not just to blame for issues of screen exposure.

It is especially critical to identify and intervene in the first years of life. Zwaigenbaum et al. (2015) highlighted that early intervention should be developmentally appropriate and learning opportunities should be embedded in daily activities. Parent involvement comes into play in particular, because parents offer the child repeated opportunities for communication, play, social interaction, emotional support, and learning within natural contexts. In a meta-analysis of parent-implemented language interventions, Roberts and Kaiser (2011) found positive outcomes for children's receptive and expressive language skills. In a similar fashion, Dawson et al. (2010) showed that a comprehensive developmental-behavioural intervention that includes parent participation is beneficial for young children with ASD.

Parental training could include developmental opportunities that are missed by excessive screen time, as well as the parental media environment. Parents can be supported to develop regular media rituals, limit what they call "spare" viewing time, and find alternatives to screen time, such as interactive play, shared reading, communication time, physical activity, and social time. Importantly, the goal of intervention should not just be to take away screens, but to add to the meaningful caregiver-child interaction and provide developmentally appropriate alternatives.

Although there is a growing interest in the issues relating to excessive screen time, intervention research specifically focusing on structured parent-mediated programmes is still limited. Existing literature has focused on associations between screen use and developmental outcomes, but not on testing interventions to alter children's media environments and increase parent-child interaction. Moreover, the concept of "virtual autism" is still debated by scientists and should not be considered the same as ASD. Research is thus required with well-defined behavioral outcomes and standardized developmental assessment that is standardized.

The current study aims to fill this gap by investigating the relationship between the structured parental training programme and improvements in a set of developmental and behavioural challenges among young children with excessive screen time. The intervention targeted parents' awareness, the proper handling of digital media use, communication, interactive play, emotional interaction, and developmentally supportive activities. This study focused on communication, social responsiveness, eye contact, emotional regulation, attention, and screen dependency. The study will contribute empirical evidence to an emerging field of early childhood and parent-mediated intervention research by focusing on measurable developmental and behavioural outcomes instead of the assumption that screen exposure is a cause of ASD.

2 METHODOLOGY

2.1 Aim of the Study

To explore the effectiveness of parental training to alleviate and reverse children's virtual-autistic symptoms in young children with overexposure to digital media.

2.2 Objectives

- To measure the prevalence of virtual autism symptoms among children who have high levels of screen time prior to intervention.
- To assess the effectiveness of parental training in enhancing communication and language in children who exhibit virtual autism symptoms.
- To explore how digital overexposure affects children's social interaction and eye contact are affected by parental training.
- To examine the effects of parental training on attention span and behavioral regulation.
- To evaluate a decrease in screen dependency and overuse of screens after the parental training intervention.
- To compare developmental outcomes of the experimental group and control group.

2.3 Research Design

This study employed a pre-test–post-test controlled experimental design to test the effectiveness of parents' training by comparing scores of a pre-test and a post-test administered to children with excessive digital media exposure and virtual autism symptoms. The study comprised an experimental group that received a structured parental training intervention, and a control group that received usual advice without specialized intervention. The choice of experimental design was made because it would permit scientific comparison between intervention and non-intervention groups and help to assess the effectiveness of parental training on developmental outcomes.

2.4 Sample and Sampling Procedure

2.4.1 Sample

All 40 children, aged 2–5 years, presented with developmental and behavioural characteristics associated with excessive screen exposure, including difficulties in communication, social interaction, attention, emotional regulation, and behavioural functioning. Autism-related features were assessed using the Indian Scale for Assessment of Autism (ISAA), while the study specifically examined symptoms occurring in the context of high digital-media exposure rather than assuming that excessive screen use itself constituted a diagnosis of autism. Early Intervention Centres (EIC) in Hyderabad were used as the source for participants. The study design had two groups of children, each group consisting of 20 children: the experimental group and the control group. For the children in the experimental group, their parents completed a structured parental training programme, while for the children in the control group, parents received routine developmental guidance. The two groups were comparable with respect to age, gender, developmental difficulties, and the amount of screen exposure.

2.4.2 Inclusion Criteria

Children were included if they met the predetermined inclusion criteria. The participants had to be 2–5 years old, and their level of screen exposure was above the recommended screen time for their age. Also, children had to have at least one developmental or behavioral trait that would be related to the study: delayed speech, limited eye contact, limited social interaction, attention difficulties, and emotional dysregulation. Severe neurological disorders and/or major sensory impairments were excluded. There was also a criterion of having at least one parent/carer who was willing to attend the recommended parental training sessions.

2.4.3 Exclusion Criteria

Children were not included in this study if they had a severe diagnosis of Autism Spectrum Disorder and a significant genetic or neurological disorder. Hearing and/or visual impairment was excluded if the child was severely impaired, as this could impact on their ability to communicate and interact with others, or on evaluation of their development. Children who were already receiving intensive developmental intervention before the study began were also excluded so as to reduce the impact of pre-existing intensive intervention on outcomes of the study. Those children who had serious medical conditions that might impact their ability to participate in the intervention or assessment procedures were also excluded.

2.4.4 Sampling Technique

The participants were selected using the purposive sampling method. Children were identified according to their developmental presentation and the eligibility criteria that had been set for the study. Developmental screening,

parent report, and clinical observations were gathered and included in the selection process. This allowed the researchers to identify children with the characteristics of interest for this study and whose parents were willing to engage with the parental training programme. Eligible children were identified and screened, and then randomized into the experimental and control groups, with each group being matched for age, gender, developmental challenges, and amount of screen time.

2.5 Tools used for data collection.

The Demographic Information Schedule, a study-developed Virtual Autism Symptom Checklist, Indian Scale for Assessment of Autism (ISAA), Screen Time Assessment Schedule, and Parent Observation Record were used for data collection. These measures provided information regarding participants' background characteristics, developmental and behavioural features, screen exposure, and changes observed during the intervention.

2.5.1 Demographic Information Schedule

Information was gathered about the child's age, gender, family background, developmental history, daily screen time, and type of digital media using a structured schedule. These data provided background for the interpretation of assessment data and comparison of experimental and control groups.

2.5.2 Virtual Autism Symptom Checklist

The Virtual Autism Symptom Checklist was used to identify the presence and severity of developmental and behavioural symptoms associated with excessive screen exposure and virtual-environment use in young children. A study-specific checklist was created to record specific developmental and behavioural features linked to excessive screen time. This included eye contact, social interaction, speech and language, attention, emotional responsiveness, behavioural regulation and reliance on digital devices. It is important to note that the instrument was created for the present study and was not considered a standardised diagnostic tool. The term virtual autism was descriptive and was not regarded as a separate diagnostic category. The checklist is intended for screening and research purposes and not for diagnosing autism spectrum disorder. Autism-related concerns should be evaluated using standardized instruments such as the ISAA or M-CHAT-R/F and, where indicated, comprehensive clinical assessment.

2.5.3 Indian Scale for Assessment of Autism (ISAA)

These were the autism characteristics assessed using the Indian Scale for Assessment of Autism (ISAA) with six domains: Social relationship & reciprocity, Emotional responsiveness, Speech-language and communication, Behaviour patterns, Sensory aspects and Cognitive components. This scale consists of 40 items rated according to a 5-point scale, with higher scores reflecting higher degrees of severity of characteristics assessed (Gothi et al., 2009; Matson et al., 2015). ISAA findings, however, were interpreted with caution and must be viewed in the context of the participants being young children and in relation to other study measures and developmental history. Previous studies have noted problems with the diagnostic performance and severity thresholds of the ISAA in young children (Mukherjee et al., 2019).

Schedule for screening of time spent in front of screens.

The daily duration, type of digital media, and overall patterns of digital media use were recorded using a structured schedule at baseline and throughout the intervention. This was pertinent because media exposure characteristics that are including amount, content, context, and caregiver involvement which may be associated with developmental outcomes, which may differ (Madigan et al., 2020).

2.5.4 Parent Observation Record

During the intervention, parents kept track of observable changes in communication, social interaction, emotional responsiveness, behavioural regulation, and screen-use patterns. The observations were used to give information about the child's functioning in the natural home environment, and this was supplemented by formal assessments. There is also evidence that parent-implemented interventions benefit children's communication and language development (Roberts & Kaiser, 2011).

2.6 Intervention Program

The parent training intervention was a structured 12-week developmentally appropriate parent-child interaction and communication intervention that reduced excessive and inappropriate digital-media exposure and facilitated more developmentally appropriate parent-child interaction, communication, play, physical activity, emotional engagement, and participation in daily routines. The intervention was informed by the principles of parent-mediated intervention, responsive interaction, positive behaviour support, developmental learning, and healthy media use practices.

The program involved weekly structured training sessions with developmental specialists and psychologists, and systematic practice at home by parents. The intervention was not only designed to minimize screen time, but to

replace passive screen time with meaningful developmental activities like communication, shared attention, play, storytelling, physical activity, social interaction, and participation with family.

