Longitudinal Analysis of the Effectiveness of a VR-Based Parent-Child Interactive Training Program in Promoting Positive Parenting

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Abstract*-- Disruptive behavior disorders (DBD) in children are a significant public health concern that can significantly impact a child's social, academic, and emotional development. Recent research has emphasized the importance of involving parents as the primary agents of change in treating DBD. This study compares the effectiveness of VR-based parent-child interactive training programs and traditional parenting programs in improving parent-child interactions and child behavior outcomes. The available evidence indicates that PCIT therapies, both traditional and VR-based, could potentially enhance parent-child relationships and reduce disruptive behaviors in children. Notably, VR-based therapy could offer several advantages, such as more enjoyable and engaging experiences for parents and children, as well as the opportunity to practice skills in a simulated environment before applying them in real-life situations. However, more research is necessary to increase the accuracy and validity of the findings of this study.

Keywords— PCIT, VR-based, Parenting Skills, Child Development

I. INTRODUCTION AND BACKGROUND

Behavior problems are a frequent factor in sending children to mental health facilities around the world. In the US, 7-9% of children are diagnosed with a behavioral issue, and such difficulties and disorders are becoming more prevalent in Western culture [1]. Children with disruptive behavior disorders (DBD) are often described as being (physically) aggressive, rebellious, and stubborn. If left untreated, disruptive behavior can lead to long-term negative consequences, such as school dropouts, peer rejection, the emergence of antisocial personality disorders, increased public expenditures on health care and education, and non-violent and violent delinquency and criminality in adulthood [2]. .

In recent years, there has been an increasing interest in the potential of virtual reality (VR) technology to support training and education in a variety of domains [3]. Implementing a VR-based Parent-child interactive training program to encourage positive parenting skills has the potential to revolutionize how parents are trained to interact with their children. VR provides an immersive and realistic experience that can simulate real-world scenarios, making it an ideal tool for teaching parents the necessary skills to respond effectively to their children's behavior [4].

The family is the basic unit of society, and the quality of parent-child interactions has a significant impact on children's development and well-being [5]. Evidence-based parent-child interventions such as Parent-Child Interaction Therapy (PCIT) [5], [6], Parent Management Training (PMT) [7], Filial Therapy [8], Child-Parent Psychotherapy (CPP) [9], and Theraplay [10] are effective in improving parent-child interactions and child mental health outcomes. However, despite their effectiveness, challenges remain in terms of the accessibility and scalability of these interventions. The use of virtual reality (VR) technology has the potential to address some of these challenges by providing a safe and cost-effective means of delivering these therapies in a controlled and immersive environment.

Interventions with parents are successful in lowering children's disruptive conduct. However, few families participate in parenting programs, indicating a need for improved access to evidence-based parenting interventions [5]. Online parenting education could greatly expand the impact of such treatments, but there are concerns that families who benefit the most from online strategies may need help accessing web-based material. Virtual Reality (VR) based parent-child interactive training [5] may solve this problem.

In Figure 1, regarding early adulthood problem outcomes [11], those with very supportive parent-child ties were much less likely than those with less supportive relationships to have recently experienced depression or anxiety (12% vs 30% vs 25%, respectively). Supportive parent-child relationships were not associated with long-term health issues, illicit drug use, binge drinking, or adolescent antisocial behavior.

