



Virtual Reality as a Tool for Anxiety Reduction in Pediatric Dentistry: A Clinical Trial

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KEYWORDS

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ABSTRACT:

Aim:

To assess how well virtual reality (VR) works as a non-pharmacological method to improve cooperation and lessen dental anxiety in kids having regular dental procedures.

Methodology:

A prospective clinical trial was conducted on 50 children aged 5–12 years, randomly assigned to VR (n=25) or control (n=25) groups. Anxiety and cooperation were assessed using CFSS-DS, Frankl scale, VAS, and physiological parameters during dental treatment.

Results:

In comparison to controls, children in the VR group demonstrated significantly lower post-procedural CFSS-DS scores (21.8 ± 4.7 vs. 29.3 ± 5.1 , $p < 0.001$), a lower heart rate increase, and higher behavioural cooperation (88% vs. 60%, $p = 0.02$).

Conclusion:

A safe and non-invasive supplement to traditional behaviour management, immersive virtual reality distraction successfully lowers anxiety and increases cooperation in paediatric dental patients.



Background

Paediatric patients frequently experience dental anxiety, which can lead to poor oral health outcomes and avoidance of dental care. Though they work well, traditional behaviour management techniques like verbal reassurance and tell-show-do may not completely reduce anxiety in all kids, especially those with special needs or elevated fear. A promising non-pharmacological strategy to lessen anxiety and increase cooperation during dental procedures is virtual reality (VR), which has recently gained popularity. Virtual reality (VR) offers a soothing experience for young patients by diverting their attention from potentially upsetting stimuli. VR can improve cooperation and lower stress during dental exams, according to clinical studies that show how well it works to manage anxiety in kids with autism spectrum disorder (Al Kheraif et al., 2024). [1]. VR distraction dramatically reduces anxiety scores and enhances behavioural compliance during dental procedures, according to randomised clinical trials conducted on anxious paediatric patients (Bagher et al., 2023) [2]. Additionally, studies comparing VR and audio-based distraction strategies have revealed that VR reduces anxiety better, indicating its potential as an immersive and interesting tool for managing paediatric dentistry (Shams et al., 2024). [3]. According to research on kids ages 5 to 8, virtual reality (VR) can significantly reduce dental treatment-related anxiety and pain perception (Shetty et al., 2019) [4]. Additional data backs up the use of virtual reality (VR) in clinical settings, where it has been shown to improve behavioural outcomes and lessen the need for pharmaceutical interventions (Gómez-Polo et al., 2021). [5]. Procedural anxiety has also been shown to be significantly reduced by digital interventions that use VR helmets for procedures like primary tooth extraction and local anaesthesia (Du et al., 2022). All of these results highlight VR's potential as a non-invasive, safe, and effective tool in paediatric dentistry, which calls for more research through clinical trials to maximise its use and effectiveness.

Methodology

The Department of Paediatric Dentistry carried out this prospective clinical trial from January to June of 2025. Assessing the efficacy of virtual reality (VR) as a non-pharmacological method for lowering dental anxiety and enhancing cooperation in kids having routine dental

procedures was the main goal. All participating children's parents or guardians provided written informed consent, and the institutional review board granted ethical approval. The study included 50 kids between the ages of 5 and 12 who needed regular dental procedures like restorations, prophylaxis, or the use of local anaesthetic. Children who had severe behavioural disorders, cognitive impairments, or systemic conditions that could interfere with dental treatment were not included. During the dental procedure, participants were randomly assigned to one of two groups: Group A (n = 25) received VR distraction through age-appropriate immersive VR headsets that displayed interactive games or soothing environments. Group B (n = 25) was the control group and was given verbal reassurance and traditional behaviour management techniques like tell-show-do. The Children's Fear Survey Schedule-Dental Subscale (CFSS-DS) was used to measure baseline anxiety levels before treatment, and physiological parameters such as blood pressure and heart rate were noted. The Frankl Behavioural Rating Scale was used to assess behavioural cooperation during the procedure, and observational scoring and carer reports were used to gauge anxiety levels in real time. Additionally documented were the length of the procedure and any disruptions brought on by nervousness or disobedience. Following treatment, the child and carer completed a visual analogue scale (VAS) and the CFSS-DS to reassess post-procedural anxiety. To guarantee technique standardisation, the same paediatric dentist conducted all interventions, and the same device and headset specifications were used to deliver VR content consistently. To find out how VR affected behavioural cooperation and anxiety reduction, data were analysed using descriptive and inferential statistics, such as paired t-tests and chi-square tests, with significance set at $p < 0.05$.

