

Effectiveness of Virtual Reality on Behavioral Adjustment and Dental Fear in Children

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ABSTRACT

The present study aimed to determine the effectiveness of virtual reality on behavioral adjustment and dental fear in children. This study employed a quasi-experimental design with a pretest-posttest and a control group. The statistical population consisted of children aged 8–12 years who attended pediatric dental centers in the study area. From this population, 30 children were selected through convenience sampling and randomly assigned to an experimental group and a control group, with 15 participants in each group. The research instruments included the Children's Fear Survey Schedule-Dental Subscale (CFSS-DS) and the Strengths and Difficulties Questionnaire (SDQ). Initially, both groups completed the research instruments as a pretest. Subsequently, the experimental group used a virtual reality headset providing age-appropriate audiovisual content while receiving dental treatment, whereas the control group received routine dental care without virtual reality. After the intervention, both groups completed the posttest measures. Data were analyzed using multivariate analysis of covariance (MANCOVA) in SPSS version 26. The results indicated that, after controlling for pretest scores, virtual reality significantly reduced dental fear in children. In addition, a significant difference was found between the experimental and control groups in behavioral adjustment, with children in the experimental group demonstrating better behavioral adjustment at posttest. Overall, virtual reality may be considered a non-pharmacological and minimally invasive approach for reducing dental fear and improving behavioral adjustment among children in dental settings, thereby contributing to a more positive dental treatment experience.

Keywords: Virtual Reality, Dental Fear, Behavioral Adjustment, Children, Pediatric Dentistry

1. Introduction

Oral and dental health is an important component of children's general health, and their experiences with dental care during the early years of life may influence their attitudes, behavior, and patterns of dental service use in later years. However, fear and anxiety arising from the dental environment and procedures are among the barriers that can interfere with the successful delivery of dental treatment in children (Padilha et al., 2023; Sun et al., 2024).

The prevalence of this problem is considerable. A systematic review and meta-analysis by Sun et al. showed that approximately 30% of children aged 2-6 years experience some degree of dental fear and anxiety, with a greater likelihood among children without previous dental visits and those with a history of dental caries (Sun et al., 2024). Dental fear may intensify when a child encounters stimuli such as local anesthetic injection, the sound of dental equipment, the sight of treatment instruments, and the expectation of pain. In addition to emotional and

physiological reactions, it may lead to treatment avoidance, resistance to dental procedures, and reduced cooperation (Demir Kösem et al., 2024; Shokravi et al., 2023). Persistence of such experiences may create a cycle in which fear leads to avoidance or delay in receiving care, worsening oral health problems, and ultimately the need for more complex treatment; difficult treatment experiences may, in turn, increase the child's fear of subsequent visits (Ra'ed-Naser et al., 2026; Sun et al., 2024).

One important consequence of dental fear in children is the emergence of behavioral problems and reduced adjustment and cooperation during treatment, because increased emotional distress may lead to refusal to open the mouth, crying, body movements, resistance to the clinician's instructions, and greater difficulty in completing treatment (Ra'ed-Naser et al., 2026; Shokravi et al., 2023). Behavioral adjustment in the dental setting may be considered the child's ability to accept treatment conditions, achieve relative control over behavioral and emotional responses, and cooperate appropriately with the dentist during procedures; facilitating this process is also a major goal of many behavior-guidance approaches in pediatric dentistry (Padilha et al., 2023; Ra'ed-Naser et al., 2026). Although anxiety and child behavior are related, these constructs are not completely synonymous. Some children may experience considerable anxiety while remaining relatively cooperative, whereas unfavorable behavior in the dental setting is not necessarily caused solely by fear or anxiety. Therefore, simultaneous assessment of emotional and behavioral indicators may provide a more accurate understanding of the child's treatment experience (Shokravi et al., 2023). In an Iranian study, Shokravi et al. separately assessed dental anxiety and behavioral cooperation in children aged 7-10 years using a child dental anxiety measure and the Venham clinical cooperation scale, and reported that a cognitive-behavioral intervention significantly reduced dental anxiety (Shokravi et al., 2023). Enshaei et al. also evaluated the Persian version of the Children's Experiences of Dental Anxiety Measure in 275 Iranian children and adolescents aged 9-16 years and demonstrated favorable reliability and validity, highlighting the importance of accurate identification and measurement of children's emotional experiences in dental settings (Enshaei et al., 2024).

