Turkish Journal of Dental Hygiene
2025, Volume 5, Page No: 16-23

Available online at: www.tsdp.net

ISSN: 3062-3472

Original Article

Effectiveness of Virtual Reality-Based Training on Dental Plaque in Female High School Students

Ai-Hua Chang[1], Pei-Chen Lin[1], Pei-Chao Lin[2,3], Yi-Ching Lin[4], Yuji Kabasawa[5], Cheng-Yu Lin[6], Hsiao-Ling Huang[1]*

[1]Department of Oral Hygiene, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung 807, Taiwan.
[2] College of Nursing, Kaohsiung Medical University, Kaohsiung 807, Taiwan.
[3] Center for Long-Term Care Research, Kaohsiung Medical University, Kaohsiung 807, Taiwan.
[4] School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung 807, Taiwan.
[5] Oral Care for Systemic Health Support, Faculty of Dentistry, School of Oral Health Care Sciences, Graduate School, Tokyo Medical and Dental University, Tokyo 113-8510, Japan.
[6] Department of Radio, TV & Film, Shih Hsin University, Taipei 116, Taiwan.

***E-mail** ✉ hhuang@kmu.edu.tw

Received: 15 February 2025; **Revised:** 27 March 2025; **Accepted:** 29 March 2025

ABSTRACT

This study aimed to compare the effectiveness of supragingival plaque removal after oral hygiene education using virtual reality (VR) software in female secondary school students. This study was conducted as a field clinical trial on 90 students. Three schools were randomly selected and their PI (plaque index) was recorded using a standard method during clinical examination. The schools were divided into three groups. In the first group, oral hygiene education was provided in one session based on virtual reality. In the second group, oral hygiene education was provided orally in one session, and the third group was a control group in which no education was provided. After one month, all three groups were re-examined and the PI index was measured. Based on the results, the mean plaque on the teeth under study in the virtual reality group showed a statistically significant decrease after the intervention compared to before ($P < 0.001$). The mean plaque in the oral education group showed a statistically significant decrease after the intervention compared to before the intervention ($P = 0.014$). This difference was significant in the virtual reality and oral education groups compared to the control group ($P < 0.01$). The findings indicate that oral health education in general and virtual reality-based education, in particular, are effective in removing dental plaque and in improving and promoting oral health.

Keywords: Dental, Dental plaque, Virtual reality-based training, Students

How to Cite This Article: Chang AH, Lin PC, Lin PC, Lin YC, Kabasawa Y, Lin CY, Huang HL. Effectiveness of Virtual Reality-Based Training on Dental Plaque in Female High School Students. Turk J Dent Hyg. 2025;5:16-23. https://doi.org/10.51847/nNZ42iryyY

Introduction

Dental plaque consists of a biofilm of microorganisms on the tooth surface that play an important role in the etiology of caries and periodontal disease [1-3]. Gram-negative and Gram-positive bacteria present on the surface of dental plaque can cause gingivitis, which, if left untreated, can lead to gingivitis and periodontitis [4, 5]. The chronic form of gingivitis is observed in more than 90% of people and is accompanied by redness, swelling, bleeding, and sometimes bad breath. Periodontitis is a condition in which the gums and supporting tissues of the teeth are destroyed, which manifests as inflammation, bleeding, and redness of the

gums, often accompanied by periodontal pockets and may even cause tooth loss [6]. Plaque control is an effective way to treat and prevent gingivitis and is an essential part of all periodontal disease treatment and prevention methods [7-9].

Tooth brushing is performed to remove plaque and debris from the tooth surface and maintain the health of the teeth and periodontal tissues. However, its use index is low. In addition, most people are unable to remove dental plaque, and daily experiences of dentists show that dental plaque is present even in people who observe oral hygiene, which indicates the inadequacy of traditional methods of hygiene education; therefore, brushing alone does not mean cleaning the tooth surfaces, but the technique used, the duration of brushing, and physical factors such as hand pressure also affect this process. The American Dental Association recommends brushing twice a day with gentle pressure and rotational or vibrating movements [10, 11]. However, the modified bass brushing technique, which emphasizes the removal of dental plaque, is also often recommended [12-14].

Carrying out health activities requires having sufficient information and knowledge that leads to motivation and ultimately the formation of behavior, but in most cases, the presence of knowledge alone does not cause behavior change. As with the measures taken, the DMFT index is still high. Therefore, for health education to be effective, newer ways must be sought [11, 15].