This parent-mediated approach was based on the evidence that parents can be trained to implement interactional and behavioural strategies that will aid their child to develop. Oono et al. (2013) found more consistent effects for the outcomes of parent-child interaction, such as shared attention and synchrony among parents and children, with less consistent evidence for other child outcomes in a Cochrane review of parent-mediated interventions. A subsequent meta-analysis of randomized clinical trials (RCTs) also identified small overall effects for communication-language, socialization, cognition, and symptom-severity outcomes and highlighted the heterogeneity of the literature in terms of interventions and outcome measures (Nevill et al., 2018). Hence, the programme was designed as a multicomponent behavioural and developmental intervention, not just a withdrawal from screens.

2.6.1 Parent education about digital-media use

Parents were provided with formal "psychoeducation" on appropriate, supervised, and developmentally appropriate use of digital media. The training emphasized the potential for excess, extended, passive, and/or unregulated screen time to limit opportunities for communication, play, physical activity, sleep, learning, and in-person interactions. Parents were directed to recognise the typical patterns of problematic screen time, such as spending too much time watching TV, allowing too much screen time with a Smartphone or tablet, constant access to online videos, screen use at meal times and before bedtime, and using electronic devices to calm down, fill time, support tantrums, or to deal with crying.

Parents were encouraged to set clear and consistent rules about their children's media use, monitor media use, choose media that is developmentally and age-appropriate, and use co-viewing appropriately. They were also encouraged to make sure that digital media was not used to occupy or soothe the child, but rather was used in a purposeful way. The training focused on the idea that the goal was not to eliminate technology but to build a healthy family media environment that would not take a developmental experience that was necessary away from the screen. Parents were thus asked to offer frequent chances for communication, interactive play, shared reading, physical activity, social interaction, and family participation (American Academy of Pediatrics, 2016; Moreno et al., 2024).

2.6.2 Screen-Time Reduction Strategies

Reducing screen time was integrated as a step-by-step, programmatic, and personalized element of the parenting intervention. First, parents were asked to look for and document the child's current screen use habits, such as when, how long, and how often the child uses digital media, as well as what kinds of digital screens and which types of content the child is watching or using, and when and how. The use of screens during mealtimes, waiting times, transitions, boredom, crying, and challenging behaviour was specifically considered. Parents were taught to set clear guidelines about screen time and then expand screen-free time over time, based on the child's age and family situation.

Parents were instructed to use advance warning, timeouts, verbal cues, and visual cues when terminating screen time activities to help with predictability. Instead of taking devices away, parents were encouraged to prepare their children for transitions and offer them an alternative activity. Use of digital media for immediate response to crying, boredom, and tantrums was not encouraged. Rather, parents were educated on providing other alternative activities like shared reading, storytelling, discussions, puzzles, drawing, colouring, household assistance, outdoor activities, physical activities, and social interaction.

Positive reinforcement, including verbal praise, encouragement, and positive attention, was used to encourage participation in non-screen activities. The importance of consistent media use from parents/carers was highlighted to ensure children were provided with consistent expectations about media use. So a focus of screen reduction was considered to be substitution of screen time for meaningful developmental opportunities in communication, play, movement and social interaction. This parallels the recommendations for individualized family media planning, predictable media boundaries, parental involvement, and protection of sleep, physical activity, learning, and family interactions from the displacement they experience as a result of media exposure (American Academy of Pediatrics, 2016; Moreno et al., 2024).

2.6.3 Development of Healthy Family Media Practices

Families were coached to develop regular, developmentally appropriate family media habits at home. The training focused on fostering screen-free time and environment, especially at dinner, during direct parent-child activities, learning, and bedtime. Parents were encouraged to remove the recreational digital devices from the dining and sleeping areas whenever possible and to set fixed times for the family to engage in screen-free activities.

With the use of digital media, parents were encouraged to choose media suitable for the child's age and developmental level and to actively participate in the media by co-viewing and dialogue. They learned to critique the content, pose some basic questions, acknowledge the child's responses, and link media experiences to the real world. The practices were supposed to be more interactive and meaningful in the use of media, not passive. Another emphasis was on parents as models of healthy digital media usage. Parents received instructions to keep track of their own cell phone use and to limit unnecessary cell phone use when directly interacting with their child. This could be related to the notion of technofence, which is the interference that caregiver technology may cause or decrease in responsive parent-child interaction (Radesky et al., 2014; McDaniel & Radesky, 2018). Parents were encouraged to show the same media-management behaviours that children were to do.

The overall goal of the intervention was to create a family environment that purposefully and consistently uses digital devices in developmentally appropriate ways that support opportunities for communication, emotional connection, shared activities, sleep, physical activity, and social interaction. These practices aligned with the recommendations for family media planning, parental involvement, co-use of media, healthy routines, and protecting essential developmental activities (American Academy of Pediatrics, 2016; Moreno et al., 2024; World Health Organization, 2019).

2.6.4 Responsive Parent-Child Interaction

One of the focal points of the parental training programme was the development of responsive and reciprocal parent-child interaction and child-centredness. Parents were instructed to listen to and respond to their child's verbal and non-verbal communication, follow the child's interests in play and make many opportunities for social interactions. They were encouraged to be at the child's level, establish shared attention, imitate appropriate sounds and actions, use simple developmentally appropriate language, and give the child enough time to respond.

Parents also learned to accept and encourage verbal and nonverbal communication attempts such as gestures, eye gaze, vocalizations, and words. Turn-taking, imitation, engagement together, choice-making, and reciprocal interaction were promoted through everyday activities including play, mealtimes, stories, daily routines, and outdoor activities. The child's opportunities to initiate interaction were emphasized, not adult directed/initiated interaction. This is in line with parent-mediated and naturalistic developmental approaches, which highlight responsive interactions and learning in naturalistic environments (Oono et al., 2013; Pickles et al., 2016; Schreibman et al., 2015).

2.6.5 Communication Enhancement

Communication training involved the child's increased use of functional verbal and non-verbal communication in daily activities. Parents were provided with training to encourage requesting, choice-making, pointing, sounding and imitating sounds and actions, responding to name, and following simple instructions. They were instructed to model functional words and phrases, increase the verbal attempts of the child, use simple language, and give adequate processing time.

Parents were asked not to expect or need to immediately meet all needs. Rather, they were instructed to allow natural moments of communication by pausing for just a second before giving them the object, activity, or help they wished for. For instance, when your child is playing, eating, getting ready to dress, bathing, or doing other activities in the home, you might wait for the child to look, point, enjoy pointing, talk, or use a word before making a response. To further promote purposeful communication, choices between two preferred objects and/or activities were provided. Communication attempts occurred, followed by social or natural reinforcement at the time.

The focus of the intervention was on functional communication in the natural environment, not just on isolated practice. Communication opportunities were integrated into play, self-care, and family routines, and into community events to foster generalization across people and settings. They are consistent with naturalistic developmental and behavioural approaches, and research evidence that supports parent-mediated communication interventions (Oono et al., 2013; Schreibman et al., 2015; Steinbrenner et al., 2020).

2.6.6 Storytelling and Shared Reading

To reduce passive screen time and promote language development, joint attention, social interaction and reciprocal communication, storytelling and shared reading were introduced as regular interactive parent-child activities. Parents were asked to choose developmentally appropriate books for their child, taking into account their interests, developmental stage, and ability to communicate. Parents learned to use reading cues such as pointing and labelling pictures, asking simple questions, encouraging pointing and identification, pausing for answers, imitating verbal attempts, and praising participation during reading.

Storytelling was also employed as a tool to facilitate vocabulary, listening, comprehension, attention, sequencing, imagination, and conversational turn-taking. Parents were invited to relate stories to their child's life experiences and slowly engage the child in identifying objects, describing activities, answering questions, filling in familiar phrases, and recounting simple events. Interactive and dialogic reading methods offer repeated opportunities for children to hear and experience language in rich social contexts (Bus et al., 1995; Mol et al., 2008; Whitehurst et al., 1988).

Activities were modified based on the child's developmental and communication level. Children who had limited language were encouraged to look at pictures and say sounds, imitate sounds, point, use gestures, and say a word, while children with better communication skills were progressively introduced to answering questions, sequencing events, describing actions, and talking about simple emotions and social situations. Independent participation was encouraged in a gradual manner with decreasing parent prompts (Mol et al., 2008; Noble et al., 2019).

Shared reading/storytelling was therefore not only introduced as a reading/literacy activity, but as a meaningful alternative to passive screen time. Parents were asked to integrate these activities into their daily routine and have them be fun and social. This is aligned with the strategies recommended by the WHO for developmentally appropriate alternatives to sitting and watching more screens, which include reading and storytelling with caregivers (World Health Organization [WHO], 2019).

