

## Effects of Virtual Reality Versus Game Applications on Children's Dental Fear: A Randomized Clinical Trial

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### Abstract

**Background:** Management of dental anxiety and fear of pediatric dental patients is a major goal in pediatric dentistry to create a positive attitude towards dental procedures and perform a successful treatment. Preoperative positive imagery and distraction during treatment are some of the non-pharmaceutical approaches for reduction of fear and anxiety of pediatric dental patients. This study aimed to compare the efficacy of dental simulation game applications (apps) in smartphones and virtual reality glasses on the management of dental anxiety and fear in 5-8-year-old dental patients.

**Methods:** This randomized clinical trial was conducted on 42 eligible children between 5-8 years in their first dental visit. After prophylaxis and fluoride therapy, patients were randomly assigned to two groups (n=21). Group 1 used Virtual reality glasses during the procedure while group 2 used dental simulation game apps prior to treatment. After completion of dental procedure, dental anxiety and fear of children were recorded in both groups using the Facial Image Scale (FIS) and Modified Child Dental Anxiety Scale (MCDAS); and the results were compared by t-test and Mann-Whitney test (alpha=0.05).

**Results:** The FIS scores were not significantly different between the groups (P=0.068). However, the MCDAS scores showed significantly lower levels of dental anxiety and fear in the VR group compared with the app group (P=0.002).

**Conclusion:** Wearing Virtual reality glasses operating based on the distraction technique during dental procedures was more effective than preoperative use of dental simulation game apps for reduction of dental anxiety and fear of 5-8-year-old children.

**Key Words:** Dental Anxiety, Mobile Applications, Pediatric Dentistry, Virtual Reality.

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## 1- INTRODUCTION

Dental fear and anxiety is a common problem in pediatric dentistry, which can lead to some avoidant behaviors in children (1). Fear and anxiety during childhood can have significant adverse effects on brain functions throughout life (2). Thus, behavioral control of children in dental visits and creating a positive experience and attitude in them in this respect are among the main goals of pediatric dentists (1). Not paying attention to controlling dental fear and anxiety of children can make children reluctant to go to a dentist in the future (3), which is considered a failure according to McElory (1).

Several pharmaceutical and non-pharmaceutical approaches have been proposed for reduction of dental fear and anxiety of children and for their behavioral control. Pharmaceutical methods such as sedation or general anesthesia are often indicated for highly uncooperative children and those with underlying conditions; however, dentists and parents prefer non-pharmaceutical behavioral control methods for other children (4). Prior to commencing the procedure, Children can be familiarized with the dental office environment by the tell-show-do technique, live modeling by direct observation or by watching a movie, or by training the parents to prepare their children for a dental visit (1, 5).

Several other methods are also used during dental procedures to control pediatric patients' fear and anxiety. Distraction is a safe and highly efficient technique to control dental fear and anxiety of pediatric dental patients. Non-verbal communication, positive reinforcement, and occasionally voice control are among other approved techniques to control dental fear and anxiety of children (1, 6, 7).

By the advances in science and technology, some novel techniques are currently employed for this purpose, in addition to basic behavioral control approaches. Virtual reality (VR) glasses are a novel gadget used for entertainment, movies, and sports. In this technology, the user wears a headset or glasses, and a virtual environment is created in front of his eyes with visual and sensory stimuli (voice, vibration, and smell in more advanced devices).

The user can communicate with the virtual environment by head or body movements. This technique can prevent adverse behaviors of children in dental offices, since it is highly attractive for children and can cause their distraction. Accordingly, a pleasant memory about the dental visit is created for children (8).

Another novel technique that is currently used for this purpose is dental simulation game applications (apps) in smartphones that are highly favored by children. Several dental simulation apps are available that can be suggested to the parents. Playing with such games can cause positive imagery in children prior to their dental visit, decrease their anxiety, and increase their interest in dental treatment (9).

The efficacy of such novel approaches has been extensively studied, and their effectiveness, compared with the conventional approaches, has been confirmed in dental procedures (10-26). Considering all the above, this study aimed to compare the efficacy of dental simulation apps of smartphones and VR glasses for reduction of dental anxiety and fear of 5-8-year-old children in their first dental visit.

