



QUALITY IN SPORT

eISSN 2450-3118 · Open Access · Peer-reviewed

apcz.umk.pl/QS Nicolaus Copernicus University in Toruń



POCIASK, Weronika, JĘDRAS, Aleksandra, CZEREPAK, Gabriela, BEDNARZ, Katarzyna, GLIWA, Katarzyna, CZAJKOWSKA, Weronika, KALICKA, Karolina, GRZEGORCZYK, Julia, OPALA, Krzysztof and KROWIŃSKI, Jakub. Virtual Reality and Other Non-Pharmacological Approaches to Reducing Dental Anxiety: A Literature Review. 2026;71:74940. <https://doi.org/10.12775/QS.2026.71.74940>

ARTICLE TIMELINE

Received: 03.08.2026. Revised: 20.08.2026. Accepted: 07.09.2026. Published: 13.09.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).

Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych). © The Authors 2026.

OPEN ACCESS · CC BY-NC-SA 4.0 This article is published with open access under the License Open Journal Systems of Nicolaus Copernicus University in Toruń, Poland, and is distributed under the terms of the Creative Commons Attribution Non-commercial Share Alike License (<http://creativecommons.org/licenses/by-nc-sa/4.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the work is properly cited. The authors declare no conflict of interest regarding the publication of this paper.

Virtual Reality and Other Non-Pharmacological Approaches to Reducing Dental Anxiety: A Literature Review

Abstract

Introduction: Dental anxiety is a common barrier to effective dental care and may lead to avoidance of visits, deterioration of oral health, and reduced cooperation during treatment. Growing interest in non-pharmacological methods has increased attention to virtual reality and other supportive interventions.

Objective: This review assessed current evidence on the effectiveness of virtual reality and other non-pharmacological approaches in reducing dental anxiety and pain and improving patient cooperation.

Materials and Methods: A narrative review of full-text English-language articles published between 2019 and 2025 was conducted using PubMed and reference list screening. Search terms covered dental anxiety, virtual reality, distraction, behavioral interventions, and other non-pharmacological techniques.

Results: Virtual reality generally reduced dental anxiety and improved cooperation, particularly in pediatric patients. Some studies also reported beneficial effects on physiological

stress indicators, while evidence for pain reduction remained inconsistent. Audiovisual distraction, breathing techniques, and behavioral preparation were also associated with favorable outcomes.

Conclusions: Virtual reality is a useful adjunct in managing dental anxiety, especially in pediatric dentistry. Evidence is strongest for anxiety reduction and improved cooperation, whereas its effect on pain requires further research. Other non-pharmacological interventions may also support anxiety management.

Keywords: *dental anxiety; dental fear; dentophobia; virtual reality; VR; behavior management; distraction techniques; audio-visual distraction; pediatric dentistry; pain management; anxiety reduction*

Introduction

Dental anxiety associated with dental treatment is a significant clinical and public health concern affecting children, adolescents, and adults alike. The terms *dental anxiety*, *dental fear*, and *dental phobia* are commonly used in the literature to describe related but not entirely synonymous phenomena. Dental anxiety generally refers to a nonspecific feeling of apprehension and anticipation of negative events before or during dental treatment, whereas dental fear represents a response to a specific stimulus, such as local anesthetic injection, the sound of dental instruments, the sight of blood, or the anticipation of pain. Dental phobia is the most severe and persistent manifestation of this condition, characterized by disproportionate anxiety, avoidance behaviors, and substantial impairment of daily functioning. Nevertheless, epidemiological studies frequently examine these conditions collectively under the term *dental fear and anxiety* (DFA); therefore, reported prevalence estimates should not be interpreted as reflecting the prevalence of clinically diagnosed dental phobia alone (Silveira et al. 2021; Piechal et al. 2026).

The etiology of dental phobia is multifactorial and involves complex interactions among psychological, environmental, familial, and treatment-related factors. One of the principal mechanisms is considered to be the direct conditioning of fear following painful, unpredictable, or traumatic dental experiences. Factors such as ineffective local anesthesia, loss of perceived control, inability to interrupt treatment, abrupt or forceful clinical procedures, and inadequate communication between the dental team and the patient may play particularly important roles. Subsequently, anxiety responses may be triggered by characteristic stimuli encountered in the dental setting, including the smell of dental materials, the sound of dental equipment, the sight

of needles, and treatment positions that restrict the patient's freedom of movement (Piechal et al. 2026).