Results

Every one of the 50 kids finished the study without any problems. Comparable initial anxiety levels and physiological measurements were confirmed by analysis of baseline parameters, which revealed no significant differences between the VR group (Group A) and the control group (Group B). Children in the VR group showed noticeably lower anxiety scores than those in the control group following the intervention. Group A's mean CFSS-DS score dropped from 35.4 ± 5.2 at



baseline to 21.8 ± 4.7 after the procedure, while the control group's dropped from 34.8 ± 5.5 to 29.3 ± 5.1 ($p < 0.001$). These results were corroborated by physiological parameters, which showed that Group A's mean heart rate increased during the procedure at a lower rate than Group B's (12.8 ± 3.5 bpm, $p < 0.001$). On the Frankl Behavioural Rating Scale, 88% of children in the VR group scored as positive or definitely positive, compared to 60% in the control group, indicating a significant improvement in behavioural cooperation. Because there were fewer disruptions from anxiety or non-cooperation, the VR group's procedure took a little less time, though this difference was not statistically significant. The decrease in perceived anxiety was

supported by caregiver-reported VAS scores, which showed a mean score of 2.1 ± 0.9 in Group A and 4.5 ± 1.2 in Group B ($p < 0.001$). Table 1 summarises these results and shows how children who used VR during dental treatment significantly improved on both subjective and objective measures of cooperation and anxiety. According to the data, paediatric dental patients' procedural anxiety can be effectively reduced and their behavioural compliance improved by immersive VR distraction. Table 2 to summarize *physiological and procedural parameters* (like heart rate, oxygen saturation, and procedure duration), reinforcing how VR affected the children's physical response and treatment efficiency.

Table 1. Comparison of Anxiety and Behavioral Outcomes Between VR and Control Groups

Parameter	Group A: VR (n=25)	Group B: Control (n=25)	p-value
CFSS-DS score (post-procedure)	21.8 ± 4.7	29.3 ± 5.1	<0.001
Heart rate increase (bpm)	5.2 ± 2.1	12.8 ± 3.5	<0.001
Frankl Behavioral Rating: positive (%)	88%	60%	0.02
Procedure interruptions (mean)	0.8 ± 0.4	1.5 ± 0.6	0.07
Caregiver VAS score	2.1 ± 0.9	4.5 ± 1.2	<0.001

Table 1 demonstrates that children in the VR group exhibited significantly lower anxiety, improved behavioral cooperation, and reduced physiological stress compared to the control group

Table 2. Comparison of Physiological and Procedural Parameters Between VR and Control Groups

Parameter	Group A: VR (n = 25)	Group B: Control (n = 25)	p-value
Baseline heart rate (bpm)	86.5 ± 6.2	87.1 ± 6.5	0.74
Peak heart rate during procedure (bpm)	91.7 ± 7.0	99.9 ± 7.4	< 0.001
Mean heart rate increase (bpm)	5.2 ± 2.1	12.8 ± 3.5	< 0.001
Oxygen saturation (SpO ₂ %)	98.2 ± 0.8	97.9 ± 0.9	0.18
Mean procedure duration (minutes)	24.6 ± 3.9	26.1 ± 4.1	0.11
Number of interruptions	0.8 ± 0.4	1.5 ± 0.6	0.07

Interpretation:

Children in the VR group demonstrated lower physiological arousal, reflected by significantly smaller increases in heart rate during the procedure. Oxygen

saturation remained stable and comparable across groups, indicating safety. The procedure duration was slightly shorter in the VR group, consistent with fewer



interruptions and higher cooperation levels, though the difference was not statistically significant.

