Immersive virtual reality training to identify and investigate child abuse: a review of emerging progress and future directions

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Child abuse is a pervasive global issue with enduring consequences, and conversations with children are central to its detection and intervention. However, these conversations are fraught with psychological and developmental complexities, and professionals across legal, medical, and educational fields often report feeling ill-equipped to navigate them. Most critically, forensic interviewers frequently rely on coercive questioning techniques, undermining the validity of children's testimonies in court. Traditional training methods to elicit reliable verbal disclosures have remained ineffective, driving interest in using immersive virtual reality (VR) to provide simulated conversations with child victims. To assess the existing evidence base, a reproducible systematic search was conducted across APA PsycInfo, PsycArticles, PubMed, Mendeley, and Google Scholar. While early studies suggest immersive VR training enhances professionals' self-efficacy and learning outcomes, the empirical validation remains limited, indicating critical gaps for future studies to address. This scoping review synthesizes emerging research on immersive VR for child protection training, evaluating its efficacy, limitations, and methodological rigor across professional contexts.

KEYWORDS

child abuse, child protection, virtual reality, training, immersion, investigative interview, 3D

1 Introduction

Child abuse, defined by the American Psychological Association (APA) as neglect or physical, sexual, or psychological harm to a child by a parent or caregiver, is a widespread societal issue (APA Dictionary of Psychology, 2018). Recent estimates from UNICEF and the World Health Organization (WHO) indicate that 1.6 billion children experience violent punishment by caregivers[1], with 400 million under the age of five[2], and 90 million children worldwide have experienced sexual violence[1]. The effects of child abuse extend beyond immediate harm, leaving victims more vulnerable to mental health disorders, suicidality,

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1 https://www.unicef.org/press-releases/fast-facts-violence-against-children-widespread-affecting-millions-globally

2 https://www.who.int/news-room/fact-sheets/detail/child-maltreatment#:~:text=Key%20facts,as%20a%20child%20

substance abuse, and cognitive impairments in adulthood (Norman et al., 2012; Angelakis et al., 2019; Nakayama et al., 2020; Wang et al., 2023).

The COVID-19 pandemic further exacerbated these issues by increasing risk factors for abuse like economic instability, stricter parenting norms, and homeschooling pressures. These challenges caused a surge in parental burnout, linked by Sari et al. (2021) to harsher disciplinary and caregiving behaviors (Xu et al., 2020; Van Bakel et al., 2022). Moreover, a recent meta-analysis revealed that more than one in five children experienced violence during the pandemic, reinforcing the urgent need for improved child protection and investigation measures worldwide (Lee and Kim, 2022; Niu et al., 2024).

1.1 The role of conversation in detecting and investigating child abuse

As most cases of abuse leave no material evidence, a child's testimony of their experiences is often the primary source of information relevant to forensic and legal proceedings (Baugerud et al., 2020; Hassan et al., 2022; Fernandes et al., 2023). However, eliciting reliable disclosures from children poses significant challenges. Young victims are often hesitant to disclose details of abuse due to fear of retaliation, emotional distress, or attachment to their abuser (Malloy et al., 2011; Ettinger, 2022; Fernandes et al., 2023). Additionally, children's cognitive abilities, including memory recall, communication skills, and resistance to coercion, vary strongly with age and developmental stage, further complicating verbal disclosures (Conway, 2005; Collin-Vézina et al., 2015; Alaggia et al., 2019; McElvaney et al., 2020; Fernandes et al., 2023).

Developmentally informed techniques, such as projective and play-based tests, were designed to address these challenges. Tools like the MacArthur Story Stem Battery and creative art therapies have demonstrated value in enabling children to express trauma nonverbally through open-ended storytelling and symbolic play (Woollett et al., 2020; Lev-Wiesel et al., 2022; Korkman et al., 2024). Conversely, props such as anatomically detailed dolls, body diagrams, and the now-outdated Blacky Pictures Test have faced criticism for their suggestiveness, potential to encourage vague or false claims, and limited scientific validation (Erickson et al., 2007; Santtila et al., 2004; Otgaar et al., 2016; Korkman et al., 2024).