Dental anxiety may also develop in the absence of direct traumatic experiences. It can be acquired through observational learning from parents or other close family members, exposure to negative accounts of dental treatment, or media portrayals depicting dental visits as painful or threatening experiences. Additional predisposing factors include high levels of general anxiety, specific temperament traits, limited adaptability to unfamiliar situations, low pain tolerance, and poorly developed coping strategies. In children, emotional immaturity, lack of prior familiarization with the dental environment, and initiation of dental treatment only after the onset of pain may further increase susceptibility to dental anxiety (Sun et al. 2024; Piechal et al. 2026).

Dental fear and anxiety constitute a global health concern, although reported prevalence varies considerably depending on the study population, assessment instrument, and diagnostic threshold employed. A meta-analysis including 31 studies and 72,577 adults estimated the prevalence of overall DFA at 15.3%, high DFA at 12.4%, and severe DFA at 3.3%. Higher prevalence rates were observed primarily among women and younger adults (Silveira et al. 2021). A more recent meta-analysis restricted to studies using the Modified Dental Anxiety Scale (MDAS) with a cutoff score of ≥ 19 reported a pooled prevalence of high dental anxiety of 18%. These estimates should not be directly compared with previous findings because of differences in outcome definitions and substantial methodological heterogeneity among the included studies (Leśna et al. 2026).

Dental anxiety is of particular clinical importance in pediatric dentistry. A global meta-analysis demonstrated that DFA affects approximately 23.9% of children and adolescents. The highest prevalence was reported among preschool children (36.5%), followed by school-aged children (25.8%), whereas the prevalence among adolescents was estimated at 13.3% (Grisolia et al. 2021). Another meta-analysis focusing on children aged 2–6 years estimated the prevalence of DFA at approximately 30%. The likelihood of developing DFA was higher among children with no previous dental experience and those with a history of dental caries (Sun et al. 2024). Consequently, the youngest children, patients with previous painful dental experiences, individuals with elevated levels of general anxiety, and those experiencing a reduced sense of control during treatment appear to be particularly vulnerable to developing dental anxiety.

The consequences of dental phobia extend far beyond temporary discomfort during dental visits. Severe anxiety may result in postponement or complete avoidance of preventive and therapeutic dental care, irregular attendance, and seeking treatment only after the onset of

severe pain or advanced oral disease. Consequently, patients are more likely to require extensive and invasive dental procedures, which may reinforce previous negative experiences and perpetuate avoidance behaviors. This creates the well-recognized "vicious cycle" of dental anxiety, whereby anxiety leads to avoidance of treatment, deterioration of oral health increases treatment complexity, and subsequent negative experiences further intensify anxiety (Silveira et al. 2021; Piechal et al. 2026).

High levels of dental anxiety have also been associated with poorer oral health-related quality of life. Patients may experience pain, difficulties with eating, impaired dental aesthetics, embarrassment, reduced self-esteem, and limitations in social functioning. The association between severe dental anxiety and diminished oral health-related quality of life has been demonstrated in both adults and pediatric populations (Hakeberg and Wide 2018; Alharbi et al. 2021; Aardal et al. 2023). In pediatric dentistry, DFA may additionally compromise patient cooperation, prolong treatment time, hinder the successful completion of dental procedures, and increase stress experienced by children, their caregivers, and dental professionals.

The management of dental phobia should be individualized according to the patient's age, severity of symptoms, underlying causes of anxiety, and the type of planned dental procedure. Available interventions include effective communication, gradual familiarization with the dental environment, the tell-show-do technique, modeling, positive reinforcement, breathing and relaxation exercises, distraction techniques, audiovisual distraction, music therapy, hypnosis, and virtual reality-based interventions. Current evidence suggests that non-pharmacological interventions can reduce self-reported anxiety, improve patient cooperation, and attenuate physiological stress responses. However, their effectiveness varies depending on the type of dental procedure, the patient's age, the intervention protocol, and the outcome measures used. Although findings regarding virtual reality are promising, the available evidence remains inconsistent, particularly with respect to pain reduction (Barros Padilha et al. 2023; Almarzouq et al. 2024; Kong et al. 2024).

The aim of the present review was to provide a comprehensive analysis of contemporary approaches for the prevention and management of dental phobia and dental anxiety associated with dental treatment, with particular emphasis on non-pharmacological behavior management strategies, distraction techniques, and virtual reality interventions. The review evaluates the effectiveness of these approaches in reducing anxiety and pain, improving patient cooperation, and attenuating physiological stress responses, while also discussing the principal methodological limitations of the currently available evidence.