Given the negative effects of fear and anxiety on the treatment experience and child cooperation, behavior-guidance techniques are a fundamental component of pediatric dentistry, and increasing attention has been

directed toward non-pharmacological, minimally invasive methods that are acceptable to children and parents (Almarzouq et al., 2024). Techniques such as distraction, tell-show-do, modeling, positive reinforcement, and audiovisual interventions are used to reduce children's attention to threatening stimuli and improve cooperation; however, their effectiveness varies according to the child's age, type of treatment, baseline anxiety, and method of implementation (Almarzouq et al., 2024). A systematic review and meta-analysis by Almarzouq et al., which included 66 studies, showed that distraction techniques in many settings were associated with reduced self-reported anxiety, better cooperation, and lower heart rate, although the magnitude of effectiveness of approaches such as virtual reality was heterogeneous across studies (Almarzouq et al., 2024).

Among the newer non-pharmacological methods that have received attention in recent years for child behavior management is virtual reality, which creates a computer-generated, multisensory, partially or fully immersive environment and allows the child's attention to shift from the actual treatment environment to engaging visual and auditory stimuli (Padilha et al., 2023). By limiting exposure to visual and auditory stimuli associated with the dental environment and engaging the child's attentional resources with attractive content, virtual reality may reduce attention to instruments, sounds, injections, pain, and other fear-provoking stimuli, thereby making the treatment experience more tolerable (Padilha et al., 2023). This feature has led to the study of virtual reality not only as a method for reducing fear and anxiety but also as a potential behavior-guidance tool for improving child cooperation in dental settings (Padilha et al., 2023; Ra'ed-Naser et al., 2026). Padilha et al., in a systematic review of 22 randomized trials, showed that virtual reality reduced anxiety and pain and produced a more positive dental treatment experience in many studies, although substantial differences in participant age, dental procedures, and measurement instruments were limitations of the available evidence (Padilha et al., 2023). Yan et al., in a systematic review and meta-analysis of 12 randomized trials involving 818 participants, also reported that virtual reality was associated with significant reductions in anxiety, pain, and heart rate during pediatric dental treatment (Yan et al., 2023).

Recent international studies have also supported the effectiveness of this technology. For example, Demir Kösem et al., in a randomized trial involving 120 children aged 7-10 years, showed that the use of virtual reality

glasses during tooth extraction and pulp treatment was associated with significantly lower post-intervention fear and anxiety scores than the control condition (Demir Kösem et al., 2024). Balik and Usluoglu examined children aged 7-12 years undergoing dental treatment for the first time and found that providing information about the treatment process through virtual reality glasses before treatment could reduce dental anxiety and improve child behavior and cooperation (Balik & Usluoğlu, 2024). These findings suggest that the function of virtual reality may extend beyond temporary distraction and may influence children's adjustment to the treatment environment by promoting cognitive and emotional preparedness (Balik & Usluoğlu, 2024; Ra'ed-Naser et al., 2026).