Given these considerations, verbal interactions remain central to detecting abuse and gathering legally admissible information. When conducted effectively, forensic child interviews are considered to provide a reliable structure for eliciting accurate disclosures in legal proceedings (Lamb et al., 2007; Baugerud et al., 2020; Korkman et al., 2024). Outside of forensic settings, professionals such as teachers, physicians, and childcare providers engage with children and caregivers primarily through conversations. While not responsible for conducting formal investigations, they play a decisive role in gathering and reporting actionable information to authorities (Brubacher et al., 2016). The cross-disciplinary reliance on conversational interactions in advancing child protection emphasizes the need to maximize their efficacy.

1.2 Challenges faced by professionals

A substantial body of research outlines 'best practices' for professionals conducting these conversations, including open-ended questioning, rapport-building, and nonverbal cue recognition (Brubacher et al., 2020; Powell et al., 2022; Krause et al., 2024). However, adherence to these recommendations, such as those established by the National Institute of Child Health and Human Development (NICHD), remains inconsistent. Research indicates that forensic interviewers often rely on leading or coercive questioning, undermining the accuracy and evidentiary value of children's statements (Pompedda et al., 2014; Faller, 2015; Johnson et al., 2015; Baugerud et al., 2020; Fernandes et al., 2023). Additionally, healthcare professionals and educators, often without structured protocols guiding conversations with children, report feeling underprepared or hesitant to act on suspicions of abuse due to a lack of confidence, experience, and specialized training (Goebbels et al., 2007; Hazzard, 1984; Schols et al., 2013; Márquez-Flores et al., 2016; Foster et al., 2017; Krause et al., 2024; Ko et al., 2025).

1.3 Limitations of traditional training methods

'Mock' conversations or interviews remain the traditional training method to improve professional adherence to 'best practice' recommendations (Lamb et al., 2010; Benson and Powell, 2015; Lawrie et al., 2020; Powell et al., 2022). However, as ethical concerns preclude the use of abused children as conversation partners, training conventionally involves either (1) questioning untrained adults roleplaying abused children or (2) interviewing mainstream children about necessarily innocuous events. These methods often fail to replicate the complexity of real-world child abuse interviews, as untrained adults too readily and eloquently disclose, while interviewing about innocuous events lacks applicability to serious conversations about abuse (Powell et al., 2008; Powell et al., 2022). Attempts to use trained adult actors similarly lack age-specific realism, incur hiring and training costs, and can even be counterproductive to training aims (Powell et al., 2011; Hassan et al., 2022; Nicol et al., 2023). Given these challenges, novel training approaches must bridge theoretical knowledge and real-world applicability while upholding ethical standards.

1.4 Virtual reality as an emerging training approach

Virtual reality (VR) has emerged as a potential alternative, offering professionals a controlled, realistic, and low-risk alternative to traditional role-play by replacing live participants with interactive child avatars (Fertleman et al., 2018). However, while computer-based or 2D VR child avatar simulations have shown some success in skill improvement, they often struggle with realism, contextual responsiveness, and adaptability beyond preset conditions (Kask et al., 2022; Powell et al., 2022; Hassan et al., 2022).

FIGURE 1
Immersive virtual reality simulation of conversation with a child victim.
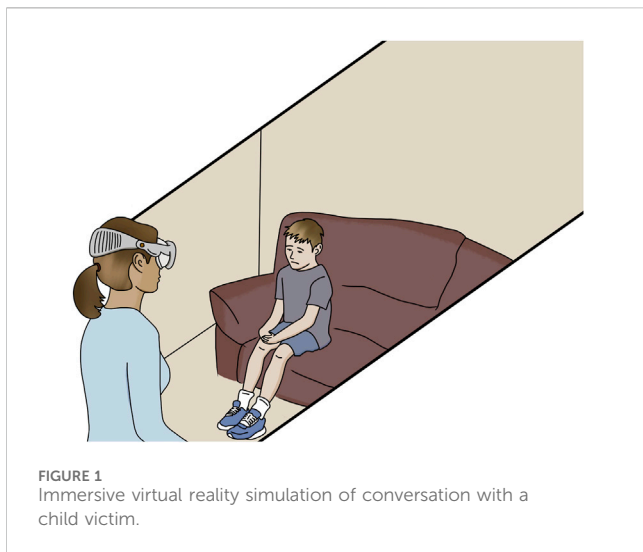
Research on full-immersion VR links its distinct sense of presence and embodiment to improved knowledge retention and transfer, empathy development, and ecologically valid stimuli (Schultheis and Rizzo, 2001; Herrera et al., 2018; Makransky and Petersen, 2021; Yang et al., 2023; Petersen et al., 2023; Krause et al., 2024). Several recent studies have employed immersive VR simulations of conversations with child victims, as shown in Figure 1, to train child protection workers, physicians, and educators in detecting or discussing suspected child abuse.