Studies have shown that the use of video-based instructional formats has been very effective in teaching oral hygiene to individuals with mental retardation, even when using manual toothbrushes [16-18]. Thanks to the widespread availability of mobile phones, laptops, and computers, the impact of health education through these media is undeniable. In particular, the positive impact of such programs on caring for other parts of the body has also been demonstrated [19, 20].

The impact of multimedia software in an educational format such as virtual reality simulation in oral hygiene education has not been fully studied. Virtual reality is a computer program that, by bringing together multiple senses, evokes the real world for the user [21]. Given the increasing use of virtual reality technology, examining the audience's visual perception is one of the key issues in the human-environment relationship with this technology, which can be of particular importance in recognizing and promoting its educational, research, and design capabilities in the field of health and hygiene [22, 23].

In previous studies conducted in the field of virtual reality, the effectiveness of this medium in education has been proven [24-27].

Considering the priority of prevention over treatment and the low level of culture of the majority of society in the field of oral and dental health and the high costs resulting from improper performance in this field, we decided to use new methods of oral health education. By using virtual reality simulation and the use of three-dimensional environments and objects, we seek to teach the correct and principled method of oral and dental health and involve people in this process. Therefore, this study was conducted to investigate the effect of teaching the correct way to observe oral and dental health based on virtual reality simulation on dental plaque in female students.

Materials and Methods

The present study was a randomized controlled field trial conducted on 90 female students. The inclusion criteria in the study were mild to moderate gingivitis, no systemic diseases, no continuous use (for 6 months) of medication, and no orthodontic treatment. The exclusion criteria included dissatisfaction, withdrawal, and unwillingness to cooperate with the project. The sample size was calculated based on the formula for comparing two means and based on the results of the pilot study on 10 students in the virtual reality group.

Three schools that were geographically located in the city center and had a mix of students from different social levels were selected. In total, 230 students were examined in 3 schools, and 90 students with mild to moderate gingivitis were selected for the project. In each school, 3 groups of 10 students were randomly formed (virtual reality training group, oral training, and control group).

PI was measured by clinical examination and using a detector tablet. Sampling was performed in the shade using natural light and on a chair while the examiner was positioned in front of each sample using a mirror and Abeslang. At the beginning of the work, demographic information including the age and education level of the student's parents was recorded.

To examine dental plaque, the mouth was divided into 6 sextants. The index teeth were teeth 46, 36, 26, 16, 11 and 21. The FDI (Federation Dentaire International) system was used to name the teeth. In this method, each tooth is coded with two digits. The first digit indicates the patient's jawbone, which is assigned a number from one to four (1: upper right, 2: upper left, 3: lower left, and 4: lower right) and the second digit indicates the tooth number, which is numbered from one to eight from the central tooth area towards the third molar. In

this study, the Quigley-Hein plaque index, which is coded from zero to 5, was used. The highest degree of plaque seen on an index tooth surface was assigned to the entire corresponding tooth, and then the index plaque in each individual was calculated and recorded by summing the plaque of the index teeth and dividing it by 6.

In the first group, after the initial examination and recording of the plaque index after using the detector tablet, each student put on a virtual reality headset and watched two 3D videos on the correct way to brush their teeth according to the Modified Bass technique and the correct way to floss their teeth. The detector tablet and its function are also introduced in one session. The second group was examined like the first group and the index plaque was recorded. Then, with the help of a tooth model, toothbrush, and dental floss, the previous educational items were taught orally in one session. The third or control group did not receive an educational plaque after the initial examination and index registration. After completing the first stage, about a month later, all three groups were re-examined and the final index plaque was recorded. To comply with ethical principles, health education was given to the control group after completing the second examination.

After collecting the information, the data were entered into SPSS version 23 software and, while providing descriptive statistics, the normal distribution of the data was examined using the Kolmogorov-Smirnov test. Considering the age of the subjects with a normal distribution, the one-way analysis of variance test was used, and regarding the dental plaque variables, considering the lack of a normal distribution, the non-parametric, Mann-Whitney, and Wilcoxon statistical tests were used. Fisher's exact test was used to compare qualitative variables in the three groups. The significance level was considered ($\alpha = 0.05$) in all cases.

Results and Discussion

This study was conducted on 90 students in three groups of 30 (virtual reality training, verbal training, and control group). The mean age and frequency distribution of parental education level in the three study groups did not show any statistically significant difference, with P-values for parental age and education level being 0.38 and 0.52, respectively **(Tables 1 and 2)**.