2.6.7 Play-Based Learning

Play-based learning was a key aspect of the intervention and was used to help children communicate, interact socially, learn cognitively and adaptively, and learn through fun and developmentally appropriate activities. Block play, puzzle play, matching and sorting, drawing, colouring, role play, turn-taking, ball play, action songs and simple problem-solving activities were introduced to parents based on the child's age, interest, attention and capabilities. Parents were encouraged to follow the child's interests and, over time, provide opportunities for the child to ask for, imitate, share, take turns, and problem solve.

Specific attention was given to joint attention and social reciprocity, to communication, and to imitation and turn-taking. Parents were instructed to participate in the child's play, to wait for the child's responses, to respond contingently to the child's attempts to communicate, and to provide praise and positive attention for their appropriate participation. For instance, during block play, parents could model construction, encourage requests and sharing, and bring in simple problem-solving experiences. They could demonstrate actions and speech and facilitate turn-taking during pretend play. Common daily activities were also included to foster generalization across settings and family members. This aligns with findings that highlight the role of play in supporting social, emotional, cognitive, and communication development (Ginsburg, 2007; Yogman et al., 2018) as well as naturalistic developmental and behavioural approaches in which learning is a part of meaningful activities (Schreibman et al., 2015; Steinbrenner et al., 2020).

2.6.8 Emotional Bonding and Social Engagement

Activities were provided to increase positive, responsive, and emotionally meaningful parent-child interactions. Parents were encouraged to use smiling, shared enjoyment, songs, action rhymes, praise, turn-taking games, and other activities that they enjoyed as a preference of the child. They were taught to look for cues that indicated they were interested in, enjoying, frustrated by, uncomfortable with, or wanting something done for them, and they were taught to build consistent social routines, like greetings, songs that are enjoyed together, and activities that are preferred.

Specific praise and positive attention were encouraged for children who tried to communicate, joined in with others, took turns, listened to directions given, and performed socially appropriate behaviour. Repeated warnings and confrontational reactions were avoided in favor of calm redirection. Parents were also encouraged to design time and space for frequent moments of undisturbed parent-child togetherness, without mobile phone or TV. It was not intended to do more, but to do better, in terms of direct interpersonal contact. These strategies align with the evidence highlighting responsive care, parent-mediated interventions, and relationship-based strategies for child development (Oono et al., 2013; Schreibman et al., 2015; World Health Organization [WHO], 2019; WHO, UNICEF, & World Bank Group, 2018).

The intervention therefore incorporated emotional connection and social engagement into ordinary family routines, including play, meals, household activities, and outdoor activities. Parents were encouraged to follow the child's interests, maintain shared attention, respond to communication attempts, and gradually extend reciprocal interaction. Positive and responsive caregiving was emphasized as a means of creating predictable and supportive opportunities for social and emotional development.

2.6.9 Behavioural Management Techniques

Behavioural management training has been provided to parents, which involves supporting them to use positive, consistent and proactive strategies to understand and respond to challenging behaviours. Parents were exposed to the ABC framework to identify the events that occur before a behaviour, define a behaviour in an objective way, and examine the consequences of behaviour. This was useful for parents to understand patterns in behaviour and what might be causing it, and to examine the potential for how they might respond, which could further increase or decrease challenging behaviour. Parent-mediated behavioural interventions also focus on the understanding of behaviour patterns, consistent response, reinforcement and teaching alternative skills (Bearss et al., 2015; Postorino et al., 2017).

Clear and brief instructions, predictable expectations, choices, positive reinforcement, redirection, and differential reinforcement were taught to parents. Specific praise and attention (or other meaningful reinforcement) followed appropriate behaviour. It was encouraged for parents to reinforce alternative appropriate behaviours and not to reinforce challenging behaviours. Consistency between staff was highlighted to ensure consistency of responses to situations. The results indicated that parent training can contribute to a decrease in undesirable and maladaptive behaviors, but the effects of parent training vary depending on the children and the type of parent training (Postorino et al., 2017; Tabatabaei et al., 2022).

The parents were also educated in the use of transition warnings, especially during the end of activities they enjoy and when decreasing screen time. Simple language, visual and verbal cues, and advance warnings and immediate engagement in an alternative activity supported smoother transitions. Play, storytelling, drawing, household involvement, outdoor activities, and other preferred non-screen activities were used to replace the screen. Planned ignoring was only recommended for behaviours that were minor, safe, attention-maintained, and not aggression, self-injury, significant distress, or behaviors that required immediate adult intervention.

The programme was specifically against the use of physical violence, threats, humiliation or intimidation, and extended conflict. Rather, parents were encouraged to use calm communication, positive reinforcement, redirection, predictable routines, and teaching alternative behaviours. This caregiver-focused approach aligns with the WHO Caregiver Skills Training framework that focuses on implementing practical strategies for enhancing children's engagement, communication, positive behaviour, and daily functioning in natural family routines.

Overall, the focus of behavioural management training was on assisting parents to be consistent, responsive and proactive in addressing challenging behaviour. Parents were encouraged to recognise behaviours, change antecedents, reinforce behaviours, teach alternative behaviours and build routines both in the home and community.

2.6.10 Sensory Play and Physical Activities.

Enhanced opportunities for active, exploratory and socially interactive experiences in the children's everyday settings through sensory play and physical activities. Parents were asked to supply activities for the children to do that were developmentally appropriate for them, including walking, running, jumping and dancing, ball games, playground activities, gardening, water and sand play, drawing, craft activities and nature exploration. Activities were tailored to the developmental level, physical capabilities, interests and tolerances of the child. Parents were encouraged to be active, demonstrating actions, giving simple instructions, waiting for their child to respond, encouraging imitation, and adding in turn-taking and shared enjoyment. Therefore, there were also opportunities for children to practice communication, share attention, imitate, follow directions, and communicate with parents during their physical and sensory play activities (World Health Organization [WHO], 2019; Schreibman et al., 2015; Steinbrenner et al., 2020).

A sensory approach was encouraged, and parents were given autonomy to follow the child's interests and slowly increase participation. For instance, water play may include pouring and scooping; movement interests may be explored by dancing, jumping, ball games, or simple obstacle play. Sustained engagement, choice-making, communication, and gardening were also encouraged through a variety of other activities in the home. Physical activities also allowed gross motor coordination, balance, body awareness, attention, and adaptive participation to be developed. There is evidence of the motor-skill interventions and physical activity supporting motor outcomes in children with ASD, but results are inconsistent with respect to type of intervention and individual characteristics. As such, in this current intervention, physical activity was seen as a developmentally supportive and engaging component of the intervention and not as a separate treatment for symptoms of autism.

This component was also part of the overall objective to replace long hours of sitting with more productive activities. Notably, it was not designed to be a standardised 'sensory integration therapy' nor was it designed to suggest that sensory activities were independent treatments for autism. Rather, sensory-rich play and physical

activities were integrated into the normal routines of the family to encourage more active participation, exploration, communication and parent-child interaction, and fewer opportunities for prolonged sedentary screen time (WHO, 2019).

2.6.11 Outdoor Activities and Social Participation

The activities in the outdoor environment and social participation were integrated to offer opportunities for physical activity, environmental exploration, communication, and meaningful parent-child engagement. Parents were encouraged to engage the children in developmentally appropriate activities including visits to the park, walking, play activities in the park, ball games, observing nature, cycling (when appropriate), family activities and community activities. These experiences offered children alternative activities to screen time and allowed them to practise their physical, social and adaptive skills in the real environment (WHO, 2019).

Developmental learning was used in natural contexts of the outdoor activities. Parents were encouraged to walk, run, climb, balance, jump, take turns, ask for help, and listen to simple instructions while attending playground activities. Nature-based activities enabled the identification and naming of objects, answering questions, showing interest, and joint attention. Parents were encouraged to actively participate, demonstrate appropriate behaviors, respond to communication attempts, and support social participation. These spontaneous, naturally occurring interactions align with parent-mediated and naturalistic methods of supporting social communication and developmental skills (Oono et al., 2013; Schreibman et al., 2015; Steinbrenner et al., 2020).

This supported the practice of independence and emotional regulation through outdoor activities. Children were encouraged to make simple decisions, carry out familiar activities, engage in age-appropriate activities, and take increasingly less assistance to complete activities. Parents were encouraged to offer calm support during waiting times, transitions, frustration or when new situations arise, and to rehearse previously taught communication and coping skills. This meant that outdoor activities were not only used to limit screen time but were also designed to include physical activity, interaction, community learning, communication, independence, and parent-child involvement in the daily life of the community (WHO, 2019 and WHO, 2020).

2.6.12 Establishment of Screen-Free Daily Routines

A major component of the intervention was the establishment of predictable and meaningful screen-free daily routines to gradually replace prolonged or unstructured digital-media use. Parents were trained to organize the child's day around a consistent sequence of activities, including personal hygiene, meals, learning, play, physical activity, outdoor activities, family interaction, reading or storytelling, quiet activities, and bedtime routines. The structure and duration were individualized according to the child's age, developmental level, school schedule, interests, and family circumstances. Consistent routines were intended to support predictable transitions and increase opportunities for communication, learning, physical activity, social interaction, and daily living skills (WHO, 2019; WHO, UNICEF, & World Bank Group, 2018).