## 2- MATERIALS AND METHODS

### 2-1. Design and setting

This study was conducted at the Pediatric Dentistry Department of the

School of Dentistry in Tehran University of Medical Sciences. The study was a randomized clinical trial conducted, one group wore VR glasses during dental procedure and the other group used dental simulation apps, prior to the procedure. The results were reported in accordance with the guidelines of Consolidated Standards of Reporting Trials.

## 2-2. Sample size

According to the study done by Patel et al. (23) and Analysis Power Two-test Two-sample, the values of  $\alpha$ : 0.2,  $\beta$ : 0.5 and the standard deviation of 5.6 were considered. The Significance level was set at 0.05. Finally, the sample size was calculated as 21 children in each group.

## 2-3. Participants Randomization and Blinding

Among the 58 children eligible for entering the study, 46 samples were selected based on Frankl's behavior scale. The patients were randomly divided into two groups (21 individuals each), using randomization with selected block sizes. Blinding was necessary at the end of procedure and the interviewer who helped children to complete the questionnaire was not aware of grouping.

## 2-4. Inclusion and exclusion criteria

The inclusion criteria were (I) no systemic disease and no history of hospitalization, (II) no previous history of dental treatment, and (III) not requiring emergency dental treatment. Children who had acute pain or dental infection and needed emergency treatment as well as the children whose parents were not interested to participate in this study were excluded.

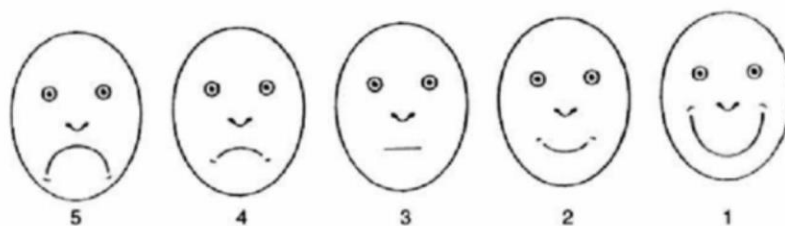
## 2-5. Interventions

In the first treatment session, the patients underwent prophylaxis and fluoride therapy and children with Frankl's behavior rating scale 3 or 4 (27) were

selected. The patients were randomly divided into two groups ( $n=21$ ). In both groups, the next appointment was set one week after the first dental visit as in specialized clinical conditions. In group 1, Parents of children were asked to download dental simulation game apps (Dentist Bling) and install them on their smartphone and ask their children to play the games one day before their dental visit. It included games related to dentistry and cartoon characters. In their dental visit, the treatment was performed after ensuring that children in this group had used the apps. In group 2, the patients were given VR glasses (VR box in combination with a cell phone) during the procedure in the second appointment and they watched an animation related to dentistry during the procedure. There were four animations which the child could choose among. The procedure was similar in all children and included the infiltration of anesthetic solution and pulpotomy and restoration of primary first molar and all procedures were done with the same operator. After completion of the treatment, children in both groups expressed their general feeling about the entire experience using the Facial Image Scale (FIS) (**Fig. 1**) (28). Also, someone blinded to group allocation of children helped them to answer the questions of the Modified Child Dental Anxiety Scale (MCDAS) (**Fig. 2**) (29) to determine their level of anxiety. In this questionnaire, a total score of 19 (for 9 questions) would indicate a high level of dental anxiety and phobia. No interim analyses were performed, and no stopping guidelines were established in this trial.

## 2-6. Statistical analysis

Data was analyzed through SPSS version 11 by the use of t-test and Mann-Whitney test.  $P < 0.05$  was considered statistically significant.