Recent studies on the application of virtual reality in pediatric dentistry have also been conducted in Iran. Bahrololoomi et al., in a crossover clinical trial involving Iranian children aged 6-8 years who required pulpotomy of primary molars, showed that anxiety and perceived pain scores were significantly lower under the virtual reality condition than under the condition without virtual reality (Bahrololoomi et al., 2024). In another study involving 45 Iranian children aged 7-10 years, Bahrololoomi et al. compared virtual reality, auditory distraction, and no intervention during inferior alveolar nerve block injection and found that the virtual reality group experienced the lowest anxiety levels (Bahrololoomi et al., 2025). Mir Mohammadi et al., in an Iranian clinical trial involving children aged 6-12 years, found that the use of virtual reality animation during dental treatments requiring local anesthesia significantly reduced dental anxiety scores and heart rate compared with the control group (Mir Mohammadi et al., 2025). Taken together, these domestic findings indicate the potential of virtual reality to reduce negative reactions among Iranian children in dental settings. However, most recent Iranian studies have focused on outcomes such as anxiety and pain, and further evidence is still needed regarding simultaneous emotional changes and children's behavioral adjustment or cooperation (Bahrololoomi et al., 2025; Bahrololoomi et al., 2024; Mir Mohammadi et al., 2025).

In addition, a recent systematic review by Ra'ed-Naser et al. showed that, besides reducing anxiety, virtual reality was associated with increased positive behavioral responses and improved Frankl behavior-rating scores in children and may therefore be considered a behavior-management tool in pediatric dentistry (Ra'ed-Naser et al., 2026). Nevertheless, differences in the degree of immersion of

virtual reality systems, the content delivered, duration of device use, children's age, previous dental experience, type of dental procedure, and measurement instruments have resulted in variability in the observed magnitude of effect across studies (Almarzouq et al., 2024; Padilha et al., 2023). Moreover, reduction in fear or anxiety does not necessarily imply favorable behavioral adjustment, and simultaneous assessment of emotional and behavioral outcomes may provide a more comprehensive evaluation of the effectiveness of virtual reality (Shokravi et al., 2023). Therefore, considering the considerable prevalence of dental fear in children, its effects on acceptance and continuation of treatment, the need for non-pharmacological and minimally invasive interventions, and the promising findings of Iranian and international studies, investigating the effectiveness of virtual reality on dental fear and behavioral adjustment in children is of theoretical and clinical importance (Padilha et al., 2023; Ra'ed-Naser et al., 2026; Sun et al., 2024). Such research may expand local evidence regarding the use of emerging technologies in pediatric dentistry and provide practical information to dentists for selecting behavior-management methods, reducing negative treatment experiences, and improving child cooperation (Bahrololoomi et al., 2024; Mir Mohammadi et al., 2025). Accordingly, the fundamental question of the present study was whether the use of virtual reality could improve behavioral adjustment and reduce dental fear in children.

2. Methods and Materials

2.1. Design and Participants

The present study used a quasi-experimental pretest-posttest design with a control group. The study population consisted of all children aged 8-12 years who attended pediatric dental centers and clinics in Isfahan during Iranian calendar year 1404 and required dental services. The 8-12-year age range was selected based on children's ability to respond to self-report instruments and the use and psychometric evaluation of the Persian version of the child dental fear scale in this age group. Thirty eligible children were selected through convenience sampling from attending patients and were subsequently allocated randomly to the experimental and control groups. Inclusion criteria were age 8-12 years, need for dental treatment, ability to understand and respond to the questionnaires, written parental consent for the child's participation, absence of reported severe physical, psychiatric, or