Methodology

This study was conducted as a narrative literature review aimed at analyzing current scientific evidence regarding contemporary approaches to reducing dental phobia and dental anxiety associated with dental treatment.

The literature search was performed through a manual search of full-text articles indexed in the PubMed electronic database. In addition, the reference lists of the retrieved publications were screened to identify further studies relevant to the topic.

The search strategy employed combinations of keywords connected by the Boolean operators AND and OR, including the following terms: *"dental anxiety," "dental fear," "dentophobia," "virtual reality," "VR," "behavior management," "distraction techniques," "audio-visual distraction," "pediatric dentistry," "children," "pain management," "anxiety reduction,"* and *"non-pharmacological methods."*

The review included full-text articles published in English between 2019 and 2025 that investigated contemporary approaches to reducing dental anxiety. Eligible studies comprised clinical investigations, particularly randomized controlled trials, crossover studies, split-mouth studies, and systematic reviews addressing non-pharmacological interventions for the management of dental anxiety.

Publications unrelated to the scope of this review, articles not published in English, case reports, conference abstracts, studies without full-text availability, and duplicate publications reporting previously published findings were excluded.

Following the screening and evaluation of the identified literature, 17 scientific articles were included in the review. A qualitative synthesis was subsequently performed, comparing study populations, intervention characteristics, assessment tools used to evaluate dental anxiety, and outcomes related to the effectiveness of the investigated therapeutic approaches. Based on the available evidence, the current state of knowledge regarding contemporary non-pharmacological strategies for the management of dental phobia was synthesized.

Most of the included studies were conducted in pediatric populations, reflecting the current focus of research on interventions for reducing dental anxiety. Only a limited number of studies involved adult patients; therefore, the findings presented in this review should be interpreted in light of this imbalance.

Given the narrative design of the review, no formal assessment of the methodological quality of the included studies or risk of bias analysis was performed.

Results

A total of 17 scientific publications published between 2019 and 2025 met the predefined eligibility criteria and were included in the analysis (Table 1). Sixteen of the included studies were conducted in pediatric populations, whereas only one randomized clinical trial involved adult participants (Lahti et al. 2020). The reviewed studies primarily evaluated the effectiveness of virtual reality (VR), audiovisual distraction, breathing exercises, and behavioral interventions in reducing dental anxiety and pain during dental treatment. The effectiveness of these interventions was most commonly assessed using validated anxiety scales, including the Children's Fear Survey Schedule–Dental Subscale (CFSS-DS), Modified Child Dental Anxiety Scale (MCDAS), Face Image Scale (FIS), and Venham Picture Test (VPT), as well as pain assessment tools such as the Wong–Baker FACES Pain Rating Scale, Face, Legs, Activity, Cry, Consolability (FLACC) scale, and Modified Behavioral Pain Scale (MBPS). Physiological parameters, particularly heart rate and blood oxygen saturation, were also frequently evaluated.

Virtual reality was the most extensively investigated intervention for reducing dental anxiety. Most studies demonstrated that VR significantly reduced dental anxiety compared with standard care or other distraction techniques (Du et al. 2022; Gs et al. 2021; Jyoti et al. 2024; Bahrololoomi et al. 2024; Chandran et al. 2024). Anxiety reduction was consistently confirmed using different assessment instruments, including the CFSS-DS, MCDAS, and Face Image Scale (Du et al. 2022; Gs et al. 2021; Bahrololoomi et al. 2024; Chandran et al. 2024). Several studies also reported improvements in children's behavior and patient cooperation during dental treatment, as assessed, among other measures, by the Frankl Behavior Rating Scale (Jyoti et al. 2024; Delgado et al. 2021). Beneficial effects of VR were observed during restorative dental procedures, tooth extractions, and selected procedures performed under local anesthesia (Du et al. 2022; Jyoti et al. 2024; Zaidman et al. 2023; Chandran et al. 2024).

The effect of virtual reality on pain perception was less consistent. Most studies reported reductions in self-reported pain measured using the Wong–Baker FACES Pain Rating Scale or other validated pain assessment instruments (Du et al. 2022; Bahrololoomi et al. 2024; Chandran et al. 2024). However, several authors found no statistically significant differences between intervention and control groups with respect to subjective pain perception (Shetty et al. 2019; Felemban et al. 2021; Nunna et al. 2019; Koticha et al. 2019). Zaidman et al. (2023) demonstrated that VR effectively reduced both pain and behavioral responses during rubber dam placement, whereas during local anesthetic administration the intervention primarily reduced behavioral manifestations of pain without significantly affecting patient-reported pain

intensity. Similarly, Felemban et al. (2021) observed improved child behavior during local anesthetic administration despite the absence of statistically significant differences in subjective pain ratings.