**Fig. 1:** Facial image scale used in this study (1: Very happy; 2: happy; 3: not happy not sad; 4: sad; 5: very sad)



How do you feel about ...	1	2	3	4	5
... going to dentist generally?	1	2	3	4	5
...having your teeth looked at?	1	2	3	4	5
...having your teeth scraped and polished?	1	2	3	4	5
... having an injection in the gum?	1	2	3	4	5
...having a filling?	1	2	3	4	5
...having a tooth taken out?	1	2	3	4	5
...being put to sleep to have treatment?	1	2	3	4	5
...having a mixture of 'gas and air ' which will help you feel comfortable treatment but cannot put you to sleep?	1	2	3	4	5

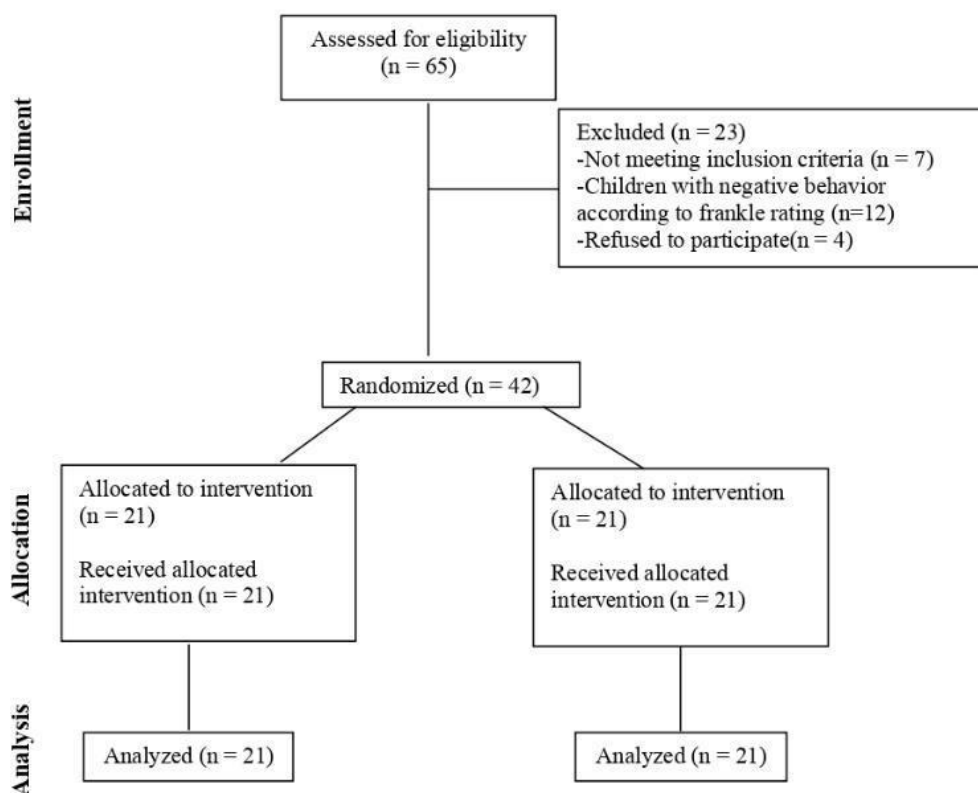
**Fig. 2:** Modified Child Dental Anxiety Scale (MCDAS) used in this study (1: Very happy; 2: happy; 3: not happy not sad; 4: sad; 5: very sad)

### 3- RESULTS

#### 3-1. Participant flow

The sample initially consisted of 58 children; out of which, 46 were selected since they were categorized as Frankl's

behavior scale 3 or 4. Among 46 patients, 4 were excluded since their parents did not consent to their participation in the study. **Fig. 3** shows the flow diagram of patient selection and allocation.



**Fig. 3:** The consort diagram of patient selection and allocation

A total of 42 children between 5-8 years were evaluated including 21 in the app group and 21 in VR group. All children had relatively good corporations during the study. **Tables 1** and **2** show gender and age distribution of the patients. Non-parametric Mann-Whitney test showed no significant difference in age between the two groups ( $P=0.12$ ).

### 3-2. Subgroup analyses

**Table 3** presents the frequency of FIS scores in the two groups. The frequency of very happy was the highest in both groups. The Mann-Whitney test showed no significant difference in FIS scores between the two groups ( $P=0.068$ ).

The mean MCDAS score was 14.90 ( $\pm 5.34$ ) and 10.80 ( $\pm 2.01$ ) in the app and VR groups, respectively. According to t-test results, the patients in the VR group experienced significantly lower levels of anxiety ( $P=0.002$ ).