While findings suggest immersive VR may enhance investigative skills and confidence, the field remains in its early stages with limited empirical validation. This scoping review synthesizes recent findings in immersive VR conversation training across professions concerned with child protection while identifying critical gaps and opportunities for improvement.

2 Methods

This review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018). A systematic literature search and filtration identified peer-reviewed studies evaluating fully immersive VR for child abuse investigation training, as summarized in Figure 2 (Haddaway et al., 2022). Though strict inclusion and exclusion criteria narrowed this review's focus, it aligns with Scoping Review objectives to map emerging evidence, assess key themes and gaps, and propose future directions (Munn et al., 2018).

2.1 Linguistic selection

A systematic literature search was conducted across APA PsycNet (PsycInfo, PsycArticles), PubMed, Mendeley, and Google Scholar for studies broadly using VR in child abuse situations. The following search term sequences were applied:

1. PsycInfo, 2. PsycArticles: (virtual reality) AND (child abuse)

3. PubMed, 4. Mendeley: (virtual reality) AND (child*) AND (abuse)

5. Google Scholar: (virtual reality) AND (child*) AND (abuse) AND (investigative interview)

All records from PsycInfo, PsycArticles, and PubMed were imported into EndNote, along with the first 100 of 151 Mendeley results and the first 200 of 34,600 Google Scholar results. These thresholds were applied to exclude results from unrelated fields with no connection to VR or child abuse.

This process yielded $n = 426$ records, from which $n = 50$ duplicates and $n = 8$ unpublished records were removed before screening.

2.2 Screening for topic pertinence and eligibility

A total of $n = 368$ records were then screened:

1. PsycInfo: $n = 77$
2. PsycArticles: $n = 4$
3. PubMed: $n = 19$
4. Mendeley: $n = 85$
5. Google Scholar: $n = 183$

Of these, $n = 304$ were excluded for being either out of scope or non-peer-reviewed, and $n = 3$ were unretrievable. This left $n = 61$ full-text reports to be assessed for eligibility.

