



# Effects of Virtual Reality Exposure Therapy on Dentophobia in Clients of Dental Offices in Isfahan, Tehran, and Shahrekord (Iran)

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## Abstract

**Background:** Dentophobia can reduce the number of regular visits to dentists and endanger the oral health of people. New technologies such as virtual reality (VR) can be used in the treatment of psychological problems such as dentophobia.

**Objectives:** The present study aimed to investigate the effectiveness of virtual reality exposure therapy (VRET) on dentophobia in clients of dental offices in the cities of Isfahan, Tehran, and Shahrekord in 2020.

**Methods:** The research method was quasi-experimental with a pre-test, post-test, and follow-up design and a control group. The statistical population of this study consisted of all clients with dentophobia visiting private dental clinics of Isfahan, Tehran, and Shahrekord in 2020. Thirty clients with dentophobia who were willing to participate in the research were selected as the sample using convenience sampling and randomly divided into experimental and control groups (n = 15 per group). The experimental group underwent eight sessions (15-minutes sessions per week) of virtual reality exposure therapy, while the control group received no intervention. The follow-up was performed after 45 days. The research instruments included the Modified Dental Anxiety Scale (MDAS), Samsung Gear 360 (2017 Edition), and HTC VIVE Pro Virtual Reality Headset. Data were analyzed using repeated-measures ANOVA.

**Results:** The results showed that virtual reality exposure therapy effectively decreased dentophobia in clients of dental offices in the experimental group ( $P = 0.0001$ ).

**Conclusions:** According to research findings, virtual reality exposure therapy was an efficient therapy for improving dentophobia and reducing phobia symptoms in clients of dental offices.

**Keywords:** Dental Anxiety, Dentistry, Psychotherapy, Virtual Reality

## 1. Background

Dentophobia, also known as odontophobia, is defined as the fear of dental interventions that originates from the wrong assumption that these interventions are harmful and dangerous (1). Studies show that 10 - 27% of adults experience moderate to high levels of dental anxiety, and 4 - 6% of them suffer from dentophobia (2, 3). It has also been shown that the prevalence of dentophobia is almost stable over time (4, 5). Yousefi and Piri (6) reported that the mean age of the onset of dentophobia is 12 years. The highest and the lowest prevalence rates of dentophobia are observed among people aged 15 - 33 and 55 - 65 years, respectively. Epidemiological studies have also indicated that 20 - 30% of people have fear of dental treatments, which can cause problems. Dentophobia can reduce the number of regular visits to dentists and endanger the oral health of people. When avoidance, anxiety prediction, or distress evidently interfere with one's normal routine, job functionality, so-

cial activities, or social relationships in frightening situations or cause substantial fear of dental interventions, this complication can be defined as dentophobia or dental anxiety (which is categorized as a specific phobia in the Diagnostic and Statistical Manual of Mental Disorders, DSM-5, 2013) (7, 8).

New technologies, such as virtual reality (VR), are now commonly applied in the treatment of psychological problems. Indeed, VR refers to a situation in which people of the age of information imagine a different experience in the real world to get rid of routine life (9). The main features of VR technology are high flexibility, high security, and the use of attractive images and visual effects. Since imagery is an important part of psychotherapy, VR exposes the clients to a score of images, colors, and sounds as well as real physical movements and activities to draw their attention to the virtual environment desired by the therapist and help them have a sense of presence, be in the present

moment, and get the gist of the point. A sense of presence is a prerequisite for feeling different emotions during the treatment (10, 11).

Rothbaum and Hodges (12) were the first who applied virtual reality exposure therapy (VRET) to treat fears and phobias. They prefer VR to VRET for the treatment of phobias for several reasons. First, VR has been proven beneficial and effective in the treatment of acrophobia and claustrophobia. Second, VRET is costly and difficult to plan, and all variables involved in the treatment cannot be controlled by the therapist. By contrast, VR provides a greater sense of presence and immersion than VRET. Moreover, it is not much easy to design virtual panic scenarios in VR (13). A successful virtual experience provides clients with such a real sense that they are completely immersed in (14). Since this feeling is created by pointing to real-world stimuli, only virtual stimuli may be seen or heard (15). Recent studies have shown that VR has been effective in the treatment of aerophobia (16), anxiety, depression, and stress (17), anxiety (18), acrophobia (19), basophobia (20), and glossophobia (21). Wald and Taylor (22) showed the effectiveness of this method in the treatment of amaxophobia, also known as ochophobia, motorphobia, or hamaxophobia. Some researchers argue that attractive environment, lack of fear of failure, lack of frustration with disabilities, movement perception, and movement observation are positive features of VRET and state that this method can motivate and encourage individuals, increase their self-confidence, and help them better control the conditions. VR therapy helps clients control and examine their adaptation to the existing conditions based on their needs with the help of a clinical psychologist. Another feature of this therapy is that it gives the client a sense of self-sufficiency, mastery, and self-efficacy (22-24).