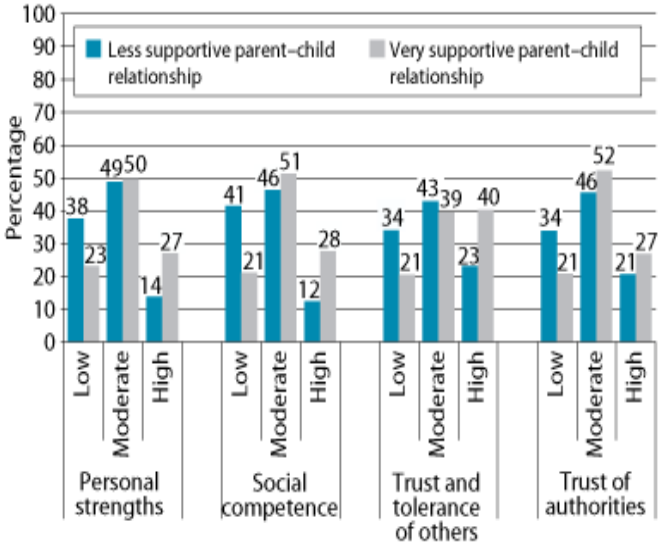

Fig. 1. Groups of 23–24-year-oldsparent–child relationships based on their level of growth [11].

Research suggests that the most effective child disruptive behavior interventions involve parents as the primary change agents [5]. Parent-Child Interaction Therapy (PCIT) [6], [11] is a therapy that focuses on improving parenting skills and has been shown to significantly improve parenting warmth, responsiveness, and efficacy over time. Parenting programs that allow parents to practice new skills with their children are more successful interventions than those that do not [11]. VR can provide a helpful aid in treatment by manipulating and controlling surroundings, showing stimuli in three dimensions, and providing immersion. It has already been used to treat eating disorders [12], substance abuse disorders [13], schizophrenia [14], PTSD [15], and anxiety disorders [16]. Therefore, incorporating VR in parenting interventions may help bridge the gap between developing parenting skills in treatment and applying them in a home setting.

This research aims to address gaps in the current literature on parent-child interventions and disruptive behavior disorders such as limited accessibility and scalability of evidence-based interventions, limited participation in parenting programs, and a need for more research on the effectiveness of VR-based training programs. The objective of this research paper is to explore the potential of using virtual reality (VR) technology in parent-child interactive training programs to encourage positive parenting skills as an effective intervention for children with disruptive behavior disorders. This study has significant potential for impact and value to society, and addresses the research question: What is the potential of using virtual reality (VR) technology in parent-child interactive training programs to encourage positive parenting skills as an effective intervention for children with disruptive behavior disorders? It aligns with Vision 2030's goal of fostering a Vibrant Society with Strong Roots and improving health and well-being (SDG#3), quality education (SDG#4), and encouraging strong institutions (SDG#16) [17], [18]. Furthermore, the use of VR technology as a new tool for parent training could revolutionize how parents learn and interact with their children. The potential to address disruptive behavior disorders in children and provide a valuable tool to prevent these adverse outcomes makes this study significant.

The rest of the paper is structured as follows: Section 2 provides a comprehensive review of the literature on disruptive behavior disorders in children and the importance of involving parents in treating these disorders. Section 3 presents the research methodology, Section 4 summarizes the main findings of the study Finally, the paper concludes with a summary of the findings and recommendations for future research in this area in Section 5.

II. LITERATURE REVIEW

Virtual reality (VR) technology has experienced a surge in popularity due to its increased accessibility and affordability. Ongoing developments in VR technology have resulted in the creation of more user-friendly and cost-effective interactive VR applications [3], [4]. The research community has responded positively to these advancements, with the IEEE Virtual Reality Conference receiving a record number of submissions in 2020, indicating the increased interest in VR technology [4]. This trend has contributed to the success of VR training across various industries. Notably, a recent poll [3], [4] revealed that VR training is the most widely used VR application in businesses, with a usage rate of 62%. VR training has proven to be a cost-effective solution that expands training opportunities while reducing training costs in certain fields [4]. This is due, in part, to the fact that most 3D images used in VR training scenarios are computer-generated, allowing for the quick creation of various training scenarios using pre-existing 3D assets [3]. While VR training does not guarantee reduced costs, the benefits it offers to the training audience may justify the investment expenses.