Following full-text review, $n = 54$ studies were excluded based on the following criteria:
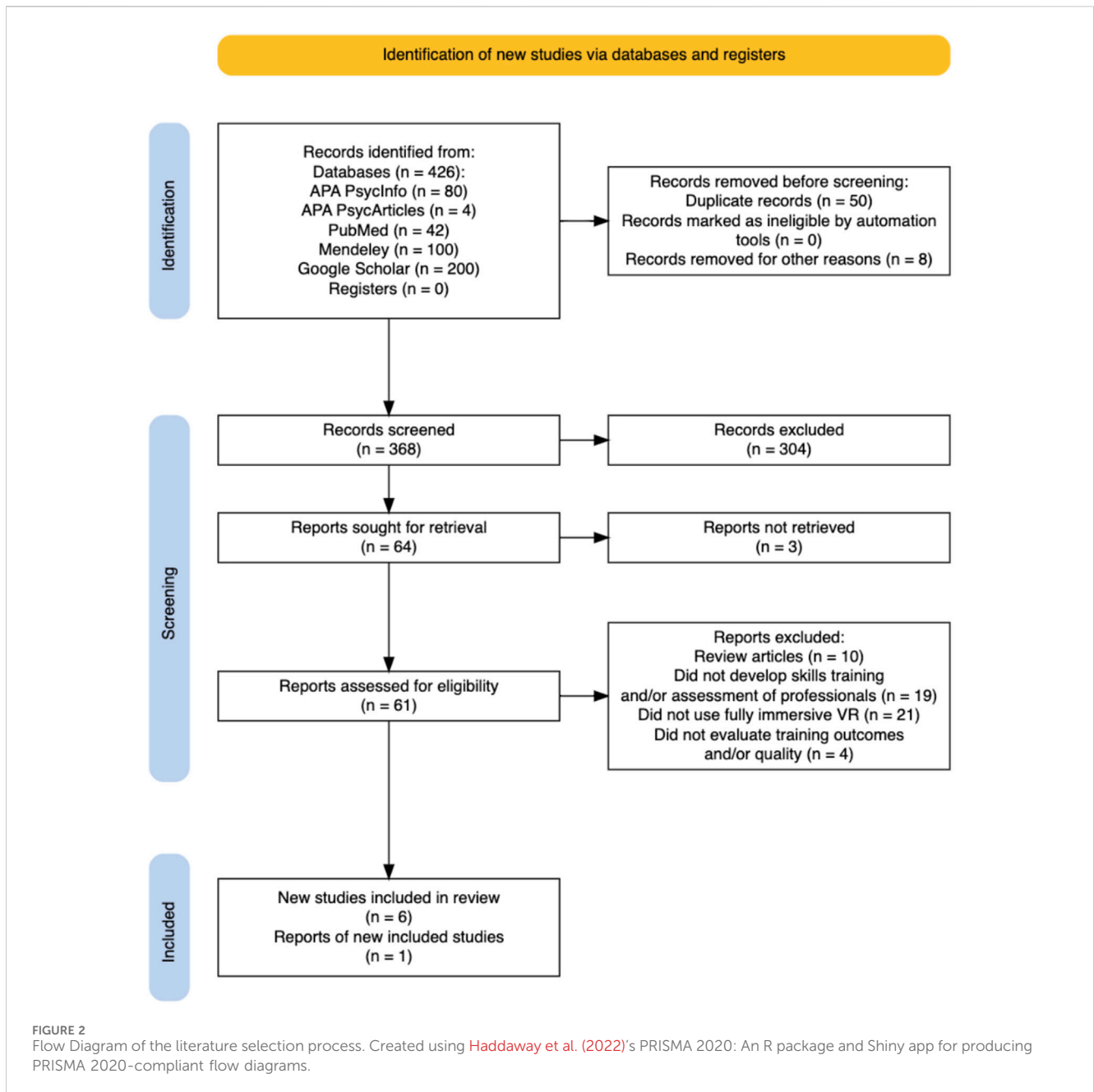
1. Review articles that did not present primary research ($n = 10$).
2. Studies developed interventions for survivors rather than training professionals ($n = 19$).
3. Studies employed technologies other than fully immersive VR, such as 2D avatars, computer-based interfaces, and non-immersive simulations ($n = 21$).
4. Studies did not evaluate training outcomes or quality ($n = 4$).

This review included only studies utilizing fully immersive VR to evaluate its potential and limitations in enhancing child protection training. This criterion was informed by research linking immersive VR's heightened sensory realism, presence, and embodiment to improved skill retention and transfer (Herrera et al., 2018; Makransky and Petersen, 2021; Yang et al., 2023; Petersen et al., 2023; Krause et al., 2024). Ultimately, $n = 6$ studies met the inclusion criteria, along with $n = 1$ perspective article discussing a 1-year follow-up of an included study.

3 Results of review

3.1 Characteristics of reviewed studies

Studies trained professionals across three contexts of conversation with children: family medicine consults ($n = 1$), classroom conversations ($n = 1$), and forensic interviews ($n = 4$),

FIGURE 2
Flow Diagram of the literature selection process. Created using Haddaway et al. (2022)'s PRISMA 2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams.

and were published in journals spanning public health, child maltreatment, and engineering.

The selected literature primarily originated from Europe ($n = 7$), including the United Kingdom ($n = 2$), Germany ($n = 1$), and Norway ($n = 4$). Notably, one Norway-based study collected data in the United States, and another included some Australian participants. However, no studies collected data from Asia, Africa, or South America, indicating a geographic research gap.

While all studies employed fully immersive VR, technologies varied based on specific objectives. While one simulation used a 3D Cave Automatic Virtual Environment to allow notetaking, others ($n = 5$) employed head-mounted displays (HMDs) to provide maximum physical immersion with 3D child avatars. $N = 4$ of

these studies used the Oculus Quest 2, while $n = 1$ utilized the HTC Vive Pro 2.