neurological disorders, and absence of visual or hearing problems that could interfere with the use of virtual reality equipment. Children with a history of photosensitive epilepsy, severe dizziness, or motion sickness were not enrolled because of the possibility of discomfort while using the virtual reality headset. Exclusion criteria were withdrawal of the child or parents from continued participation, inability to tolerate the virtual reality headset, incomplete questionnaires, and absence from the pretest or posttest stages. At the beginning of the study, after the aims and procedures had been explained, written informed consent was obtained from parents and the child's agreement to participate was obtained. They were assured that personal information would remain confidential and that participation was entirely voluntary. The Children's Fear Survey Schedule-Dental Subscale (CFSS-DS) and the Strengths and Difficulties Questionnaire (SDQ) were then completed by the participants or their parents, as appropriate to the instructions for each instrument, and the resulting scores were considered the pretest. After the pretest, children in the experimental group used a virtual reality headset during dental treatment. Before the procedure, the headset was introduced to the child using an explanation-and-demonstration approach, and age-appropriate audiovisual and animated content was presented through the device. Headset use continued from the beginning of the main treatment stages until completion of the dental procedure. Immersive animated content during dental treatment has also been used as a virtual reality intervention in recent clinical studies involving Iranian children. Children in the control group received the same routine dental services but did not use a virtual reality headset during treatment. To reduce potential confounding factors, the treatment environment, dentist-child communication, type of dental procedure, and treatment duration were kept as similar as possible between the two groups. After completion of the intervention period and the final dental treatment session, the study questionnaires were completed again in both groups, and the resulting scores were considered the posttest. After data collection, the data were analyzed using SPSS version 26. Descriptive statistics, including mean, standard deviation, frequency, and percentage, were first calculated. After assessment of assumptions such as normality of data distribution, homogeneity of variances, and homogeneity of regression slopes, multivariate analysis of covariance was used to evaluate the effectiveness of virtual reality on dental fear

and behavioral adjustment. The significance level was set at 0.05.

2.2. Measures

Children's Fear Survey Schedule-Dental Subscale (CFSS-DS): This questionnaire was developed by Cuthbert and Melamed in 1982 to assess children's fear of dental situations and procedures and is one of the established instruments for measuring dental fear in children (Cuthbert & Melamed, 1982). The questionnaire contains 15 items, each scored on a five-point Likert scale ranging from 1, 'not afraid at all,' to 5, 'very afraid.' The total score therefore ranges from 15 to 75. Higher scores indicate greater fear of dental treatment, and in many studies a score of 38 or higher has been considered indicative of considerable or clinically relevant dental fear (Cuthbert & Melamed, 1982).

The Persian version of the CFSS-DS was psychometrically evaluated by Javadinejad et al. in Iranian children aged 8-12 years, with a Cronbach's alpha of 0.92 reported for the instrument, indicating favorable internal consistency (Javadinejad et al., 2011). In addition, Farzanegan et al. used the standardized Persian version of the CFSS-DS in 2025 among 290 Iranian children aged 8-12 years attending the pediatric dentistry department in Babol, supporting its use in recent Iranian studies (Farzanegan et al., 2025). In the present study, the total CFSS-DS score was used as the indicator of the child's dental fear at pretest and posttest.

Strengths and Difficulties Questionnaire (SDQ): This questionnaire was developed by Goodman in 1997 to assess behavioral and emotional characteristics of children and adolescents and consists of 25 items (Goodman, 1997). It includes five subscales: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behavior, with five items in each subscale (Goodman, 1997). Responses are provided on a three-point scale comprising 'not true,' 'somewhat true,' and 'certainly true,' and are scored 0, 1, or 2 depending on item direction (Goodman, 1997). The total difficulties score is obtained by summing the four subscales of emotional symptoms, conduct problems, hyperactivity, and peer problems. A higher score indicates greater behavioral-emotional difficulties and therefore poorer behavioral adjustment; accordingly, a reduction in the total difficulties score at posttest was considered an indication of improved behavioral adjustment. The psychometric properties of the Persian SDQ have been examined in Iranian children.

Shahrivar et al., in a study of 600 Iranian children aged 6-12 years, reported acceptable validity and internal consistency for the parent and teacher versions of the questionnaire (Shahrivar et al., 2009). Iranian studies have also reported a Cronbach's alpha of approximately 0.73 for the total difficulties score across SDQ forms, with the psychometric properties of the Persian version considered acceptable (Shahrivar et al., 2009). The parent version of the SDQ was used in the present study, and a reduction in the total difficulties score was considered evidence of improved child behavioral adjustment.

3. Findings and Results

In the present study, data from 30 children in the experimental and control groups were analyzed, with 15 children in each group. The mean age of children in the experimental group was 9.87 ± 1.25 years, and the mean age of children in the control group was 10.13 ± 1.18 years. Regarding sex distribution, the experimental group included 8 girls and 7 boys, whereas the control group included 7 girls and 8 boys.