As a result, VRET is a relatively new cognitive-behavioral approach that has been successfully applied to treat some specific subtypes of phobias, including claustrophobia, acrophobia, aerophobia, and arachnophobia. Moreover, VRET is performed in a computer-generated virtual environment that facilitates targeted exposure to fear-inducing stimuli. One of the greatest benefits of VRET is that clients face computer-generated counterparts of their frightening stimuli in a gradual and controlled manner under training and practice by a therapist (25). Some researchers have reported that VRET is better and a more effective method than exposure therapy in the treatment of anxiety disorders (26). However, VRET has a strong modifying effect due to its dramatic nature. Among the most important innovations and necessities of the present study, the following can be mentioned: making VRET appropriate to Iranian culture for the first time, its greater effectiveness compared to real face-to-face therapies, and also

the effectiveness of this treatment has not been studied in Iran so far. Since the highest rate of avoidance of dental treatments has been reported to be among people with the highest level of dental anxiety, it is necessary to treat such people.

## 2. Objectives

Accordingly, the present study aimed to investigate the effectiveness of virtual reality exposure therapy on dentophobia in clients of dental offices.

## 3. Methods

### 3.1. Participants

The research method was quasi-experimental with a pre-test, post-test, and 45-day follow-up design and a control group. The statistical population of this study consisted of all clients with dentophobia visiting private dental clinics of Isfahan, Tehran, and Shahrekord in 2020. The inclusion criteria were having dentophobia (getting a score of 25 on the modified dental anxiety scale), age range between 25 and 40 years, have at least a middle school level, no epilepsy, and migraine. Thirty clients with dentophobia who were willing to participate in the research were selected as the sample using convenience sampling and randomly divided into experimental (virtual reality exposure therapy) and control groups. We included 15 participants in each group by the use of G\*power statistical software. Randomization was done by the researcher after obtaining participants' consent, and participants were assigned to the groups by a coin-throwing method. The study was approved by the Ethics Committee of Islamic Azad University-Isfahan (Khorasgan) Branch (code: IR.IAU.KHUISE.REC.1399.167).

### 3.2. Research Instruments

#### 3.2.1. Samsung Gear 360 (2017 Edition)

The gear-360 camera applied in this study was manufactured by Samsung in 2017 to help produce VR content. As a major transformation in spherical imaging, this camera allows users to record their experiences in a variety of situations as a real-time panoramic VR movie (27). This model of VR camera is equipped with two 180-degree, 15-megapixel lenses that cover a total of 360 degrees. The videos and photos of this camera can be watched by smartphones equipped with a gyroscope sensor and a VR headset. The users who wear a VR headset can see the images recorded by the camera at the same angle by turning their head upside down in all directions, and they actually feel themselves functioning like a camera. Accordingly, they experience an audio-visual reality of the same location.

### 3.2.2. HTC VIVE Pro Virtual Reality Headset

The headset usually used for watching VR images is called HTC VIVE. This headset is equipped with two boxes consisting of 37 laser sensors that track the user's motions. These two boxes are placed at the corners of the VR environment to track the smallest motions of the user. Display quality is another strength of this headset; this headset is equipped with two displays with a resolution of  $1200 \times 1080$ , which together provide a resolution of  $1200 \times 2160$ . The viewing angle of the lenses used in this headset is also equal to 110 degrees. Since the weight of this headset is only 555 grams, it can be easily used for a long time. This headset has been designed in a way to fit the physique of the human face so that it may not cause fatigue or pain in the area around the eyes if used for a long time.

### 3.2.3. Modified Dental Anxiety Scale (MDAS)

The MDAS was first developed by Humphris et al. (28). This scale comprises five questions, each assessing the dental anxiety levels in different dental situations: first visit, in the waiting room, during dental trimming, during scaling, and during anesthesia. The items are scored based on a 5-point Likert scale: 1 = not anxious, 2 = slightly anxious, 3 = fairly anxious, 4 = very anxious, and 5 = extremely anxious. The maximum score on this scale ranges between 5 and 25, and scores equal to or greater than 25 indicate dentophobia. Humphris et al. (28) evaluated its reliability as 0.89. In addition, Javadinejad et al. (29) reported an alpha Cronbach coefficient of 0.85 for the Persian version of this scale. In the present study, Cronbach's alpha coefficient was 0.92 for the scale.