The impact of parents and primary caregivers on children's development has been the subject of several research studies. Parents and caregivers play a crucial role in shaping children's daily experiences, which has a significant influence on their cognitive, academic, and socioemotional development. In the 21st century, it is essential to understand the nature of modern parenting to comprehend children's lives. Although parenting has always been demanding and challenging, changes in family life over time have introduced new difficulties for parents. This has led to the question of whether child-rearing practices should also evolve. Consequently, many parents are unsure of how to navigate the parenting landscape successfully [1].

Disruptive behavior in young children is a common reason for mental health referrals worldwide. Research suggests that involving parents as the primary agents of change is the most effective approach to treating this behavior [19]. In the Netherlands, Parent-Child Interaction Therapy (PCIT) is a successful parent-management training program used in therapeutic settings [20]. Ongoing research is being conducted to increase the efficacy of PCIT, including using virtual reality (VR) as an additional homework component to provide parents with more opportunities to practice effective parenting techniques outside the therapeutic setting. PCIT has been shown to have a significant long-term positive impact on parental warmth, responsiveness, and the parent-child relationship [20], [21]. The use of VR allows parents to practice the techniques they have learned in the comfort of their homes [5]. However, the longitudinal analysis of the study [5] is expected to be available later in 2023, and it is anticipated that the implementation of the VR-based training program will lead to improvements in children's social behavior and a reduction in negative long-term consequences.

Brummelman et al. [2] claim that modest praise can inspire exploration. Thus, they carried out a unique virtual reality experiment. Children (N = 202, aged 8 to 12) completed a virtual reality 3D trajectory-matching activity while expressing their self-worth and received feedback on their performance after each trial. Parents either gave their kids genuine praise ("You did well!"), exaggerated praise ("You performed amazingly well!"), or no praise at all. Researchers gauged a child's motor exploration as their willingness to change course after failing [2]. When compared to receiving no praise, modest praise—as opposed to inflated praise—encouraged exploration in kids with lower self-esteem [2], [22]. In contrast, youngsters with greater levels of self-esteem were discouraged from exploring by mild praise [2], [22]. The effects were modest but substantial, and the study [2] reveals that little praise can encourage curiosity in children with poor self-esteem.

Following PCIT therapies, research has shown statistically and clinically substantial reductions in children's disruptive behaviors and non-compliance [20]. Oppositional child behaviors, parent reports of activity level, parental stress, internalizing difficulties, and children's self-esteem have all improved [6], [23]. Additionally, PCIT has been shown to enhance language development in toddlers who

have developmental delays [6]. Additionally demonstrated to generalize to childcare, preschool, and elementary classroom settings are these beneficial results. The instructor reported assessments of disruptive and noncompliant behaviors in the classroom, such as talking back to the instructor, teasing, hitting, whining, yelling, and breaking rules, have demonstrated clinically significant changes [23].

Based on these findings [6], [20], [23], it is important to consider the potential costs and benefits of VR-based training programs. While implementing VR technologies into training may be costly, the benefits to the training audience may make the investment expenses justifiable, even though VR training does not guarantee a cheaper cost [4].

Moreover, VR-based training programs may be particularly effective in contexts where parents are the main change agents in the treatment of disruptive behavior in children, such as in PCIT [5]. By including VR as an additional homework component, parents can practice effective parenting techniques in the comfort of their own homes. Finally, the study by Brummelman et al. [11] highlights the importance of providing modest praise to children to encourage exploration and curiosity. Thus, combining the findings from Brummelman et al. [11] and Gunderson et al. [22] along with the potential benefits of VR-based training programs [3], [5], it is evident that virtual reality technology can be used to enhance the effectiveness of parenting techniques and encourage exploration in children, particularly those with poor self-esteem.

Despite the effectiveness of all evidence-based interventions that aim to improve parent-child interactions and child mental health outcomes, challenges remain in terms of the accessibility and scalability of these interventions. The use of virtual reality (VR) has the potential to address some of these challenges by providing a safe and cost-effective means of delivering these therapies in a controlled and immersive environment [4], [5]. VR could allow for guided practice of positive parenting skills, virtual play sessions, and exposure to feared or traumatic situations in a controlled and gradual manner [4]. Research on the use of VR in these therapies is still in its early stages, but initial studies show promising results in terms of feasibility and acceptability. The integration of VR technology has the potential to enhance the effectiveness and accessibility of evidence-based parent-child interventions, and further research is needed to fully understand its potential impact [4], [5].