Several studies demonstrated that VR use was associated with a significant reduction in heart rate during dental treatment (Nunna et al. 2019; Koticha et al. 2019; Gs et al. 2021). Nunna et al. (2019) and Felemban et al. (2021) reported this effect particularly during local anesthetic administration. Koticha et al. (2019) observed lower heart rates in children using VR but found no significant differences in anxiety levels assessed with the Venham Picture Test or in blood oxygen saturation. Conversely, Shetty et al. (2019), Bahrololoomi et al. (2024), and Gala and Kalaskar (2024) reported no significant between-group differences in any of the evaluated physiological parameters, indicating inconsistent evidence regarding the effects of VR on physiological responses associated with dental treatment.

In addition to evaluating VR as a standalone intervention, several studies compared its effectiveness with other distraction techniques or investigated alternative non-pharmacological interventions.

Studies comparing virtual reality with conventional distraction methods consistently demonstrated that immersive VR technology was generally more effective in reducing dental anxiety and improving children's cooperation during treatment. In the study by Jyoti et al. (2024), children using VR headsets achieved lower scores on the Face Image Scale and more favorable Frankl behavior ratings than those watching videos on a television screen. Similar findings were reported by Gs et al. (2021), who demonstrated greater effectiveness of VR in reducing anxiety and lowering heart rate compared with conventional distraction methods. Likewise, Chandran et al. (2024) found VR to be superior in reducing anxiety and improving children's cooperation during dental treatment.

Audiovisual distraction constituted another important group of interventions evaluated in the included studies. Delgado et al. (2021) found that this approach did not significantly reduce subjective pain perception; however, it resulted in a marked improvement in children's behavior as assessed by the Frankl Behavior Rating Scale. A greater proportion of children in the intervention group exhibited positive behavior during treatment compared with the control group. In contrast, Jafarimofrad et al. (2022) demonstrated that the combined use of visual and auditory stimuli was more effective than visual distraction alone, resulting in significant reductions in anxiety, pain, and heart rate among children undergoing dental treatment.

Among the remaining non-pharmacological interventions, breathing exercises using a bubble blower were also investigated. Bahrololoomi et al. (2022) demonstrated that this technique

significantly reduced pain associated with inferior alveolar nerve block administration, as measured using the Wong–Baker FACES Pain Rating Scale and the FLACC scale. However, no significant differences were observed between groups regarding anxiety levels assessed with the Face Image Scale or physiological parameters, suggesting that the beneficial effect of this intervention was primarily limited to pain reduction.

The review also included the study by Wang et al. (2025), which evaluated a contemporary behavior management strategy implemented before dental treatment. The intervention consisted of active patient preparation through role-playing activities and familiarization with the planned dental procedures. Compared with standard care, this approach significantly reduced dental anxiety measured using the CFSS-DS and improved children's cooperation during treatment. Furthermore, parents of children assigned to the intervention group reported higher satisfaction with the overall treatment experience.

The only study involving adults was the randomized clinical trial conducted by Lahti et al. (2020), which included 277 participants. The authors demonstrated that the use of relaxation-oriented virtual reality before dental treatment significantly reduced overall dental anxiety, particularly anticipatory anxiety experienced before the dental appointment. The beneficial effect was more pronounced among women than men, whereas the influence of the intervention on anxiety experienced during treatment itself was less evident.

The systematic review by Barros Padilha et al. (2023), included in the present review, concluded that most available studies demonstrated beneficial effects of virtual reality on reducing dental anxiety and improving children's behavior during dental treatment. In contrast, findings regarding pain perception were more heterogeneous and appeared to depend on the type of dental procedure performed and the assessment instruments used. The authors also emphasized substantial heterogeneity among the included studies with respect to sample size, intervention protocols, and outcome measures, which limited direct comparison of the reported findings.