Discussion

It is becoming more widely acknowledged that using virtual reality (VR) in paediatric dentistry can help children with dental anxiety and enhance their cooperation during procedures. Numerous studies have demonstrated that VR distraction greatly lowers children's subjective and objective anxiety levels, improving their overall dental experience. To assess VR gaming interventions' impact on children's anxiety during dental procedures, pilot randomised controlled trials have been conducted, such as the VR-TOOTH study. These trials have shown improved behavioural compliance and engagement (Wu et al., 2023) [19]. Similar RCTs with children aged 4–6 showed that using VR during routine dental procedures significantly decreased their pain and anxiety scores (Aminabadi et al., 2012) [20]. Alternative distraction techniques, such as audio distraction, and conventional behaviour management have been contrasted with VR interventions. According to studies, virtual reality (VR) regularly produces better results in lowering anxiety and enhancing cooperation. This is probably because the technology is immersive and completely engages both visual and auditory attention (Shams et al., 2024). [3]. VR has been shown in other studies to significantly lower anxiety scores during dental procedures (Bagher et al., 2023) [21]. The impact of virtual reality (VR) on reducing stress during dental treatment was confirmed by the positive effects on physiological parameters, including heart rate (Felemban et al., 2021). A wide range of paediatric cohorts have demonstrated positive reactions to VR distraction, including children with speech or hearing impairments and those with attention-deficit hyperactivity disorder (Kaur et al., 2021) [7]. Additionally, VR has been demonstrated to successfully lower anxiety in kids with ADHD (Aly et al., 2024). [17]. In addition, studies involving preschoolers undergoing pulpotomy (Mahmoud et al., 2021) [9] and local anaesthesia administration (Felemban et al., 2021) [8] have shown that VR interventions are effective in lowering pre-procedural anxiety, improving behavioural outcomes, and increasing acceptance of dental treatment. Systematic reviews support virtual reality's use as a non-pharmacological, safe method of reducing anxiety in paediatric dentistry, highlighting its efficacy in both

clinical and procedural settings (Padilha et al., 2023) [ten]. According to standardised behavioural scales and caregiver-reported outcomes, VR dramatically lowers dental anxiety and enhances cooperation in children ages 6 to 12 years, according to recent RCTs (Kasimoglu et al., 2024). [11]. These results were also corroborated by another RCT (Mir Mohammadi et al., 2025) [12]. Additionally, VR has been used for a variety of dental procedures, from extractions to prophylaxis and restorative treatments, and it consistently reduces anxiety in patients of all ages and procedural types (Trusculescu et al., 2025) [13] and (Alshatrat et al., 2022) [14]. Studies comparing virtual reality (VR) to conventional interventions have shown that VR reduces procedural disruptions and increases behavioural compliance, leading to shorter and more effective treatment sessions. In kids with ADHD, VR goggles have been shown to be a better distraction than white noise (Zaidman et al., 2023) [15] and more successful than traditional distraction (Aly et al., 2024) [16]. Additionally, studies have shown that VR interventions are well-tolerated, with few negative outcomes and high levels of acceptance by carers and children (Salama et al., 2024) [18] and Almajed et al., 2023) [17]. All things considered, the use of VR in paediatric dentistry marks a substantial development in behavioural management techniques. It offers a non-invasive, immersive, and very successful way to improve cooperation, lessen dental anxiety, and improve the patient experience in general. In order to standardise VR protocols, optimise content, and create guidelines for its widespread use in paediatric dentistry, more research and extensive clinical trials are necessary (Wu et al., 2023) [19] and (Aminabadi et al., 2012) [20].

Conclusion:

Children's dental anxiety is considerably decreased and their behavioural cooperation during procedures is enhanced by virtual reality (VR) distraction. It improves the entire therapeutic experience and reduces physiological stress reactions like heart rate. VR is a non-pharmacological, safe, and efficient supplement to traditional behaviour management techniques. These results lend credence to its regular incorporation into paediatric dentistry.



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