Table 1 presents the mean and standard deviation of dental fear and behavioral adjustment scores at the pretest and posttest stages in the experimental and control groups.

Table 1

Mean and Standard Deviation of Study Variables in the Experimental and Control Groups

Variable	Group	Pretest, Mean $\pm$ SD	Posttest, Mean $\pm$ SD
Dental Fear	Experimental	43.60 $\pm$ 6.38	30.47 $\pm$ 5.21
	Control	42.93 $\pm$ 6.12	41.87 $\pm$ 5.98
Behavioral Adjustment Difficulties	Experimental	18.73 $\pm$ 4.06	12.20 $\pm$ 3.41

As shown in Table 1, the mean dental fear score in the experimental group decreased from 43.60 at pretest to 30.47 at posttest, whereas no substantial change was observed in the control group. The mean behavioral adjustment difficulties score in the experimental group also decreased from 18.73 to 12.20, while the mean value in the control group changed from 18.27 to 17.80. Because higher scores on both instruments indicate a less favorable condition, the reductions observed in the experimental group indicate reduced dental fear and improved behavioral adjustment following the use of virtual reality.

Before conducting the multivariate analysis of covariance, the assumptions of the test were examined. Shapiro-Wilk test results for the study variables in both groups were not significant; therefore, the assumption of normality was considered satisfied. Levene's tests for dental fear ($F = 0.86$, $P = 0.36$) and behavioral adjustment

($F = 1.04$, $P = 0.31$) were also not significant, indicating homogeneity of variances. Box's M test was not significant, and the assumption of equality of covariance matrices was therefore considered satisfied. Examination of the interaction between the pretest variable and group also indicated that the assumption of homogeneity of regression slopes was met for both variables (Box's $M = 5.27$, $F = 1.74$, $P = 0.14$).

Multivariate analysis of covariance was used to examine the overall effect of virtual reality on the linear combination of dental fear and behavioral adjustment variables. Wilks' lambda test indicated a significant difference between the experimental and control groups in the combined dependent variables after controlling for pretest scores ($\eta^2 = 0.68$). Therefore, virtual reality had an overall significant effect on children's dental fear and behavioral adjustment variables.

Table 2

Analysis of Covariance Results for the Effect of Virtual Reality on the Study Variables

Dependent Variable	Sum of Squares	df	Mean Square	F	Significance	Effect Size
Dental Fear	846.21	1	746.21	34.76	<0.001	0.57
Behavioral Adjustment	298.64	1	298.64	21.93	<0.001	0.46

The results showed that, after controlling for pretest scores, there was a significant difference between the experimental and control groups in mean posttest dental

fear scores. Based on the adjusted means, the dental fear score in the experimental group was significantly lower than that in the control group; therefore, the use of virtual

reality reduced children's dental fear. The obtained effect size also indicated a considerable effect of the virtual reality intervention on reducing children's dental fear after controlling for pretest scores. The analysis of covariance also showed a significant between-group difference in behavioral adjustment after controlling for pretest scores. The mean behavioral difficulties score in the experimental group was lower than that in the control group at posttest, which, according to the scoring method of the instrument, indicates improved behavioral adjustment among children in the experimental group. The obtained effect size likewise indicated a considerable effect of the virtual reality intervention on improving behavioral adjustment after controlling for pretest scores. Overall, the study findings showed that the use of virtual reality during dental treatment significantly reduced children's dental fear and improved their behavioral adjustment compared with the control group. Therefore, the study hypothesis regarding the effectiveness of virtual reality in reducing dental fear and improving behavioral adjustment in children was supported.