Table 1. Characteristics of the interventions and the most important findings of the studies included in the review

Author, year	Intervention	Comparison group	Key findings
Shetty et al. 2019	Virtual reality (VR)	Standard care	No significant reduction in pain; no clear effect on physiological parameters.
Nunna et al. 2019	Virtual reality (VR)	Standard care	Significant reduction in heart rate and anxiety; no significant pain reduction.
Koticha et al. 2019	Virtual reality (VR)	Standard care	Lower heart rate; no differences in anxiety (Venham Picture Test) or oxygen saturation.
Lahti et al. 2020	Relaxation virtual reality	Standard care	Significant reduction in general and anticipatory dental anxiety; greater effect in women.
Delgado et al. 2021	Audiovisual distraction	Standard care	Improved child behavior; no significant pain reduction.
Felemban et al. 2021	Virtual reality (VR)	Standard care	Reduced behavioral reactions during anesthesia; no clear pain reduction.

Author, year	Intervention	Comparison group	Key findings
Gs et al. 2021	Virtual reality (VR)	Other distraction method	Reduced anxiety and heart rate; improved child cooperation.
Bahrololoomi et al. 2022	Breathing exercises (bubble blower)	Standard care	Significant pain reduction; no effect on anxiety or physiological parameters.
Du et al. 2022	Virtual reality (VR)	Standard care	Significant reduction in anxiety and pain; improved cooperation during treatment.
Jafarimofrad et al. 2022	Audiovisual distraction (image + sound)	Image projection only	Greater reduction in anxiety, pain and heart rate than visual stimuli alone.
Zaidman et al. 2023	Virtual reality (VR)	Standard care	Reduced pain during rubber dam placement; mainly reduced behavioral reactions during anesthesia.
Barros Padilha et al. 2023	Review of VR studies	—	Most studies confirmed VR reduced anxiety; pain findings were inconsistent.

Author, year	Intervention	Comparison group	Key findings
Bahrololoomi et al. 2024	Virtual reality(VR)	Standard care	Significant reduction in anxiety and pain; no clear physiological changes.
Gala and Kalaskar 2024	Virtual reality (VR)	Standard care	Favorable trend toward lower anxiety and pain, but not statistically significant.
Jyoti et al. 2024	Virtual reality (VR)	TV screen	Greater anxiety reduction and better child cooperation than television.
Chandran et al. 2024	Virtual reality (VR)	Standard care	Significant reduction in anxiety and pain; improved patient cooperation.
Wang et al. 2025	Behavioral method (role-play and visit preparation)	Standard care	Reduced dental anxiety, improved child cooperation and higher parental satisfaction.

Discussion

The findings of the present review indicate that virtual reality (VR) is one of the best-documented non-pharmacological interventions for reducing dental anxiety, particularly in pediatric populations. Most of the included studies demonstrated significant reductions in anxiety levels and improvements in children's cooperation during dental treatment when

immersive VR technology was used. These findings support the growing role of VR as an adjunctive tool in the management of patients experiencing dental anxiety.

The systematic review by Rosa et al. (2023) demonstrated that the vast majority of studies investigating the use of VR in children reported reductions in dental anxiety and improvements in behavior during dental treatment. The authors emphasized that these benefits were observed regardless of the type of dental procedure performed, although the greatest effects were reported during invasive procedures such as tooth extractions and local anesthetic administration. These conclusions are consistent with the findings of the present review, in which the effectiveness of VR was demonstrated during restorative treatment, surgical procedures, and interventions requiring local anesthesia.

Similar observations were reported by Cunningham et al. (2021), who evaluated both VR technology and mobile applications designed to reduce dental anxiety in children. Their findings suggested that immersive technologies provide more effective distraction than conventional distraction methods. However, the authors also highlighted the limited methodological quality of several available studies and the considerable heterogeneity of the interventions evaluated. Similar limitations were identified in the present review, where studies differed substantially with respect to participants' age, the types of dental procedures performed, VR devices used, and the instruments employed to assess anxiety and pain.

Further support for these findings is provided by the meta-analysis conducted by Almarzouq et al. (2024), which evaluated a broad range of behavioral interventions for children with dental anxiety. The authors concluded that non-pharmacological approaches effectively reduce pretreatment anxiety, particularly when they actively engage children and incorporate distraction techniques. They also emphasized that the greatest benefits are achieved when interventions are individually tailored according to the patient's age, developmental stage, and severity of anxiety.