### 3.3. Procedure

First of all, three individuals with dentophobia and five cognitive-behavioral therapists were interviewed to achieve a hierarchy of scary dental situations to develop a VRET intervention. This hierarchy consisted of the following items: providing the participants with information on VR therapy and practicing muscle relaxation, seeing the dental office board, going up the stairs of the dental office, entering the dental office, entering the waiting room, sitting in the waiting room, entering the dentist's room after the secretary's announcement, seeing the dentist and sitting in the dental unit, wearing the special cover, dental examination by the dental mirror, local anesthesia or anesthetic ointment, seeing the anesthetic ampoule and the injection process, dental drilling, washing the mouth, and leaving the dental unit.

This hierarchy was then recorded in a real dental office by a gear-360 camera. To assess the content validity, the resulting video was sent to 5 experts in VR therapy and cognitive-behavioral therapy to elicit their views

about color, duration, order of presentation, and audiovisual content of the video. After making the necessary corrections, the final video was sent to them once again, and then the inter-rater agreement coefficient on the content of the video was calculated by the content validity index (CVI). Since CVI was equal to 0.9, it can be stated that the content of the final video was acceptably valid. To investigate the effectiveness of this therapy, 30 individuals with dentophobia who met the inclusion and exclusion criteria were selected based on the convenience sampling method. The participants were randomly assigned to the test and control groups (15 participants apiece). The experimental group underwent eight sessions (15-minutes sessions per week) of virtual reality exposure therapy, while the control group received no intervention. All of the participants completed the research questionnaire before and after the intervention and also 45 days later. It is noteworthy that the participants had full control over the situations during VRET, and the intervention was discontinued whenever they became anxious in the face of some scenes.

### 3.4. Statistical Analyses

Data were analyzed by descriptive and inferential statistics, such as mean, standard deviation, and repeated measures ANOVA. SPSS version 24.0 was further used to analyze the data.

## 4. Results

The participants included 30 males and females with dentophobia. According to the descriptive statistics, the mean age of participants in the experimental group was  $36.72 \pm 5.23$  years, whereas the control group was aged  $37.24 \pm 6.52$  years. The demographic variables of the participants are shown in Table 1. Table 2 shows the mean and standard deviation (SD) of dentophobia in the experimental and control groups in the pre-test, post-test, and follow-up stages. Based on Table 2, the mean score of dentophobia was significantly reduced in the experimental group in the post-test and follow-up stages.

The normal distribution of scores was examined by the Kolmogorov-Smirnov test. The results showed that the pre-test, post-test, and follow-up mean scores of dentophobia followed a normal distribution in both groups. Then Levene's test was employed to test the equality of variances. The results confirmed the equality of variances in pre-test ( $F = 0.073$ ,  $P = 0.789$ ), post-test ( $F = 4.45$ ,  $P = 0.052$ ), and follow-up ( $F = 3.22$ ,  $P = 0.083$ ) stages. The results of Mauchly's sphericity test rejected the homogeneity of variances between the two groups ( $P < 0.05$ ). Therefore, a

**Table 1.** Demographic Variables of the Participants <sup>a</sup>

Groups	Mean $\pm$ SD Age (y)	Education			Marital Status		Gender	
		Middle School Degree	High School Education	College Education	Married	Single	Male	Female
Experimental	36.72 $\pm$ 5.23	4 (26.67)	7 (46.66)	4 (26.67)	9 (60.00)	6 (40.00)	8 (53.33)	7 (46.67)
Control	37.24 $\pm$ 6.52	5 (33.33)	4 (26.67)	6 (40.00)	8 (53.33)	7 (46.67)	9 (60.00)	6 (40.00)

<sup>a</sup> Values are expressed as No. (%) unless otherwise indicated.

**Table 2.** Mean and Standard Deviation (SD) Of Dentophobia in the Experimental and Control Groups in the Pre-test, Post-test, and Follow-Up Stages

Variables/Phases	Experimental Group	Control Group	P-Value
<b>Dentophobia</b>			
Pre-test	19.60 $\pm$ 2.58	18.42 $\pm$ 2.72	0.684
Post-test	8.33 $\pm$ 0.82	18.00 $\pm$ 2.33	0.001
Follow-up	7.93 $\pm$ 1.28	17.93 $\pm$ 2.46	0.001

<sup>a</sup> Values are expressed as mean  $\pm$  SD.

conservative test like the Greenhouse-Geisser test was employed in the repeated measures ANOVA for intra-subject analysis.

The multivariate test results using Wilks' Lambda and Pillai's Trace about the mean score of dentophobia were influenced by time ( $F = 219.95$ ,  $P = 0.001$ ), and the time-group interaction ( $F = 186.76$ ,  $P = 0.001$ ) indicated a significant difference between the two groups in terms of the effect of time and time-group interaction (pre-test, post-test, follow-up) as well as the effect of time on groups.