Particular emphasis was placed on maintaining screen-free periods during family meals, parent-child interaction, learning activities, outdoor play, and designated family communication time. Parents were encouraged to replace digital engagement with conversation, shared play, storytelling, books, household activities, and other developmentally appropriate experiences. The intervention therefore emphasized replacement rather than restriction alone. Parents were guided to prepare alternative activities such as puzzles, drawing, blocks, pretend play, outdoor activities, songs, books, and parent-child games so that reduced screen exposure was accompanied by meaningful opportunities for interaction and active participation.

Overall, the routine component aimed to create a balanced daily pattern in which screen use did not displace opportunities for physical activity, sleep, play, communication, social interaction, and family engagement. This approach was consistent with WHO recommendations emphasizing the balance of physical activity, sedentary behaviour, and sleep during early childhood (WHO, 2019).

2.6.13 Sleep and Bedtime Media Hygiene

Sleep and bedtime media hygiene were included to establish consistent and calming pre-sleep routines and reduce reliance on digital media at bedtime. Parents were educated about maintaining regular sleep and wake times and developing a predictable sequence of activities such as personal hygiene, changing into sleepwear, quiet conversation, storytelling, shared reading, gentle songs, or other age-appropriate quiet activities. Parents were encouraged to avoid using mobile phones, television, tablets, or other screens as the primary method of settling the child and to minimize unnecessary digital devices in the sleeping environment. For children accustomed to screen-based settling, screen reduction was introduced gradually and supported with familiar alternatives such as books, conversation, and quiet play.

Sleep was addressed as part of the child's broader 24-hour activity pattern rather than as an isolated outcome. WHO guidelines emphasize adequate and good-quality sleep, regular sleep-wake patterns, physical activity, and

reduced sedentary screen behaviour as interconnected aspects of healthy development in young children (WHO, 2019). Accordingly, bedtime media hygiene formed part of the broader intervention goal of establishing a structured daily pattern that balanced sleep, active play, learning, social interaction, family participation, and screen-free activities.

2.6.14 Parent Training Methods

The parental-training programme used instructional and experiential methods to develop parents' practical skills for implementing intervention strategies in everyday settings. Training included psychoeducation, verbal explanation, modelling, live demonstration, video demonstrations where appropriate, role play, guided parent-child practice, observation, individualized feedback, and problem-solving. Parents were taught how to create communication opportunities, encourage interactive play, reinforce appropriate behaviour, manage transitions from screens to alternative activities, and establish predictable routines.

Supervised practice enabled parents to apply the strategies with their children while receiving immediate supportive and corrective feedback. Role play was used to practise common situations, including requests for mobile devices, transitions away from screens, communication difficulties, challenging behaviour, and introduction of alternative activities. Parents were also encouraged to discuss barriers encountered at home so that strategies could be adapted to their child's developmental level and family circumstances. These methods are consistent with caregiver-mediated approaches emphasizing coaching, modelling, practice, and feedback within natural environments (Oono et al., 2013; Schreibman et al., 2015; Steinbrenner et al., 2020).

Home assignments were provided after each session and were linked to the skills introduced during that week. Activities included increasing interactive play, creating communication opportunities, shared reading, outdoor activities, positive reinforcement, screen reduction, and establishment of predictable routines. Progress and difficulties were reviewed during subsequent sessions, creating a cycle of instruction, demonstration, practice, home implementation, feedback, and review.

2.6.15 Development of Screen-Free Daily Routines

One of the key aspects of the intervention was creating predictable and meaningful screen-free daily routines, gradually replacing prolonged and unstructured use of digital media. Parents were educated to structure the child's day around a sequence of activities: personal hygiene, eating, learning, play, physical activity, outside activities, family activities, reading or stories, quiet activities, and bedtime routines. Individualization of structure and duration was based on the child's age, developmental level, school schedule, interests, and family context. Routines were planned for predictable transitions and to enhance opportunities for communication, learning, physical activity, social interaction, and daily living skills (WHO, 2019; WHO, UNICEF, & World Bank Group, 2018). Extra attention was given to screen-free activities at mealtimes, parent-child interactions, child learning, outdoor play, and family communication time. Parents were provided with encouragement to replace digital engagement with conversation, shared play, storytelling, books, household activities, etc., and other developmentally appropriate experiences. The intervention thus focused on "replacement" rather than "restriction" only. Parents were encouraged to create alternative activities including puzzles, drawing, blocks, pretend play, outdoor activities, songs, books, and parent-child games to help ensure that reduced screen time would be paired with an opportunity for interaction and active play.

The overall goal of the routine component was to establish a well-rounded pattern in the day in which screen time wasn't taking the place of opportunities to be physically active, sleeping, playing, communicating, interacting with others, or spending time with family. It followed the WHO guidelines that highlight the importance of balancing physical activity, sedentary behaviors, and sleep in early childhood (WHO, 2019).

2.6.16 Sleep and Bedtime Media Hygiene

Sleep and bedtime media hygiene was added to ensure regular and relaxing bedtime routines, and to limit the use of digital media before sleep. Parents were given information on maintaining a regular bedtime and rising time, as well as a consistent routine of activities (personal hygiene, putting to bed, quiet conversation, stories, shared reading, quiet music or other age-appropriate quiet activities). Parents were urged to not use a mobile phone, television, tablet, or other screen to soothe the child, and to keep unnecessary digital devices out of the sleep space. Screen reduction was implemented slowly and integrated with familiar alternatives like books, talking, and quiet play for children who had been used to settling to screens.

Where sleep was discussed, it was in the context of the child's overall activity schedule over 24 hours. The WHO guidelines highlight that sleep, quality sleep, sleep-wake cycles, physical activity, and minimising sedentary screen time are related parts of healthy early childhood development (WHO, 2019). Bedtime media hygiene was therefore part of the entire intervention goal of developing a structured daily routine, characterised by a balance of sleep, active play, learning, social interaction, family involvement, and screen-free activities.

2.6.17 Parent Training Methods

The programme for parents was an instructional/experiential approach designed to build parents' skills in practical application of intervention strategies in natural environments. The contents of training were: psychoeducation, verbal explanations, modelling, demonstration, video demonstration (when appropriate), role play, guided parent-child practice, observation, individual feedback, problem solving. Parents were instructed on ways to provide communication opportunities, promote interactive play, reinforce appropriate behaviours, adjust to transition from screen time to other activities, and set up routines.

The supervised practice helped parents practice the strategies with their children and receive supportive and corrective feedback immediately. Mobile requests, screen breaks, communication and behavioural challenges, and introducing alternative activities were practised in role plays. Parents were also asked to talk about the challenges they faced at home to make adjustments to the strategies to the child's developmental level and family situation. These strategies align with the caregiver-mediated strategies that utilize coaching, modelling, practice and feedback in natural environments (Oono et al., 2013; Schreibman et al., 2015; Steinbrenner et al., 2020).

Home assignments were sent out following each session and related to the skills taught in that particular session. Strategies involved were enhanced interactive play, communication opportunities, shared reading, outdoor experiences, positive reinforcement, reducing screen time, and establishing routines. In subsequent sessions, progress and problems that arose were discussed, establishing a cycle of teaching, demonstration, practice, home application, feedback, and review.

2.6.18 Home-Based Implementation

An important part of implementation was to have this take place at home, where the behaviours of interest could be observed during children's normal activities, such as their use of screens, communication, play, family interactions, physical activity, bedtime routine, and reaction to transitions. Parents were thus encouraged to practice learnt strategies in their daily routines, including mealtimes, dressing up, bathing, chores, play activities, outdoor activities, bedtime routines, and so on. Incorporating intervention opportunities into natural activities and caregiver-mediated developmental routines aligns with naturalistic and caregiver-mediated developmental approaches (Schreibman et al., 2015; Steinbrenner et al., 2020).

Home-monitoring was kept by parents and contained a brief record of the selected indicators, including: recreational screen time, a screen-free period, interactive play, shared reading/storytelling, outdoor play, physical activity, opportunities for communication, challenging behaviors, bedtime routine, and successful engagement in alternate activities. The record was not designed to be a tool for very detailed behavioural measurement but, rather, to facilitate monitoring, discussion, and problem-solving. Parents were asked to make regular observations as they would, acknowledging potential discrepancies in observation and reporting.

In the following sessions, the professional discussed these records with the parents, determined the challenges, and created practical solutions. If having trouble with screen transitions, for instance, you can try to give advance warning, reinforce, engage in other activities, and/or change routines. For example, if shared reading or interactive play is a problem, then the activity focus selected should be shorter and developmentally appropriate. The repetition across daily activities was designed to help transfer what has been learned from the professional training to everyday life (Oono et al., 2013; Schreibman et al., 2015).