Particular attention should be paid to studies comparing VR with conventional distraction techniques. Across the reviewed studies, virtual reality consistently proved more effective than watching videos on a monitor or standard audiovisual distraction in reducing anxiety and improving children's cooperation during dental treatment. This superiority is likely attributable to the high level of immersion provided by VR headsets, which effectively minimize exposure to stimuli from the dental environment while fully engaging the patient's attention. A similar explanation was proposed by Gopalan et al. (2025) in their review of VR for acute pain management. According to the authors, virtual reality reduces pain perception by engaging attentional cognitive processes and modulating the activity of central nervous system structures

involved in pain and emotional processing. This mechanism may explain the concurrent reductions in anxiety and improvements in patient behavior observed in many dental studies. Nevertheless, the influence of VR on pain perception appears less consistent than its effect on anxiety reduction. While several studies included in the present review reported significant reductions in self-reported pain, others failed to demonstrate significant differences between intervention and control groups. Comparable conclusions were reached by Custódio et al. (2020), whose systematic review found that the available evidence regarding the analgesic effects of VR was of moderate quality and that treatment effects varied according to the dental procedure performed, the child's age, and the pain assessment methods used. The authors suggested that VR may exert a greater influence on the emotional component of pain and on behavioral responses than on the actual intensity of pain perceived by patients. This may explain the discrepancies observed in some studies, where improvements in children's behavior occurred despite the absence of significant changes in subjective pain ratings.

The analysis of the included studies also indicates that the effectiveness of non-pharmacological interventions is not limited to virtual reality alone. Beneficial effects were also observed for audiovisual distraction, breathing exercises, and structured behavioral preparation before dental treatment. Particularly noteworthy were the findings regarding active patient preparation through role-playing and familiarization with the planned dental procedures, which resulted in reduced anxiety and improved cooperation during treatment. These findings reinforce the concept that successful management of anxious patients should rely on a comprehensive approach integrating modern technologies with established psychological and behavioral techniques.

It is also noteworthy that nearly all studies included in the present review involved pediatric populations, whereas evidence regarding adult patients remains scarce. The only study involving adults was the randomized clinical trial conducted by Lahti et al. (2020), which demonstrated that relaxation-based virtual reality effectively reduced anxiety before dental treatment. However, the limited number of studies in adult populations precludes definitive conclusions regarding the effectiveness of VR in this group and highlights the need for further well-designed clinical research.

Overall, the findings of the present review, together with the available systematic reviews, indicate that virtual reality represents a promising and effective non-pharmacological intervention for reducing dental anxiety, particularly among children. The most consistently demonstrated benefits of VR are reductions in anxiety and improvements in patient cooperation during dental treatment, whereas its effect on pain perception remains less conclusive. The

available evidence also suggests that combining VR with other behavioral interventions and distraction techniques may provide the greatest clinical benefit. Nevertheless, additional randomized controlled trials employing standardized study protocols and validated outcome measures in both pediatric and adult populations are required to better define the role of virtual reality in the contemporary management of dental anxiety.

Conclusions

The findings of this literature review indicate that non-pharmacological interventions can effectively support the management of dental anxiety, particularly in pediatric patients. The strongest body of evidence concerns the use of virtual reality, which, in most of the reviewed studies, reduced dental anxiety and improved patient cooperation during dental treatment. However, the effects of VR on pain reduction and physiological parameters remain inconclusive. Beneficial outcomes have also been reported for audiovisual distraction, breathing techniques, and behavioral interventions. Given the methodological heterogeneity of the available evidence, further well-designed clinical trials using standardized assessment tools are warranted to establish the effectiveness of these interventions more conclusively.

Disclosure

Author Contributions:

Conceptualization: WP

Methodology: WP

Formal analysis: JG

Investigation: KB, KO

Data curation: KG, JK

Writing – original draft preparation: AJ, WP, KK, KG, GC

Writing – review and editing: GC, WC, KC

Supervision: WP, AJ

Project administration:

All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: Not applicable.

Conflict of Interest: The authors declare no conflict of interest.

Declaration of the use of generative AI and AI-assisted technologies in the writing process. During the preparation of this manuscript, the authors used ChatGPT (OpenAI) exclusively for language editing, grammar correction, and translation support. Following the use of this tool, the authors carefully reviewed and edited the manuscript and take full responsibility for the final content of the publication.