According to Table 3, there was a significant difference between the test and control groups in the mean score of dentophobia ( $P = 0.001$ ). The results showed that 73% of individual differences were related to differences between the two groups. The results of the intra-subject analysis indicated that there was a significant difference between the post-test and follow-up mean scores (effect of time) ( $P = 0.001$ ). The time-group interaction also caused a significant difference in this variable ( $P = 0.001$ ). In other words, there was a significant difference between the experimental and control groups in the mean score of dentophobia in the three research stages.

The results of Bonferroni post-test regarding a comparison of the experimental and control groups in the three research stages in terms of the mean scores of dentophobia as well as a comparison between the post-test and follow-up mean scores in the experimental group to examine the treatment stability are presented in Table 4. According to Table 4, there was no significant difference between the two groups in the symptoms of dentophobia in the pre-test stage ( $P > 0.05$ ), whereas a significant difference was observed between them in the post-test and follow-up

stages ( $P = 0.001$ ). In other words, VRET reduces the post-test mean score of dentophobia signs in the experimental group; this reduction was stable until the follow-up period.

## 5. Discussion

The present study aimed to investigate the effectiveness of virtual reality exposure therapy (VRET) on dentophobia in clients of dental offices in the cities of Isfahan, Tehran, and Shahrekord in 2020. The results showed that VRET decreased dentophobia in clients of dental offices in the experimental group. This finding is consistent with the research results of Rasti et al. (16), Freeman et al. (19), Levy et al. (20), and Alshatrat et al. (30). Moreover, Rasti et al. (16) reported that VRET was effective in diminishing fear of flying in subjects with flying phobia. Freeman et al. (19) showed VR treatment reduced fear of heights at the end of treatment, and evidence-based VR treatments had the potential to greatly increase treatment provision for mental health disorders.

To explain the study findings, it can be stated that people with dentophobia are much more willing to face and treat their fears under safe conditions. Compared to traditional therapies, VR offers many interesting advantages and acceptable applications (31). Attractive environment, no fear of failure, no frustration with disabilities, and movement imagination and observation are among the positive features of VR environments that can motivate and encourage people and increase their self-confidence and control over conditions (23). Although people with dentophobia tend to experience and recognize situations that are threatening to them, they face them more easily

**Table 3.** Repeated Measurement Results for the Effects of Time and Interaction Time and Group

Variable/Sources	SS	df	MS	F	P	$\eta^2$	
<b>Dentophobia</b>							
Group	852.54	1	825.54	73.90	0.001	0.73	1.00
Time	708.87	1.404	504.97	294.58	0.001	0.91	1.00
Time $\times$ group	609.89	1.404	433.89	253.12	0.001	0.90	1.00

**Table 4.** Bonferroni Post-hoc Test Results of Pairwise Comparisons

Variable/Phase A/Phase B	Mean difference (A-B)	SE	P-Value
<b>Dentophobia</b>			
Pre-test			
Post-test	-9.66	0.637	0.001
Follow-up	-10.00	0.717	0.001
Post-test			
Follow-up	0.40	0.273	0.493

in the virtual world than in the real world. Since the virtual world makes people feel competent, dominant, and efficient, they will feel higher levels of perseverance, power, and capability in interaction with the environment. That is why VR therapy can quickly reduce the anxiety level of patients.

On the other hand, the virtual world helps people to revive their past, revisit their fears and phobias, and better get to know themselves and their emotions. In fact, people test the reality to rediscover their skills and emotional arousals in this treatment and become aware of the vague aspects of their emotions. Also, VR helps people to face their fears and phobias and reduce their sensitivity to such situations through repeated exposure to them (30). In other words, one faces frightening situations without the need for mental imagery. Since several senses are involved simultaneously, one can easily identify the causes of their fears and phobias without having problems with mental imagery.

This study faced some limitations. For example, since it was conducted on people with dentophobia in Tehran, Isfahan, and Shahrekord, its findings cannot be generalized to the whole population of Iran. Moreover, physiological parameters such as heart rate and blood pressure of participants were not measured in this study. It is hence recommended that similar studies should be conducted on people with dentophobia in other cities and medical centers of Iran. Future studies are also recommended to measure the physiological parameters of participants, such as heart rate and blood pressure, during this treatment.

### 5.1. Conclusion

The study findings showed that VRET decreased dentophobia in clients with dental anxiety. Automatic psychological therapy performed by VRET can have many clinical benefits. Virtual reality exposure therapy has the potential to greatly increase the provision of treatment for mental health disorders.

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### Footnotes

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**Conflict of Interests:** No conflict of interest to declare.

**Ethical Approval:** The study was approved by the Ethics Committee of Islamic Azad University-Isfahan (Khorasgan) Branch (code: IR.IAU.KHUISE.REC.1399.167).

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