2.6.19 Individualization of the Intervention

The intervention was carried out within a standardized, structured protocol but tailored to individual child and family characteristics. Factors taken into account were age, developmental level, communication skills, previous exposure to digital media, behavioural traits, sensory preferences, interests, physical capabilities, and family situation. Parents' understanding, confidence, availability, and ability to carry out strategies were also taken into account. This individualization aligns with an evidence-based developmental approach that acknowledges children with developmental and related autism have many needs and characteristics that differ greatly from one another (Steinbrenner et al., 2020).

The major components of the intervention were the same across participants, with some adaptations made to the specific activities, prompts, reinforcement procedures, transitions, and home assignments. For instance, children who were not as verbal were encouraged to focus on gestures, pointing, requesting, imitation, and functional words, while children with higher verbal communication skills were encouraged to engage in longer verbal responses and reciprocal conversation. Alternatives to screen time activities were also chosen based on the child's interests, developmental skills, family resources, and opportunities.

The intervention took place over a period of 12 weeks and consisted of structured parental training sessions weekly, delivered by psychologists and developmental specialists. Typically, each session consisted of reviewing

previous home implementation, introducing a new topic or skill, providing a theoretical explanation, demonstrating the skill, supervised parent–child practice, individualized feedback, problem solving, and planning of home activities. This repeated cycle allowed parents to gradually learn, practice, implement, and review intervention strategies (Oono et al., 2013; Schreibman et al., 2015).

The programme was elaborated as a parent-mediated, home-supported, developmentally oriented intervention, in which parents were an active part of the intervention, not information recipients. They participated in learning, practicing, observing, and implementing intervention strategies in their regular family activities.

Importantly, the intervention was multicomponent, not simply a screen time reduction intervention. It encompassed decreasing recreational screen time, responsive parent–child interaction, communication skills, shared reading and storytelling, play-based learning, behavioural management, engagement with emotions, sensory and physical activities, outdoor activities, and predictable daily routines. Thus, any observed changes cannot be solely attributed to the reduction of screen time unless the study design controls the effect of screen-time reduction. Results should be viewed as related to the intervention package as a whole, rather than to just one intervention component, as multiple components could have been responsible for changes observed (Schreibman et al., 2015; Steinbrenner et al., 2020).

2.7 Procedure

This study was divided into three parts: pre-assessment, intervention, and post-assessment. The pre-assessment phase involved baseline assessment of the participants in both experimental and control groups on the relevant developmental scales, and parents' questionnaire data about communication, language, social responsiveness, attention, emotional regulation, and recreational screen exposure.

In the 12-week intervention phase, parents in the experimental group were trained by psychologists/developmental specialists in a structured way weekly. Psychoeducation was provided, as was modelling, guided parent–child practice, feedback, problem-solving, and home assignments. Parents were instructed to limit inappropriately high levels of recreational screen time, increase responsive interaction, communication, play, shared reading, physical/outdoor activities, behavioural management, and predictable daily routines. Home implementation was tracked using basic parent records and during subsequent sessions. The control group completed the same activities/usual care as the intervention group during the same time period.

After the intervention, the post-assessment was conducted for both groups in the same assessment framework. Pre- and post-intervention results were compared to determine if there were any changes in communication, eye contact and social engagement, social responsiveness, attention, emotional regulation and screen-use patterns. The overall reduction in screen-time in the intervention was interpreted as reflecting the overall parental-training programme and not merely the independent effect of the screen-time reduction (Oono et al., 2013; Schreibman et al., 2015; Steinbrenner et al., 2020).

2.8 Statistical Analysis

Data collected were analyzed with relevant descriptive and inferential statistical techniques. Data collected were summarized using the mean, standard deviation, and percentage analysis. The pre-test and post-test differences within groups were analysed using a paired-samples t-test, and the independent-samples t-test was used to compare differences between the experimental and control groups. A significance level of $p < .05$ was used to determine statistical significance.

2.9 Ethical Considerations

This study was done in an ethical manner, following the ethical principles of research involving children. Written informed consent of the parents/legal guardians was obtained prior to participation. Parents were given information about the purpose, procedures, time commitment, and potential benefits of the intervention, and that participation was voluntary. The privacy of the participants' information and the confidentiality of their data were ensured during the study, and data were only used for research purposes. All records and reports were kept confidential by not identifying the children and their families. Parental opportunity was also provided to ask questions about the study and to opt their child out of the study in line with the approved research processes.

3 Results and Discussion

The purpose of the current study was to investigate the effectiveness of a structured parental training program for decreasing symptoms of virtual autism in children exposed to high levels of digital media. A total of 40 children aged between 2–5 years participated in the study and were equally divided into an experimental group (n = 20) and a control group (n = 20). The experimental group received a 12-week structured parental training program, and the control group received the developmental counseling they were accustomed to.

Descriptive data analysis, paired-sample t-test, and independent-samples t-test were used to analyze the collected data. The analysis was limited to the changes in communication skills, social interaction, emotional regulation, attention functioning, sensory responsiveness, and screen dependency from pre-test to post-test.

Table 1: Demographic Characteristics of Participants

Variables	Experimental Group (n=20)	Control Group (n=20)
Mean Age (Years)	3.6	3.5
Male Children	14 (70%)	13 (65%)
Female Children	6 (30%)	7 (35%)
Average Daily Screen Exposure Before Intervention	5.8 Hours	5.6 Hours
Delayed Speech Symptoms	18 (90%)	17 (85%)
Poor Eye Contact	16 (80%)	15 (75%)
Reduced Social Interaction	17 (85%)	16 (80%)
Attention Difficulties	15 (75%)	14 (70%)

Demographic and baseline characteristics of the two groups are shown in Table 1. The average ages of the children in the experimental group (3.6 years) and the control group (3.5 years) were similar. The gender distribution was also generally the same, with 70% males in the experimental group and 65% males in the control group, respectively, and 30% and 35% females in the experimental and control groups, respectively.

Baseline patterns of developmental & behavioural difficulties were also comparable in the groups. The intervention group had an average of 5.8 hours of recreational screen time per day prior to the intervention, while the control group had an average of 5.6 hours. Of the children who did present speech symptoms, 90% of the experimental and 85% of the control groups reported delayed symptoms; poor eye contact was reported by 80% of the experimental and 75% of the control children; reduced social interaction was reported by 85% of the experimental and 80% of the control children, and attention difficulties were reported by 75% of the experimental and 70% of the control children.

The results of the demographic analysis showed that the two groups were found to be similar in terms of age, gender distribution, and baseline symptom severity. The majority of children had excessive screen time above 5 hours per day, and a number of children presented with delays in speech, difficulties with eye contact, low social engagement, and attention-related difficulties. The similarity of the groups prior to intervention allows for the validity of comparisons to be made.

3.1 Pre-intervention and Post-intervention Comparison Within Experimental Group

Table 2: Mean Scores of Virtual Autism Symptoms in Experimental Group Before and After Intervention

Variables	Pre-intervention Mean	Post-intervention Mean	Mean Difference	t-value	p-value
Communication Deficits	18.40	10.15	8.25	8.76	<0.01
Poor Social Interaction	17.65	9.80	7.85	7.94	<0.01
Eye Contact Difficulties	16.25	8.45	7.80	7.51	<0.01
Emotional Dysregulation	15.70	8.95	6.75	6.88	<0.01
Attention Problems	16.85	9.30	7.55	7.20	<0.01
Screen Dependency	19.25	7.65	11.60	10.42	<0.01

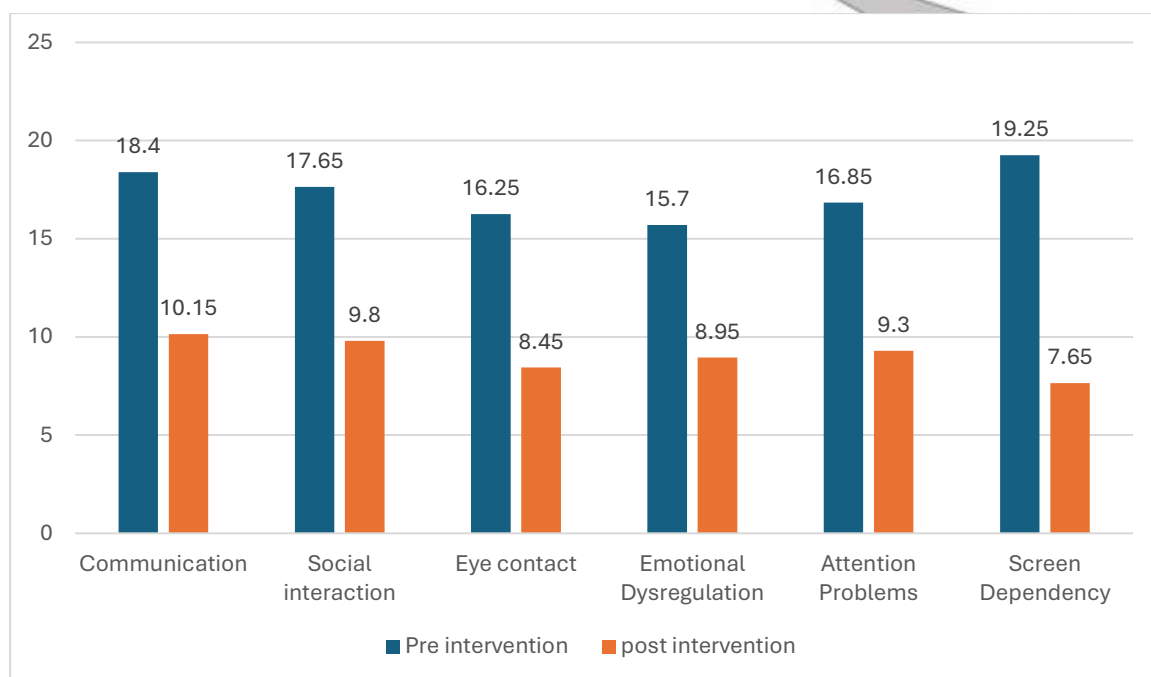


Figure 1 shows pre-intervention and Post-intervention scores within the experimental group.