References

- Aardal V , Evensen KB, Willumsen T, Hervik Bull V . The complexity of dental anxiety and its association with oral health-related quality of life: an exploratory study. *Eur J Oral Sci.* 2023 Feb;131(1):e12907. doi: 10.1111/eos.12907.
- Alharbi A, Freeman R, Humphris G. Dental anxiety, child-oral health related quality of life and self-esteem in children and adolescents: a systematic review and meta-analysis.*Community Dent Health.* 2021 May 28;38(2):119-126. doi: 10.1922/CDH_00295Alharbi08.
- Almarzouq SSFS, Chua H, Yiu CKY , Lam PPY . Effectiveness of nonpharmacological behavioural interventions in managing dental fear and anxiety among children: a systematic review and meta-analysis. *Healthcare (Basel).* 2024 Feb 23;12(5):537. doi: 10.3390/healthcare12050537.
- Bahrololoomi Z, Sadeghiyeh T, Rezaei M, Maghsoudi N. The Effect of Breathing Exercise Using Bubble Blower on Anxiety and Pain during Inferior Alveolar Nerve Block in Children Aged 7 to 10 Years: A Crossover Randomized Clinical Trial. *Pain Res Manag.* 2022 Jan 17;2022:7817267. doi: 10.1155/2022/7817267. PMID: 35082960; PMCID: PMC8786543.
- Bahrololoomi Z, Zein Al-Din J, Maghsoudi N, Sajedi S. Efficacy of Virtual Reality Distraction in Reduction of Pain and Anxiety of Pediatric Dental Patients in an Iranian Population: A Split-Mouth Randomized Crossover Clinical Trial. *Int J Dent.* 2024 Jan 12;2024:1290410. doi: 10.1155/2024/1290410. PMID: 38250512; PMCID: PMC10798833.

Barros Padilha DX, Veiga NJ, Mello-Moura ACV, Nunes Correia P. Virtual reality and behaviour management in paediatric dentistry: a systematic review. *BMC Oral Health*. 2023 Dec 12;23(1):995. doi: 10.1186/s12903-023-03595-7. PMID: 38087294; PMCID: PMC10717698.

Chandran LS, Issac JS, Girija P, Thomas PT, Shirli AD, Jalal SA. Effectiveness of Two Types of Distraction Techniques in the Management of Pain and Anxiety during Dental Treatment in 6-9-year-old Children. *Int J Clin Pediatr Dent*. 2024 Mar;17(3):291-296. doi: 10.5005/jp-journals-10005-2794. PMID: 39144506; PMCID: PMC11320797.

Delgado A, Ok SM, Ho D, Lynd T, Cheon K. Evaluation of children's pain expression and behavior using audio visual distraction. *Clin Exp Dent Res*. 2021 Oct;7(5):795-802. doi: 10.1002/cre2.407. Epub 2021 Feb 23. PMID: 33622030; PMCID: PMC8543459.

Du Q, Ma X, Wang S, Zhou S, Luo C, Tian K, Fei W, Liu X. A digital intervention using virtual reality helmets to reduce dental anxiety of children under local anesthesia and primary teeth extraction: A randomized clinical trial. *Brain Behav*. 2022 Jun;12(6):e2600. doi: 10.1002/brb3.2600. Epub 2022 Apr 29. PMID: 35485000; PMCID: PMC9226823.

Felemban OM, Alshamrani RM, Aljeddawi DH, Bagher SM. Effect of virtual reality distraction on pain and anxiety during infiltration anesthesia in pediatric patients: a randomized clinical trial. *BMC Oral Health*. 2021 Jun 25;21(1):321. doi: 10.1186/s12903-021-01678-x. PMID: 34172032; PMCID: PMC8234622.

Gala UP, Kalaskar R. Comparative Evaluation of the Effectiveness of Innovative Periorbital Eye Massager and Virtual Reality Eyeglasses for Reducing Dental Anxiety during Dental Restorative Procedures in Children. *Int J Clin Pediatr Dent*. 2024 Jan;17(1):48-53. doi: 10.5005/jp-journals-10005-2730. PMID: 38559867; PMCID: PMC10978507.

Grisolia BM, Dos Santos APP, Dhyppolito IM, Buchanan H, Hill K, Oliveira BH. Prevalence of dental anxiety in children and adolescents globally: a systematic review with meta-analyses. *Int J Paediatr Dent*. 2021 Mar;31(2):168-183. doi: 10.1111/ipd.12712.

Gs G, George S, Anandaraj S, Sain S, Jose D, Sreenivas A, Pillai G, Mol N. Comparative Evaluation of the Efficacy of Virtual Reality Distraction, Audio Distraction and Tell-show-do Techniques in Reducing the Anxiety Level of Pediatric Dental Patients: An In Vivo Study. *Int J Clin Pediatr Dent*. 2021;14(Suppl 2):S173-S178. doi: 10.5005/jp-journals-10005-2106. PMID: 35645488; PMCID: PMC9108792.

Hakeberg M, Wide U. General and oral health problems among adults with focus on dentally anxious individuals. *Int Dent J*. 2018 Dec;68(6):405-410. doi: 10.1111/idj.12400.