4. Discussion and Conclusion

The aim of the present study was to determine the effectiveness of virtual reality on behavioral adjustment and dental fear in children. Multivariate analysis of covariance showed that, after controlling for pretest effects, the experimental and control groups differed significantly in the combined variables of dental fear and behavioral adjustment, and virtual reality produced significant changes in the outcomes examined. This finding is consistent with the systematic review by Padilha et al., which identified virtual reality as an effective approach for managing anxiety, pain, and child behavior in dental settings (Padilha et al., 2023). A systematic review by Hamdane et al. likewise showed that most studies associated the use of virtual reality with reduced anxiety and pain and improved child behavior, although methodological heterogeneity remains (Hamdane et al., 2026). By creating an immersive audiovisual environment, virtual reality directs the child's attention toward stimuli outside the actual dental setting and consequently reduces processing of threatening stimuli such as the sight of instruments, equipment sounds, local anesthetic injection, and anticipation of pain (Hamdane et al., 2026; Padilha et al., 2023). Reduced emotional arousal may also facilitate greater acceptance of treatment and the

development of more adaptive behavioral responses (Hamdane et al., 2026; Padilha et al., 2023).

The first specific finding of the study showed that virtual reality was effective in reducing children's dental fear, with a significant difference between the groups after controlling for the pretest effect. This finding is consistent with the study by Bahrololoomi et al. in Iranian children, which showed that the use of a virtual reality headset during pulpotomy reduced children's anxiety and pain (Bahrololoomi et al., 2024). Mir Mohammadi et al. also reported that the use of virtual reality animation during treatments requiring local anesthesia reduced children's dental anxiety and heart rate (Mir Mohammadi et al., 2025). The present results are also consistent with another study by Bahrololoomi et al., in which children receiving virtual reality during inferior alveolar nerve block injection experienced the lowest anxiety scores (Bahrololoomi et al., 2025)].

At the international level, the present finding is also consistent with the study by Demir Kösem et al., who showed that the use of virtual reality glasses during tooth extraction and pulp treatment significantly reduced fear and anxiety in children (Demir Kösem et al., 2024). The meta-analysis by Yan et al., which included 12 randomized trials and 818 participants, likewise confirmed the effectiveness of virtual reality interventions in reducing children's dental anxiety (Padilha et al., 2023; Yan et al., 2023). However, the present finding is not entirely consistent with the results of Kasimoglu et al.; in their study, although heart rate decreased significantly in the virtual reality group, no significant between-group difference was observed in CFSS-DS scores (Kasimoglu et al., 2025). This inconsistency may be related to differences in children's baseline anxiety severity, type of dental treatment, content presented, degree of immersion, duration of headset use, and the measurement instrument (Hamdane et al., 2026; Kasimoglu et al., 2025).

The effectiveness of virtual reality in reducing dental fear may be explained by the fact that children's fear is strongly influenced by attention to potentially threatening stimuli and the anticipation of pain. By creating competition for attentional resources, virtual reality leaves less cognitive capacity available for processing such stimuli (Padilha et al., 2023; Yan et al., 2023). Immersion in engaging images, sounds, or interactive content may reduce the child's sense of presence in the treatment environment and limit attention to cues associated with fear and pain (Padilha et al., 2023). In addition, experiencing a dental

session with less tension may improve the child's appraisal of the dental situation and create a more controllable treatment experience.

The second finding of the study showed that virtual reality was effective in improving children's behavioral adjustment, with a significant difference between the experimental and control groups after controlling for pretest scores. This finding is consistent with Balik and Usluoğlu, who showed that providing treatment information through virtual reality glasses before a child's first dental treatment not only reduced anxiety but also improved behavior and cooperation according to the Frankl scale (Balik & Usluoğlu, 2024). The finding is also consistent with the systematic review by Ra'ed-Naser et al., which reported that children receiving virtual reality demonstrated more cooperative behavior and more favorable behavioral scores than control groups in a number of studies (Ra'ed-Naser et al., 2026). The systematic review by Padilha et al. also identified virtual reality as one of the behavior-management approaches used in pediatric dentistry.