Child avatars ranged in age from 5 to 10 years old. Some studies simulated 5- to 6-year-old avatars trained on interviews with children aged 5–7 ($n = 2$), while others were ambiguous in age but trained on data from 6- to 8-year-olds ($n = 2$). Only $n = 1$ study used a 10-year-old avatar, indicating a gap in the representation of older children and developmental stages.

Nature of abuse similarly varied across studies, with simulations depicting either child sexual abuse, physical abuse, emotional maltreatment, or a mix of possible events, challenging professionals to train across scenarios and lead with open-ended questioning in the absence of prior information. However, random

assignment to abuse scenarios was largely not reported, limiting cross-contextual comparison of training outcomes.

Finally, sample sizes averaged $N = 51.3$, ranging from $N = 11$ to $N = 110$, with simulation durations varying from 90 s to no upper limit. All studies shared a focus on immersive VR to train professionals in child protection through simulated conversations.

3.2 Study involving medical professionals

Pan et al. (2018) used immersive VR simulations of doctor-patient consultations to assess the ability of medical professionals to identify child abuse indicators. Among $N = 63$ family physicians, 77% recognized verbal and nonverbal signs of emotional abuse during a conversation with a simulated father who begins reprimanding his son (Fertleman et al., 2018). While most physicians praised avatar realism, many critiqued the unnatural pauses, limited facial expressions, and unrealistic surroundings. Still, the immersive experience was reported to elicit authentic discomfort and fear, which Drewett et al. (2019) found contributed to perspective shifts in physicians when discussing their responses to a 1-year follow-up questionnaire. Physicians reported their increased sensitivity to abuse cues and the needs of vulnerable patients, though this impact varied by individual experiences.

3.3 Study involving educators

ViContact, a training program for educators developed by Krause et al. (2024), provides an immersive VR simulation of a classroom conversation with a child disclosing abuse. In a randomized-controlled study of $N = 110$ student teachers, a combination of VR training and an online seminar produced the greatest improvement in self-efficacy and open-ended questioning (43%). VR-only training followed with a 35% improvement, suggesting VR is most effective when paired with traditional instruction. However, ViContact VR's scalability remains challenging due to backend reliance on human operation.

3.4 Studies involving forensic interviewing

Research from Oslo Metropolitan University and Simula Metropolitan Center for Digital Engineering aimed to improve scalability by moving from human-operated to AI-driven child avatars in immersive VR. Hassan et al. (2022) developed a proof-of-concept using AI-generated childlike speech in avatars disclosing sexual abuse. In a study of $N = 11$ CPS professionals, participants reported improved self-efficacy due to the simulation's interactivity and realism, but noted response delays and an inability to take notes.

Hassan et al. (2023) expanded this user experience study to compare four interview simulation modalities: text-based, audio-based, 2D desktop, and immersive VR in random order. Among $N = 21$ CPS workers, 66% preferred immersive VR, which was rated highest in realism, presence, and engagement, though criticized for lacking behavioral cues. Importantly, both studies were heavily limited by small sample sizes.

Salehi et al. (2024) further explored immersion's impact on the training experience, integrating a GPT-3 language model to generate dynamic responses from child avatars. Among $N = 36$ forensic professionals experiencing both 3D immersive VR and 2D computer-based child interview simulations, 61% preferred immersive VR, citing better immersion and interactivity. However, 2D VR was favored for usability and comfort, and, contrary to expectations, higher immersion was not found to improve empathy elicitation.

The first of these studies to evaluate changes in questioning techniques was Baugerud et al. (2024). Their Child Avatar Interview Program used GPT-3 to enable avatars to elaborate on open-ended questions and retreat to closed-ended ones, as seen in 2D avatar training programs (Pompedda et al., 2014; Krause et al., 2024). Among $N = 68$ professionals, $n = 1$ participated in 2D VR while $n = 67$ participated in 3D immersive VR simulations. 60% of all questions asked were open-ended (Baugerud et al., 2024), exceeding real-world averages of 2%–8% reported by Lamb et al. (2018). Participants in Baugerud et al. (2024) valued the avatar's behavioral nuances but disapproved of its aged appearance and delayed responses.