Jafarimofrad S, Sarlak H, Nourmohammadi S. Is audio a mandatory component of multimedia distraction for reduction of pain and anxiety of pediatric dental patients? A split-mouth crossover randomized controlled clinical trial. *Dent Res J (Isfahan)*. 2022 Jan 28;19:10. doi: 10.4103/1735-3327.336695. PMID: 35308438; PMCID: PMC8927978.

Jyoti D, Shams SA, Anand P, Sagar S, Raj N, Singh S. An In Vivo Study to Evaluate and Compare Anxiety and Behavior Management of Pediatric Patients Using Distraction Techniques. *J Pharm Bioallied Sci*. 2024 Jul;16(Suppl 3):S2116-S2118. doi: 10.4103/jpbs.jpbs_68_24. Epub 2024 Apr 3. PMID: 39346360; PMCID: PMC11426654.

Kong X, Song N, Chen L, Li Y . Non-pharmacological interventions for reducing dental anxiety in pediatric dentistry: a network meta-analysis. *BMC Oral Health*. 2024 Sep 28;24(1):1151. doi: 10.1186/s12903-024-04919-x.

Koticha P, Katge F, Shetty S, Patil DP. Effectiveness of Virtual Reality Eyeglasses as a Distraction Aid to Reduce Anxiety among 6-10-year-old Children Undergoing Dental Extraction Procedure. *Int J Clin Pediatr Dent*. 2019 Jul-Aug;12(4):297-302. doi: 10.5005/jp-journals-10005-1640. PMID: 31866714; PMCID: PMC6898869.

Lahti S, Suominen A, Freeman R, Lähteenoja T, Humphris G. Virtual Reality Relaxation to Decrease Dental Anxiety: Immediate Effect Randomized Clinical Trial. *JDR Clin Trans Res*. 2020 Oct;5(4):312-318. doi: 10.1177/2380084420901679. Epub 2020 Jan 21. PMID: 31962052; PMCID: PMC7495687.

Leśna M, Górna K, Kwiatek J. High dental anxiety among adults worldwide: a systematic review and meta-analysis using the MDAS. *Br J Clin Psychol*. 2026 Mar 29. Online ahead of print. doi: 10.1111/bjc.70049.

Nunna M, Dasaraju RK, Kamatham R, Mallineni SK, Nuvvula S. Comparative evaluation of virtual reality distraction and counter-stimulation on dental anxiety and pain perception in children. *J Dent Anesth Pain Med*. 2019 Oct;19(5):277-288. doi: 10.17245/jdapm.2019.19.5.277. Epub 2019 Oct 30. PMID: 31723668; PMCID: PMC6834716..

Piechal A, Siekierska E, Blecharz-Klin K. Etiology of dental anxiety and dental phobia: review. *Eur J Dent*. 2026 Feb;20(1):13-22. doi: 10.1055/s-0045-1809146.

Shetty V , Suresh LR, Hegde AM. Effect of Virtual Reality Distraction on Pain and Anxiety During Dental Treatment in 5 to 8 Year Old Children. J Clin Pediatr Dent. 2019;43(2):97-102. doi: 10.17796/1053-4625-43.2.5. Epub 2019 Feb 7. PMID: 30730798.

Silveira ER, Cademartori MG, Schuch HS, Armfield JA, Demarco FF. Estimated prevalence of dental fear in adults: a systematic review and meta-analysis. J Dent. 2021 May;108:103632. doi: 10.1016/j.jdent.2021.103632.

Sun IG, Chu CH, Lo ECM, Duangthip D. Global prevalence of early childhood dental fear and anxiety: a systematic review and meta-analysis. J Dent. 2024 Mar;142:104841. doi: 10.1016/j.jdent.2024.104841.

Wang Y , Luo S, Yang L, Wang X. Efficacy of scenario-experiential behavior management techniques on dental fear in preschool children with dental caries: a randomized controlled trial. BMC Oral Health. 2025 Dec 7;26(1):69. doi: 10.1186/s12903-025-07352-w. PMID: 41353313; PMCID: PMC12797336.

Zaidman L, Lusky G, Shmueli A, Halperson E, Moskovitz M, Ram D, Fux-Noy A. Distraction With Virtual Reality Goggles in Paediatric Dental Treatment: A Randomised Controlled Trial. Int Dent J. 2023 Feb;73(1):108-113. doi: 10.1016/j.identj.2022.06.003. Epub 2022 Aug 6. PMID: 35940954; PMCID: PMC9875280.