Data from the virtual autism-related symptom scores of the experimental group are shown in Table 2 before and after the 12-week parental-training intervention. When using the paired-samples t-test, the results showed a statistically significant decrease in all the measured domains. Communication deficit scores changed from a pre-intervention mean score of 18.40 to 10.15 at post intervention ($t = 8.76$, $p < .01$); poor social interaction scores changed from a mean score of 17.65 to 9.80 ($t = 7.94$, $p < .01$). Eye contact difficulty scores declined from 16.25 to 8.45 ($t = 7.51$, $p < .01$), and emotional dysregulation scores decreased from 15.70 to 8.95 ($t = 6.88$, $p < .01$). Likewise, scores for attention problems went down from 16.85 to 9.30 from the pre-intervention to the post-test ($t = 7.20$, $p < .01$). The significant group mean difference was found for screen dependency (-11.60, $t = 10.42$, $p < .01$), with the largest mean reduction observed for screen dependency (19.25 to 7.65). Overall, the results suggest that the intervention resulted in statistically significant changes across the various dimensions of communication, social interaction, eye contact, emotional regulation, attention, and screen use. The biggest gains were in screen dependency scores, which showed that parents' knowledge about healthy media use and consistent screen reduction strategies were very successful. Statistically significant p-values < 0.01 suggest that the improvements observed were not random, but rather were linked to the intervention.

3.2 Pre-intervention and Post-intervention Comparison Within Control Group

Table 3: Mean Scores of Virtual Autism Symptoms in Control Group Before and After Routine Guidance

Variables	Pre-intervention Mean	Post-intervention Mean	Mean Difference	t-value	p-value
Communication Deficits	18.05	17.10	0.95	1.12	NS
Poor Social Interaction	17.25	16.45	0.80	1.06	NS
Eye Contact Difficulties	15.90	15.10	0.80	0.98	NS
Emotional Dysregulation	15.35	14.75	0.60	0.91	NS
Attention Problems	16.45	15.85	0.60	0.84	NS
Screen Dependency	19.05	17.95	1.10	1.21	NS

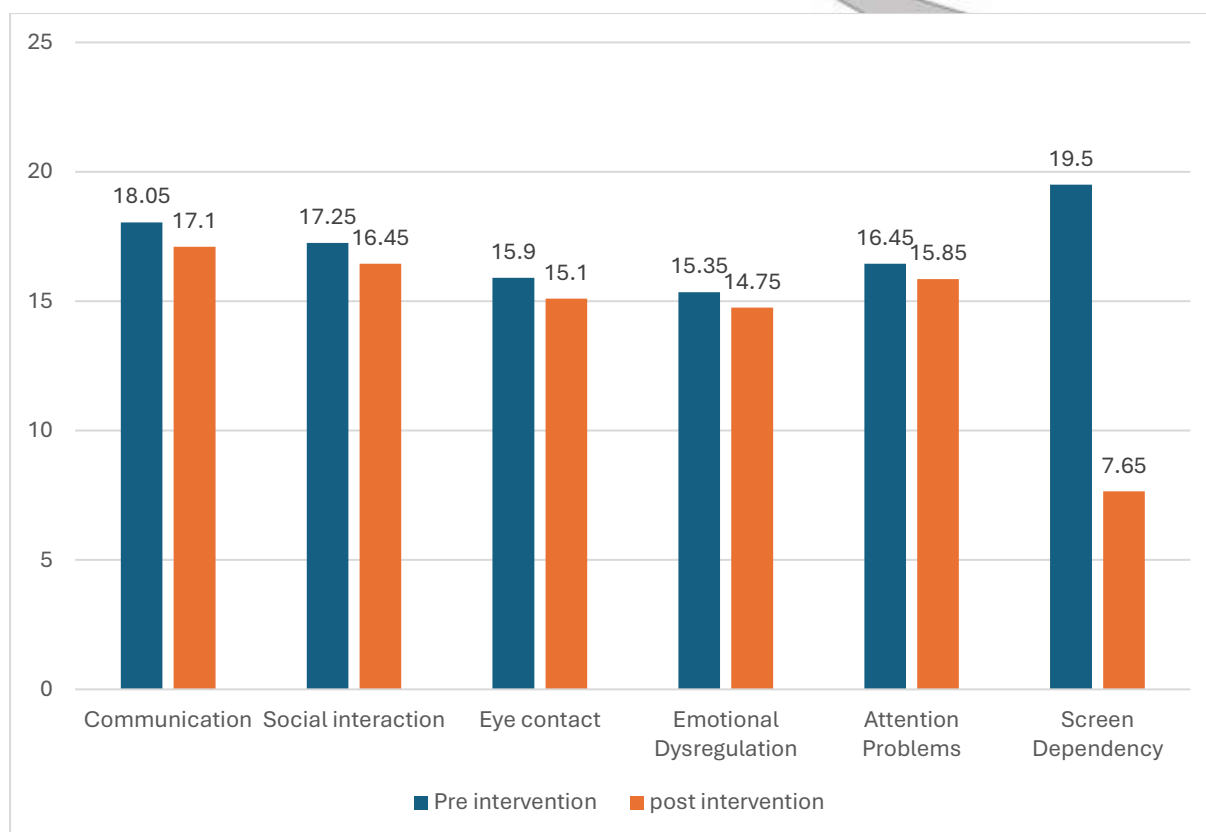


Figure 2 shows pre-intervention and Post-intervention scores within the control group.

The control group pre-test and post-test scores of virtual autism-related symptoms are shown in Table 3. Results of the paired-samples t-test revealed no statistically significant pre-test to post-test results for any of the domains assessed. Communication deficit scores decreased from 18.05 to 17.10 ($t = 1.12$, NS), while poor social interaction scores decreased from 17.25 to 16.45 ($t = 1.06$, NS). Likewise, there were slight decreases in eye contact difficulties (15.90 to 15.10), emotional dysregulation (15.35 to 14.75), attention problems (16.45 to 15.85), and screen dependency (19.05 to 17.95), all of which were not statistically significant.

Overall, the results indicated small descriptive decreases across the domains measured in the control group in the course of the study, with no statistically significant changes within the control group. The results presented here offer a good comparison with the pre-intervention to post-intervention differences found with the experimental group (larger) samples. But the between-group comparison is far more important for making conclusions about the effectiveness of the intervention than within-group significance tests are.

3.3 Comparison Between Experimental and Control Groups After Intervention

Table 4: Post-intervention Comparison Between Experimental and Control Groups

Variables	Experimental Group Mean	Control Group Mean	t-value	p-value
Communication Deficits	10.15	17.10	6.84	<0.01
Poor Social Interaction	9.80	16.45	6.52	<0.01
Eye Contact Difficulties	8.45	15.10	6.13	<0.01
Emotional Dysregulation	8.95	14.75	5.74	<0.01
Attention Problems	9.30	15.85	5.92	<0.01
Screen Dependency	7.65	17.95	8.25	<0.01