However, findings regarding behavioral outcomes have not been consistent across all studies. In the trial by Kasimoglu et al., no significant difference was observed among virtual reality, passive distraction, and control groups on the Frankl behavior scale (Kasimoglu et al., 2025). The systematic review by Hamdane et al. also showed that although the overall direction of evidence favors virtual reality, some studies reported no difference between virtual reality and other distraction methods (Hamdane et al., 2026). These differences may reflect the fact that children's behavior in the dental office is not determined solely by anxiety; temperament, age, previous treatment experience, type of dental procedure, dentist behavior, parental presence, and the child's initial level of cooperation may also play a role.

The finding regarding behavioral adjustment may be explained by the ability of virtual reality to reduce the emotional burden of the treatment situation, creating conditions in which the child is less engaged in defensive and avoidant responses and is better able to tolerate the treatment process (Padilha et al., 2023; Ra'ed-Naser et al., 2026). When the child's attention is redirected toward engaging content, continuous focus on the dentist's movements, instruments, and unpleasant stimuli may decrease, and behaviors such as resistance, crying, avoidance, and interruption of cooperation may consequently become less frequent (Hamdane et al., 2026;

Ra'ed-Naser et al., 2026). Virtual reality may also create a greater sense of control and security for the child, which can facilitate better acceptance of the dental situation and more appropriate responses to the clinician (Balik & Usluoğlu, 2024). Findings also suggest that, in addition to distraction, virtual reality may improve behavior by familiarizing the child with the situation and reducing uncertainty (Balik & Usluoğlu, 2024).

Dental fear reduction and improved behavioral adjustment may therefore be considered related but distinct outcomes. Reduced emotional arousal may increase the child's capacity to regulate behavior and cooperate during treatment, but the two variables are not equivalent (Ra'ed-Naser et al., 2026; Shokravi et al., 2023). Assessing both outcomes is important because the clinical success of virtual reality is not limited to the child feeling less afraid; in practice, the child must also be able to adjust to treatment and cooperate sufficiently for dental procedures to be completed (Hamdane et al., 2026; Ra'ed-Naser et al., 2026). Iranian studies have shown that virtual reality can reduce emotional components of the dental experience, such as anxiety and pain, and the present findings may complement this evidence from the perspective of behavioral outcomes (Bahrololoomi et al., 2024; Mir Mohammadi et al., 2025).

Overall, the results of the present study showed that virtual reality was effective in reducing dental fear and improving behavioral adjustment in children and may be considered an attractive, non-pharmacological, non-invasive approach alongside other behavior-guidance techniques in pediatric dentistry (Hamdane et al., 2026; Padilha et al., 2023; Ra'ed-Naser et al., 2026). However, the findings should be interpreted in light of limitations including the small sample size, recruitment from one or a limited number of dental centers, reliance on self-report or parent-report measures, absence of follow-up to determine the persistence of intervention effects, and the difficulty of blinding participants in virtual reality interventions. Future studies are recommended with larger samples, different age groups, follow-up periods, comparisons of virtual reality with other distraction approaches, and simultaneous use of observational behavioral indicators, self-report measures, and physiological indicators (Hamdane et al., 2026; Ra'ed-Naser et al., 2026). Pediatric dentists may also consider the child's age and preferences, type of treatment, and clinical conditions when using virtual reality as an adjunctive behavior-management tool.

Authors' Contributions

All authors contributed to the conception and design of the study, data collection and analysis, interpretation of the findings, drafting of the manuscript, and critical revision of its intellectual content. All authors approved the final version of the manuscript and agree to be accountable for the work.

Declaration

Generative AI was used solely to support English-language translation and editorial language refinement of this manuscript. It was not used to generate study data, perform statistical analyses, or alter the reported scientific results or conclusions. The author reviewed the final English version and remains responsible for the accuracy and integrity of the manuscript.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

Written informed consent was obtained from parents or legal guardians, and assent/agreement was obtained from participating children. Participation was voluntary, and participants were assured that personal information would remain confidential, as described in the Methods section.

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