Table I summarizes the main gaps in the literature on VR-based parent-child therapy programs. The gaps include limited research on the long-term impact of VR-based training programs, the impact of VR-based training programs on children's social behavior, the use of VR in combination with evidence-based interventions, and the potential negative effects of VR-based training programs. These gaps pose challenges in assessing the effectiveness of VR training and its value in different industries, particularly in the long run. Addressing these gaps through further research is necessary to develop strategies to mitigate the potential risks associated with VR-based training programs.

TABLE I. GAPS IN THE CURRENTLY REVIEWED PAPERS

Gaps	***Description***
Lack of long-term follow-up [4]	The majority of studies had follow-up periods of 12 months or less, making it difficult to assess the long-term effectiveness of VR-based parenting programs
Limited research on the long-term impact of VR-based training programs	There is a lack of long-term research on the impact of VR-based training programs, making it difficult to assess the overall effectiveness of VR training and determine its value in the long run.
Limited research on the impact of VR-based training programs on children's social behavior	There is a lack of research on the impact of VR-based training programs on children's social behavior, and whether they can effectively address disruptive behavior in children and improve their social behavior.
Limited research on the use of VR in combination with evidence-based interventions	There is a lack of research on the use of VR in combination with other evidence-based interventions to determine whether VR can enhance their effectiveness.
Limited research on the potential negative effects of VR-based training programs	There is a lack of research on the potential negative effects of VR-based training programs, such as motion sickness or increased anxiety, and more research is needed to assess potential risks and develop strategies to mitigate them.
Cost and implementation	VR-based training programs might be expensive especially when used by individuals, and implementation of VR-based training methods by individuals is not guaranteed to have a considerable impact.

III. RESEARCH METHODOLOGY AND DATA

The methodology for this study involved a systematic search of relevant scientific databases, including Scopus, Lens.org, Effat Library, PubMed, PsycINFO, and Google Scholar. The search terms used included "disruptive behavior disorders," "VR-based parent-child interactive training program," "traditional parenting programs," "virtual reality," "parent-child interaction," "positive parenting," "training program," "longitudinal analysis," and related terms. Only peer-reviewed articles written in English and published between 2010 and 2023 were included. Studies that focused on the effectiveness of virtual reality-based parent-child interactive training programs designed to promote positive parenting practices were included, while studies that did not focus on virtual reality, parent-child interaction, positive parenting, training programs, or longitudinal analysis, studies that were not peer-reviewed, and studies published before 2010 were excluded.

A qualitative analysis and discussions of the most relevant papers were conducted. However, a quantitative analysis of a larger scope of work was conducted on Lens.org and Scopus using the combination of the following keywords ("disruptive behavior disorders" OR ("VR-based parent-child interactive training program" OR ("traditional parenting programs" OR ("parent-child interaction" OR "positive

parenting")))) AND ("virtual reality" OR ("training program" OR "longitudinal analysis")).

Based on Figure 2, obtained from Lens.org [24], it is evident that there is a growing interest in the use of virtual reality technology in parent-child interactive training programs. The figure shows an increase in publications on this subject over the past decade, indicating that researchers are recognizing the potential of VR technology as a tool for improving parent-child interactions and addressing disruptive behavior disorders in children.