4 Discussion

Despite methodological differences, all reviewed studies shared a focus on the central and cross-disciplinary role of conversation in identifying child abuse and gathering relevant information.

While participants reported increased presence and engagement, concerns about avatar realism, technical limitations, and usability persisted. Improvements in open-ended questioning were observed, yet findings across most studies were constrained by small, unrepresentative samples or non-randomized designs, indicating a weak scientific base at present.

4.1 Limitations of existing and future research

Critical methodological gaps limit conclusions on immersive VR's efficacy in child protection training. Most studies relied on small, non-random, and demographically homogenous samples, restricting generalizability. Child avatars also lacked diversity in age and physical appearance, limiting trainees' exposure to the full range of developmental differences that significantly influence verbal disclosure dynamics (Alaggia et al., 2019; McElvaney et al., 2020).

The absence of randomized controlled trials (RCTs) precludes causal inferences about VR's impact on conversational skill acquisition, user experience, and knowledge retention. The only true randomized-controlled study, by Krause et al. (2024), found no advantage of VR-only over traditional training, with the latter group showing greater self-efficacy improvement. By contrast, other studies reported more favorable results but lacked randomization and relied on self-reported metrics, making them susceptible to systematic and novelty biases. To establish an unbiased scientific base, future research should prioritize randomized designs with standardized assessment metrics.

Scalability also remains a significant barrier. Immersive VR training often requires specialized hardware, financial resources, and technological infrastructure, limiting accessibility compared to 2D or web-based alternatives. Additionally, HMD discomfort and technical delays can diminish trainees' sense of immersion and engagement (Hassan et al., 2023; Salehi et al., 2024). Many reviewed studies relied on self-reported confidence rather than empirical performance assessments, leaving it unclear whether immersion increases competence. As such, while 2D VR has been evaluated for real-world skill transfer (Kask et al., 2022), immersive VR's ecological validity and longitudinal effects remain unevaluated.

4.2 Future directions and practical applications

Effective training should build lasting conversational skill improvement through spaced practice grounded in behavior change frameworks, and assess outcomes through longitudinal follow-ups as in Drewett et al. (2019) (Rischke et al., 2010; Hieftje et al., 2013). Furthermore, training to elicit verbal disclosures should follow an incremental approach, systematically increasing complexity and reinforcing "best practices" through continuous feedback (Rischke et al., 2010; Pompedda et al., 2017). Given that emotional engagement is not empirically linked to interview skill development, avatar emotionality can be introduced at later training stages to avoid overwhelming novices.

Future studies should expand beyond European samples and homogeneous avatars to ensure findings are applicable across diverse professional and cultural contexts. Standardized evaluation metrics can enable reliable cross-study comparisons, allowing researchers to identify the most effective VR features when developing training programs.

Building on these findings, optimized VR training may be integrated into mandated reporter programs and continuing medical education, providing structured opportunities for trainees to practice high-stakes conversations in a controlled, risk-free environment (Pan et al., 2018; Fertleman et al., 2018; Ko et al., 2025). Future implementations should prioritize affordability, accessibility, and alignment with institutional training requirements.

4.3 Limitations of review

This review is constrained by the limited number of studies meeting inclusion criteria, making it vulnerable to publication bias, which may underrepresent null findings. Though both authors were involved in the study selection methodology, interrater reliability could not be statistically assessed.

The lack of RCTs and standardized methods across reviewed studies prevents the formation of causal conclusions about VR's effectiveness in this field. Our review is also limited in global applicability by the lack of studies from non-Western countries. As the field expands, future reviews with a broader evidence base will provide a more systematic and critical appraisal of immersive VR for child protection training.

5 Conclusion

Emerging applications of immersive VR in child protection training provide a controlled environment for conversational practice with child victims, potentially enhancing professionals' engagement, self-efficacy, and learning outcomes. However, methodological weaknesses and a limited, bias-susceptible literature base make the technology's adoption premature. Rigorous research is needed to establish its efficacy over less immersive methods. Future studies should use randomized designs, prioritize empirical over self-reported evaluations, and assess longitudinal outcomes to ensure real-world applicability and lasting improvements in child protection practices.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Generative AI was used in the creation of this manuscript.

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