## 4- DISCUSSION

This study compared the efficacy of dental simulation apps of smartphones and VR glasses in the reduction of dental anxiety and fear of 5-8-year-old children in their first dental visit. The results showed that the children in general did not have high levels of anxiety after the procedure; although when questioned about local anesthesia, the children reported high and very high levels of fear; however, the overall MCDAS score was  $< 19$ . In FIS, selection of almost happy and very happy faces had the highest frequencies. According to MCDAS, the fear score of children in the VR glasses group was lower, which was in line with the findings of studies showing that VR glasses decreased the level of fear and anxiety of children during dental procedures (13, 14, 17, 20, 22). Some studies did not find any significant effect of VR glasses on behavioral factors but

showed its positive effect on physiological parameters, e.g., children that used VR glasses had lower levels of salivary cortisol and lower heart rates (13, 20). Ghadimi et al. (16) reported a slight increase in the anxiety of children after watching the animation. It should be noted that younger children may still have anxiety despite such distractions, and it appears that the positive effects of novel behavioral control approaches may not be sufficient (16).

Many studies have shown that dental simulation game apps on smartphones decrease the level of anxiety of children during dental procedures (11, 15, 18, 19, 21-23). Patil et al. (18) reported a reduction by up to 50% in anxiety-related parameters due to dental procedures in children; for instance the group that used such apps had lower blood pressure and pulse rates, as well as more satisfying FIS scores, compared with the group in which conventional behavioral control techniques were applied. Cost-effectiveness and availability are the advantages of using dental simulation apps in smartphones (18).

In the present study, VR had a greater efficacy in reducing anxiety and led to expression of a better feeling by children. The VR technique that is based on distraction can better decrease the level of anxiety of children during the procedure. It is possible that smartphone apps may not be able to familiarize the child with the dental office environment. These apps are cost-effective and available; however, children might have not used them at the right time, or adequately. Thus, it appears that the dentistry environmental stimuli including type of procedure and equipment are too much to be borne by children, and distraction techniques should be preferably considered by dental clinicians for children over 5 years of age. It should be kept in mind that more interactive distraction techniques that

include visual, auditory, and tactile stimuli have greater potential for distracting children (23).

The behavior of children in a dental office can be influenced by age, personality, parenting style, parenting anxiety, medical and dental history of the child, knowledge about his/her dental problem, and type of dental environment (1,28). Children between 5-8 years were included in this study. It appears that this age group is highly suitable for the comparison of the efficacy of two behavioral control techniques, because according to Piaget's cognitive developmental stage, children in this age range, unlike 4-5-year-old children, have complete verbal and speech development, are independent of parents, and accept reality and rules (1,30). However, it has been demonstrated that due to higher levels of acquired anxiety in this age range, children between 6-7 years have considerable dental anxiety, while dental anxiety decreases in ages over 9 years. Thus, using behavioral control measures, especially the novel methods, is still highly necessary in this age group (31-34).

The two groups had no significant difference in terms of age distribution in the present study; thus, age was not a confounding factor. Also, patients with a history of previous dental visits were excluded to eliminate the possible confounding effect of previous experiences on the results. Evidence shows that in children, the level of stimulation decreases as they gain experience in the dental environment (28, 35). The acquired experience in previous dental visits helps children to cope with their stress due to dental procedures.

Future studies are required on the effect of apps and VR glasses on physiological parameters of children. Also, the novel behavioral techniques and their efficacy

for different age groups should be further investigated.

## 5- CONCLUSION

Both VR glasses and dental simulation apps are effective in reducing the anxiety of children. However, it seems that wearing VR glasses operating based on the distraction technique during dental procedures is significantly more effective than preoperative use of dental simulation game apps in the reduction of dental anxiety and fear among 5-8-year-old children. It is suggested to evaluate different kinds of new devices in different ages alone or in combination with the other basic techniques used in dental settings.

## 6- ETHICAL CONSIDERATIONS

The study was approved by the ethics committee of the university (IR.TUMS.DENTISTRY.REC.1400:186) and registered in the Iranian Registry of Clinical Trials (IRCT20220123053803N1). All parents signed informed consent forms for participation of their children in the study. And no patients were harmed during the study.

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