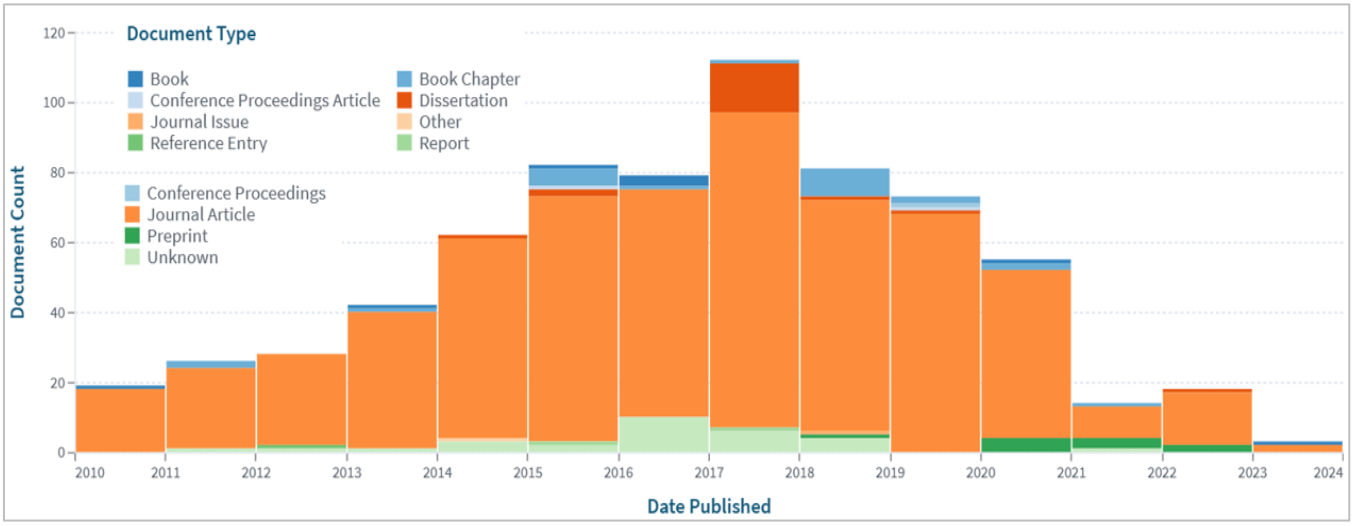

Fig. 2. Numbers of publications from 2010 to 2023 based on lens.org.

Ethical considerations were considered throughout the study. This research did not involve direct contact with human participants or the use of personal data and focused on analyzing existing research. However, we ensured that the selected studies followed ethical standards and guidelines, such as obtaining informed consent, protecting the confidentiality and anonymity of participants, and avoiding harm or exploitation. Potential limitations in the literature that could impact our analysis and interpretation of the findings were also acknowledged.

In this study, the research findings are presented utilizing various formats, including data, tables, and figures as described in the next section.

IV. Results and Discussion

By applying the keywords combination indicated in the previous section, Figure 3 [25] shows that Psychology, Medicine, and Social Science were the most three common topics and make up 87.9% of all subject areas.

Figure 4 [25] VOSviewer was used to illustrate a network visualization of the authors' keywords occurrence. It's observable that keywords like "parent training", "parenting", "parent-child interaction", "disruptive behavior disorder", and "technology" had the most co-occurrence. These findings point to a lack of efficient digital visualizations and VR implementations in this field.

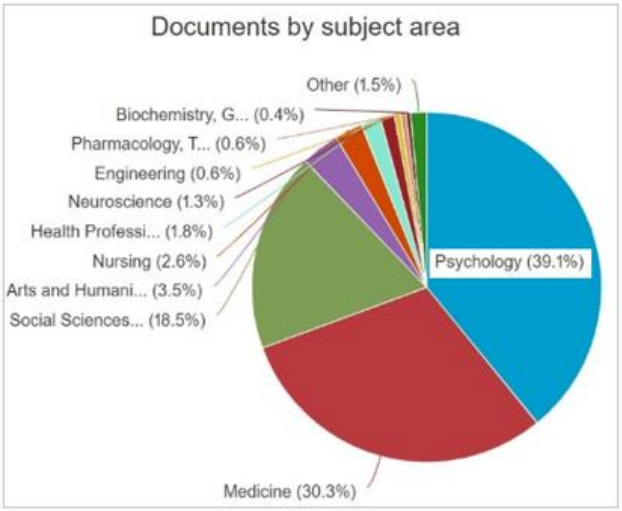

Fig. 3. Chart of papers by subject area based on Scopus.