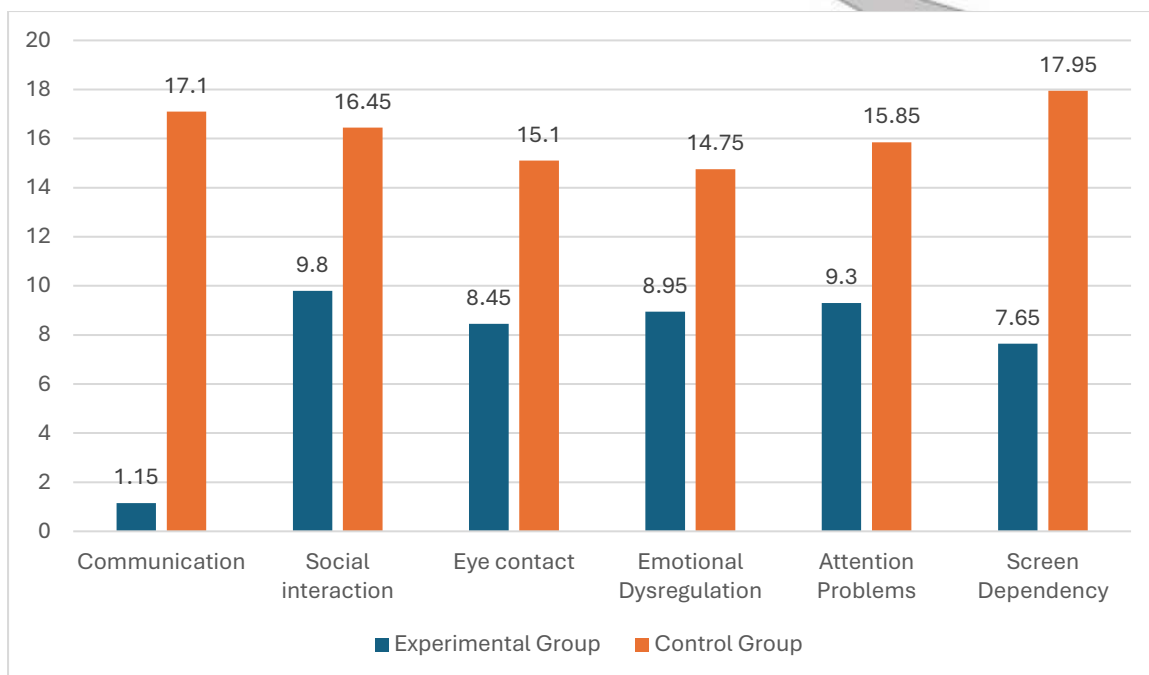


Figure 3 shows Post-intervention scores of the experimental and control groups.

Table 4 presents the number of students in each group who participated in the post-intervention assessment. The number of students in each group who took part in the post-intervention assessment is presented in Table 4.

Table 4 shows the comparison of the experimental and control groups after intervention. The results of independent-samples t-test revealed that there were statistically significant differences between the groups across all of the domains measured ($p < .01$). The experimental group had lower mean scores than the control group for communication deficits (10.15 vs. 17.10; $t = 6.84$), poor social interaction (9.80 vs. 16.45; $t = 6.52$), eye contact difficulties (8.45 vs. 15.10; $t = 6.13$), emotional dysregulation (8.95 vs. 14.75; $t = 5.74$), attention problems (9.30 vs. 15.85; $t = 5.92$), and screen dependency (7.65 vs. 17.95; $t = 8.25$).

The highest difference between groups was for screen dependency, followed by communication deficits. Overall, the results showed that the scores in all the measured domains were significantly lower in the experimental group than the control group after the intervention. The results are generally consistent with a positive relationship between involvement in the structured parental-training programme and better results when compared to those within each group (Tables 2 and 3). The largest difference was found in the areas of screen dependence and communication problems, indicating that moderate screen time reduction and engagement in parent-child interaction significantly improved functioning in these domains. The results suggest that early intervention strategies can alter virtual autism symptoms when they are effectively implemented.

3.4 Comparison Between Experimental and Control Groups on ISAA Scores

Table 5. Pre-intervention and Post-intervention ISAA Scores of Experimental and Control Groups

Group	Assessment	N	Mean ISAA Score	SD	Mean Difference	t-value	p-value
Experimental	Pre-intervention	20	112.35	14.62	—	—	—
Experimental	Post-intervention	20	82.40	13.18	29.95	8.31	< .01
Control	Pre-intervention	20	110.90	15.05	—	—	—
Control	Post-intervention	20	108.75	14.72	2.15	1.18	NS

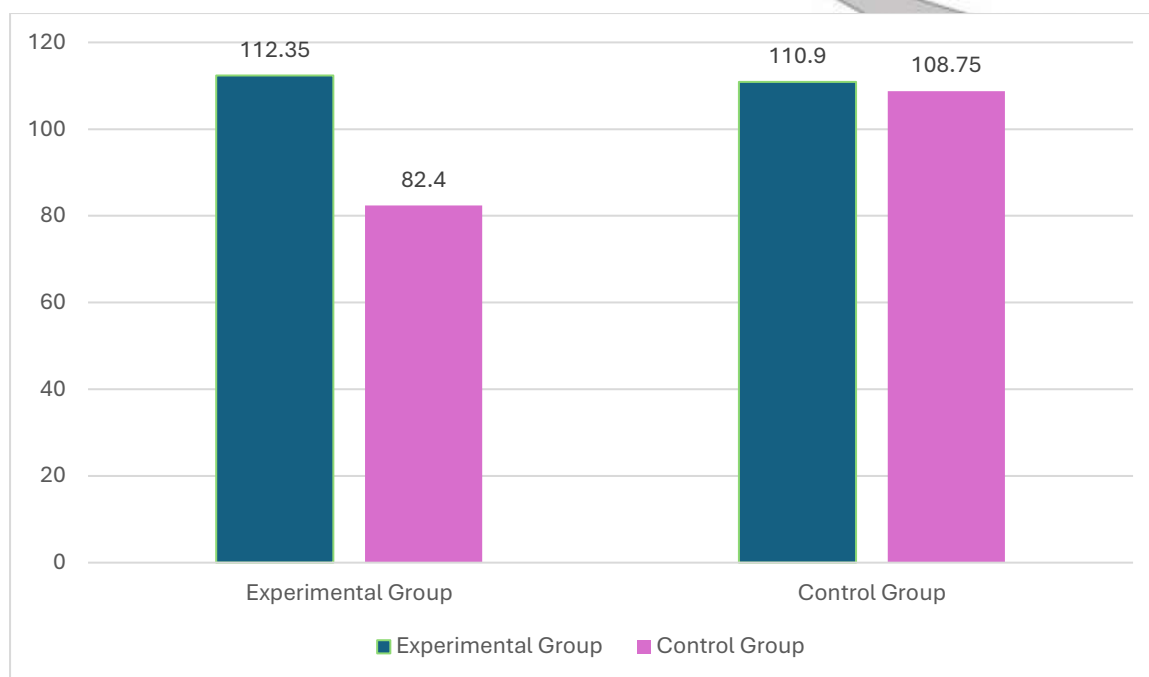


Figure 4 shows pre-intervention and Post-intervention ISAA scores of the experimental and control groups.

Note. ISAA = Indian Scale for Assessment of Autism. Lower scores indicate fewer autism-related characteristics. $p < .05$; $p < .01$; NS = not significant.

Upon completion of the 12-week parent-mediated intervention, the mean autism-related behavioural characteristics in the children in the experimental group were seen to be significantly reduced, as indicated by the ISAA results. The mean scores of the ISAA decreased from 112.35 at pre-intervention to 82.40 at post-intervention, a mean decrease of 29.95 points. The difference within the group was statistically significant ($t = 8.31$, $p < .01$). However, the mean difference for the control group was only 2.15 points, which was not statistically significant ($t = 1.18$, NS), with a decrease in mean score on the ISAA scale from 110.90 to 108.75.

Results indicated that children with the structured programme of parent education showed a greater improvement in the behaviour measured by the ISAA than those in the control group during the study period. This significant decrease in the mean score for the experimental group was parallel with the improvements seen across the other outcome measures: communication deficits, social interaction, eye contact, emotional regulation, attention, and screen dependency.

At the group level, the experimental group's pre-intervention mean ISAA score of 112.35 falls within the range generally interpreted as reflecting moderate autism-related severity, whereas the post-test mean of 82.40 represents a lower level of severity. The control group's mean score remained relatively stable across the two assessments.

Importantly, classification based on a group mean should not be interpreted as demonstrating that every individual child changed classification. Individual ISAA scores may vary substantially around the group mean. Therefore, if individual-level data are available, the manuscript should additionally report the number and percentage of children whose ISAA classification changed between pre-test and post-test.

3.5 Discussion:

The present study aimed to evaluate a structured, parent-mediated, multi-component intervention to decrease excessive screen time and increase the developmentally appropriate parent-child interaction time for young children with communication, social, attentional, emotional, and behavioral challenges. The experimental group statistically significantly increased their communication, social interaction, eye contact, emotional regulation, attention, screen dependence, and ISAA scores, while the control group did not have any significant differences pre-post. There were also significantly lower scores in the experimental group compared to the control group in the post-test comparisons. The results indicate that children's developmental and behavioural functioning may be linked to structured parental training (SPT) that includes management of screen use, responsive interaction, communication stimulation, play, behaviour management, physical activity, and predictable routines.

The results align broadly with the evidence that has been found relating screen use patterns to early childhood developmental outcomes. More screen time has been linked with poorer language outcomes, and educational programs and co-viewing with caregivers to the content have been linked to more favourable language outcomes (Madigan et al., 2020). Likewise, recent studies suggest that viewing outcomes differ depending on content, viewing context, viewing background, and, in the case of background TV, caregiver involvement, as more screen viewing of a programme is linked to poorer cognitive outcomes and more background TV to better cognitive outcomes, respectively (Mallawaarachchi et al., 2024). Therefore, the extended time spent using screens can decrease the amount of time in which face-to-face interactions, play, and socialization can take place. But such connections are complicated and may be two-way and should not be regarded as proof that screen time itself triggers developmental disorders.