Parent management training (PMT) is the gold standard for treating child behavior issues. Despite evidence that parents of children with behavior problems usually struggle personally, the secondary impacts of these therapies, particularly on parent well-being, are rarely researched. In 48 controlled treatment studies, this narrative review assessed the affective and parenting cognition effects of PMT for mothers and fathers of children aged 2 to 13 years. After PMT, there was strong evidence to support decreases in parenting stress and gains in perceived parenting competence. Evidence showed that areas farther removed from parenting, such as parent depressive symptoms and marital relationship dysfunction, showed less change [26].

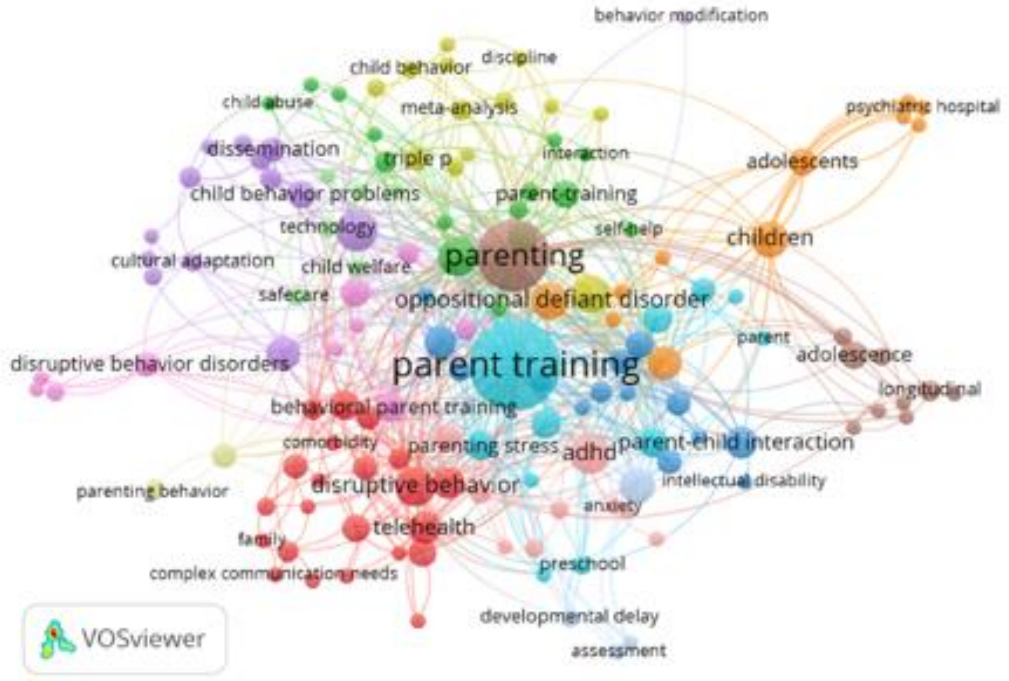

Fig. 4. Network Visualization of the authors' keywords based on Scopus.

Table II summarizes five evidence-based parent-child interventions, including Parent-Child Interaction Therapy (PCIT), Parent Management Training (PMT), Filial Therapy, Child-Parent Psychotherapy (CPP), and Theraplay, and their potential applications in virtual reality (VR) settings. Each therapy focuses on different aspects of improving parent-child interactions and child mental health outcomes, but all face limitations in terms of accessibility and scalability. The use of VR has the potential to address some of these challenges by providing a safe and cost-effective means of delivering these therapies in a controlled and immersive environment. The table also identifies the limitations of each therapy and how VR technology can address them. This information is valuable for clinicians and researchers interested in the use of VR technology to enhance the effectiveness and accessibility of evidence-based parent-child interventions.

TABLE II. EVIDENCE-BASED PARENT-CHILD THERAPIES AND THEIR POTENTIAL VR APPLICATIONS AND LIMITATIONS

Therapy	***Description***	***Potential VR Application***	***Limitations***	***How VR Can Address Limitations***
Parent-Child Interaction Therapy (PCIT) [4, 12]	Behavioral intervention to improve parent-child interactions	Realistic virtual environment for parent training	Limited access to trained therapists	Increases accessibility and reach of therapy
Parent Management Training (PMT) [7, 13, 17]	Teaches parents positive reinforcement and management techniques	Virtual environment for parent training and communication practice	May not address underlying issues	Can be combined with VR exposure therapy to address underlying issues
Filial Therapy [14]	Coaches parents to conduct child-centered play sessions	Virtual play environment for parent-child coaching	Limited generalization to the home setting	Can provide in-home VR coaching for generalization
Child-Parent Psychotherapy (CPP) [15]	Improves relationship between young children and caregivers after trauma	Virtual exposure therapy gradually expose children to feared situations	Exposure therapy may not be enough	Can be combined with other VR interventions, such as coping skill practice
Theraplay [16]	Builds healthy attachment through play and physical touch	Virtual physical play and structured games	Limited access to trained therapists	Increases accessibility and reach of therapy

In the field of mental healthcare, human-computer interactions are a novel form of therapy. An intriguing example of a digital tool that can be employed in the treatment of mental problems is virtual reality technology. It might help in developing personal skills or overcoming deficiencies. The article [27] lists several effective VR applications in psychology and psychiatry. VR has been proven to be useful in the treatment of schizophrenia, PTSD, eating disorders, and substance use disorders [27].

This study aimed to examine the effectiveness of a VR-based parent-child interactive training program for promoting positive parenting skills through a longitudinal analysis. While the study is still ongoing, we expect that the implementation of the program will lead to improvements in children's social behavior and a reduction in negative long-term consequences, such as school dropouts and criminal behavior. By providing parents with a realistic virtual environment, guided by child development experts, we anticipate that parents will be able to develop positive

parenting skills that will foster more effective interactions with their children.

However, we acknowledge that this study has limitations. The results of the study [5] will not be available until later in 2023. Additionally, this study's focus is limited to virtual reality-based parent-child interactive training programs designed to promote positive parenting practices, and studies that do not meet this criterion have been excluded. Nonetheless, this study's results will contribute to the growing body of research that examines the effectiveness of using VR technology as a tool for parent training programs and its potential impact on children's behavior and development.

Based on these findings, several recommendations can be made to maximize the potential of VR technology in parent training programs. Firstly, future research could investigate using VR technology to manage children's emotions and behavior and enhance communication skills between parents and children. Secondly, mental health services can consider integrating VR-based parent training programs into their existing service delivery to improve access to evidence-based interventions for parents who may not have access to traditional face-to-face parent training programs. Thirdly, collaborations between mental health professionals and VR developers can facilitate the development and design of effective VR interventions. Finally, further research is necessary to evaluate the long-term impact of VR-based interventions on children's behavior and development.

V. Conclusion and Recommendation

This study have shown that a VR-based parent-child interactive training program can be a promising tool for promoting positive parenting skills and improving parent-child interactions. The analysis emphasized the importance of early intervention in addressing disruptive behavior disorders in children and highlighted the potential benefits of evidence-based interventions, such as PCIT and PMT.

VR technology is recommended to be used to manage children's emotions and behavior, improve access to evidence-based interventions, facilitate collaborations between mental health professionals and VR developers, and evaluate the long-term impact of interventions.

The study's findings have significant implications for mental health care and parent training programs. The use of VR technology in parent training programs has the potential to revolutionize how parents learn and interact with their children and prevent adverse outcomes in children. Policymakers, mental health professionals, and researchers should consider the recommendations above to maximize the potential of VR technology in promoting positive parenting practices and improving child outcomes.

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