The improvements in communication could be attributed to the increased opportunities for functional communication which occurred due to parental training. Parents were asked to verbal model, make requests, choose, tell stories, read together, imitate, communicate through play, and engage in responsive interaction in their daily activities. There is a body of evidence suggesting that parent-mediated interventions are associated with improvements in joint attention, language, communication, initiation, response to interaction, and play (Schaaf et al., 2019), and meta-analytic evidence has also found that the parent-implemented interventions have a positive effect on communication, social and behavioural outcomes, although this effect is not consistent across studies (Nevill et al., 2022). Communication gains seen here may, therefore, be due to the quality and quantity of parent-child interaction, rather than to screen reduction.

Enhanced social interactions and eye gaze can also be interpreted as enhanced opportunities for face-to-face interactions, imitation, turn-taking, shared activities, and emotional responsiveness. Parent-mediated interventions have shown increases in parent responsiveness, parent-child interaction and some aspects of children's social communication (Oono et al., 2013; Conrad et al., 2021). The eye contact improvement should therefore be considered as one behavioural measure of greater social engagement, rather than as a measure of overall developmental improvement.

Predictable routines, positive reinforcement, appropriate choices, transition support, and replacing screen time with interactive time may be related to the decreased emotional dysregulation. There is mixed evidence regarding the link between greater screen time and internalizing and externalizing problems, with the nature and direction of this association also being unclear (Eirich et al., 2022). In the same way, an increase in attention may be a result of the synergistic effect of decreased screen time and increased interactive play, joint reading, physical activity, communication, and structured activity. As of yet, there is some evidence that links screen use with attention problems, but some also suggest that the link is not unidirectional: the involvement of child and family factors may also shape the link between screen exposure and attention problems (Santos et al., 2022).

The greatest effect was in screen dependency, relating to the specific focus of the intervention on management of screen time. Parents were encouraged to set clear limits, set aside time to turn off screens, plan other activities, and set a routine. This is aligned with the WHO guidelines, encouraging physical activity and good sleep habits for young children, and reducing time spent sitting in front of an electronic screen (WHO, 2019). The American Academy of Pediatrics (2016) also states the need to take into account the context and quality of media messages, the role of caregivers, and the activities lost when using the media. The significant decrease in screen time dependency, accordingly, indicates that structured parental guidance needs to be beneficial for families to develop more consistent patterns of media use.

The decrease in the ISAA scores in the experimental group can be interpreted in light of the holistic character of the intervention. In addition to minimizing recreational screen time, parents were instructed to increase responsive interactions, communication, shared reading, play, behavioral management, emotional engagement, physical and sensory activities, outdoor time, and predictable no-screen time. These strategies enhanced opportunities to communicate, imitate, share attention, participate socially, and engage adaptively. This interpretation aligns with the evidence for both caregiver-mediated and naturalistic developmental approaches (Oono et al., 2013; Schreibman et al., 2015; Steinbrenner et al., 2020), and with meta-analytic evidence of parent-implemented interventions (Cheng et al., 2023).

Important comparisons are made worthwhile because there is no significant change in the control group, and the experimental group's scores show significant change from pre- to post-test and lower post-test scores than control scores.

But the statistical significance of the results does not make them causal. The isolated effect of any one of the components of the intervention cannot be isolated since they were delivered concurrently: screening reduction, communication training, parent-child interaction, play, behavioural management, physical activity and routine modification.

The results underscore the need for parents' involvement in developmental intervention. Parents delivered intervention strategies in the meal, play, story, outdoor play, communication and bedtime themes, thus enabling repeated learning opportunities in the natural environment. Systematic reviews and meta-analyses have shown promise for parent-mediated and parent-implemented interventions for communication, social interaction, behaviour and parent-child interaction (Oono et al., 2013; Conrad et al., 2021; Nevill et al., 2022).

In general, the results indicate that a parent-mediated, structured, and multicomponent intervention might be linked to the developmental and behavioural characteristics of young children with excessive screen time exposure. It is important to note that the findings should not be interpreted as reflecting that exposure to screens causes autism or that reducing screen time can cure or reverse autism. It is probably more appropriate to understand the changes observed within the context of the intervention package and the larger interventions that were made in children's everyday environments. Larger samples, longer follow-up, the use of uniform outcome measures, treatment fidelity assessment, and component-specific designs are needed to provide clarity regarding the durability and individual contribution of the various intervention strategies.

3.6 Conclusion

The present study demonstrated that structured parental training is highly effective in reducing symptoms associated with virtual autism among young children exposed to excessive screen media. Children who participated in the intervention program showed significant improvements in communication skills, social interaction, eye contact, emotional regulation, attention functioning, and reduction in screen dependency compared to children receiving routine developmental guidance.

The findings suggest that many autism-like symptoms associated with virtual autism may be reversible when excessive screen exposure is reduced and healthy parent-child interaction is restored during early developmental stages. Parent-mediated intervention focusing on media hygiene, responsive caregiving, emotional engagement, language stimulation, and play-based interaction plays a crucial role in improving developmental outcomes.

The study highlights the urgent need for parental awareness programs regarding the developmental risks of excessive screen exposure during infancy and toddlerhood. Pediatricians, mental health professionals, educators, and policymakers should collaborate to promote healthy digital habits and early developmental screening practices. The study findings suggest that a structured, parent-mediated, multicomponent intervention was associated with improvements in communication, social interaction, eye contact, emotional regulation, attention, and screen dependency among children in the experimental group. The findings highlight the importance of active parental involvement, healthy screen-use practices, and meaningful play, communication, physical, and social activities within everyday routines.

Early intervention remains essential because neurodevelopmental plasticity during early childhood provides substantial opportunity for recovery and positive developmental change. Future research may explore long-term outcomes of parental training, larger sample sizes, neurodevelopmental mechanisms, and culturally adapted intervention models.

3.7 Educational Implications

- **Parent Education:** Parents should be provided with evidence-based guidance regarding developmentally appropriate screen use, healthy media practices, and the importance of interactive parent-child activities.
- **Awareness Programmes:** Schools, preschools, pediatric services, and community settings should conduct awareness programmes on the potential developmental and behavioural effects associated with excessive screen exposure.
- **Early Developmental Screening:** Developmental screening should include assessment of children's daily screen exposure, media-use patterns, sleep routines, and opportunities for communication and social interaction.
- **Parent-Mediated Intervention:** Structured parent-mediated programmes should be incorporated into early childhood developmental and mental-health services to strengthen parents' skills in communication, play, behaviour management, and screen-use regulation.
- **Healthy Media Practices:** Public-health and educational initiatives should promote healthy media hygiene, including screen-free meals and bedtime routines, appropriate content, co-viewing, and meaningful alternatives such as play, reading, physical activity, and social interaction (American Academy of Pediatrics, 2016; Madigan et al., 2020; WHO, 2019).

3.8 Limitations of the Study

- **Small Sample Size:** The relatively small sample size limits the generalizability of the findings to larger and more diverse populations.
- **Short Intervention Period:** The intervention was conducted over 12 weeks; therefore, the findings primarily reflect short-term changes.
- **Lack of Long-Term Follow-Up:** No follow-up assessment was conducted to determine whether the observed improvements were maintained over time.
- **Parental Reporting:** Some information was based on parental reports, which may be influenced by recall and response bias.
- **Absence of Neurobiological Measures:** Neuropsychological, physiological, or neurobiological assessments were not included; therefore, underlying mechanisms could not be examined.
- **Multicomponent Intervention:** Because the intervention included several components, such as screen reduction, parent training, communication activities, play, behavioural strategies, and routine modification, the independent contribution of each component could not be determined.

3.9 Suggestions for Future Research

- **Larger Samples:** Future studies should include larger and more diverse samples to improve statistical power and generalizability.
- **Longitudinal Research:** Long-term studies with follow-up assessments should examine the sustainability of improvements in developmental and behavioural functioning and screen-use patterns.
- **Neuropsychological Assessment:** Future research should include standardized measures of attention, language, executive functioning, social cognition, and emotional regulation.
- **Multidisciplinary Interventions:** The effectiveness of integrated interventions involving psychologists, pediatric professionals, speech and language therapists, educators, and parents should be systematically investigated.
- **Cross-Cultural Research:** Studies across different cultural and socioeconomic settings should examine variations in digital parenting practices and children's media-use patterns.
- **Digital Content and Context:** Future research should examine how different types of digital content, duration of exposure, interactivity, background media, and caregiver co-viewing influence developmental outcomes.
- **Component-Specific Research:** Controlled studies should examine the individual and combined effects of screen reduction, parent training, communication stimulation, play-based activities, and behavioural interventions.

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