Table 1. Comparison of mean age in the three study groups

Group \ Statistical index	Mean ± standard deviation	ANOVA statistical test result
Virtual reality training	16.8 ± 0.92	P = 0.38
Verbal training	17.1 ± 0.84	
Control group	17.1 ± 0.94	

Table 2. Comparison of the frequency distribution of parental education levels in the three study groups

Variable name	Study group	Virtual reality training	Verbal training	Control group	Fisher's exact test result
Mother's education level	Illiterate	0 (0%)	2 (6.7%)	0 (0%)	P = 0.52
	Underdiploma	16 (53.3%)	20 (66.7%)	19 (63.3%)	
	Diploma	8 (26.7%)	4 (13.3%)	7 (23.3%)	
	University	6 (20%)	4 (13.3%)	4 (13.3%)	
Father's education level	Illiterate	0 (0%)	2 (6.7%)	3 (10%)	P = 0.52
	Underdiploma	14 (46.7%)	16 (53.3%)	17 (56.7%)	
	Diploma	8 (26.7%)	4 (13.3%)	4 (13.3%)	
	University	8 (26.7%)	8 (26.7%)	6 (20%)	

The mean dental plaque index of 16 in the virtual reality (VR) group showed a significant decrease after the intervention ($P < 0.001$); while in the other two groups, no statistically significant difference was observed in the mean plaque index before and after the intervention (oral group $P = 0.07$ and control group $P = 0.56$). The mean changes also showed that the mean changes in the plaque index in the VR group were significantly higher than in the control group ($P = 0.002$) **(Table 3)**.

The mean dental plaque index of 11 in the VR and oral groups showed a statistically significant decrease after the intervention compared to before the intervention (VR group $P < 0.001$ and control group $P = 0.04$), and the mean changes in the plaque index in the VR group with the other two groups and also in the oral group with the control group showed a statistically significant

difference (VR group with oral P = 0.006, VR group with control P < 0.001, and oral group with control P = 0.019).

The mean plaque index of 21 in the VR group showed a significant decrease after the intervention compared to before the intervention (P < 0.001); while there was no significant difference in the other two groups (oral group P = 0.06 and control group P = 0.49). In addition, the decrease in plaque index in the VR group was significantly higher than in the oral and control groups (VR group with oral P = 0.01, VR group with control P < 0.001) **(Table 3)**.

Table 3. Comparison of mean plaque of teeth 16, 11, and 21 before and after the intervention in the 3 study groups

Tooth number	Group	Before intervention (Mean ± SD)	Before intervention (Median (Q1-Q3)*)	After intervention (Mean ± SD)	After intervention (Median (Q1-Q3)*)	Wilkation statistical test	Changes (Mean ± SD)
16	Virtual reality training	3.13 ± 1.1	4 (2-4)	3.27 ± 1.17	2 (1-3)	P < 0.001	-0.87 ± 0.94
	Verbal training	1.13 ± 2.77	3 (2-3)	1.27 ± 2.33	4 (1-4)	P = 0.07	-0.43 ± 1.3
	Control group	1.04 ± 2.4	2 (1.75-3)	1.09 ± 2.3	4 (0.75-3)	P = 0.56	-0.1 ± 0.8
11	Virtual reality training	2.8 ± 1.3	3 (2-4)	1.77 ± 1.27	2 (1-3)	P < 0.001	-1.03 ± 0.72
	Verbal training	2.77 ± 1.45	3 (1-4)	2.1 ± 3.53	4 (1-4)	P = 0.04	-0.47 ± 1.17
	Control group	1.6 ± 1.59	1 (0-3)	1.87 ± 1.45	2 (0-0.25)	P = 0.22	0.27 ± 1.08
21	Virtual reality training	2.63 ± 1.1	3 (2-4)	1.73 ± 1.23	2 (1-3)	P < 0.001	-0.9 ± 0.88
	Verbal training	2.73 ± 1.46	3 (1-4)	2.1 ± 33.54	2 (1-4)	P = 0.06	-0.4 ± 1.01
	Control group	1.47 ± 1.5	1 (0-3)	1.67 ± 1.35	2 (0.75-3)	P = 0.49	0.2 ± 1.29

*First quartile to the third quartile

The mean plaque index of 26 in the VR group before and after the intervention showed a statistically significant difference (P < 0.001); while in the other two groups, this difference was not statistically significant (oral group P = 0.06 and control group P = 0.19). Also, the mean plaque index changes in the VR group were significantly higher than the other two groups, and in the oral group were also significantly higher than the control group (VR group with oral P = 0.001, VR group with control P < 0.001, oral group with control P < 0.046) **(Table 4)**.

No significant difference was observed in the mean plaque index of 46 before and after the intervention in the three study groups (VR group P = 0.23, oral group P = 0.67, and control group P = 0.59) **(Table 4)**.

The mean dental plaque index of 36 in the VR group showed a statistically significant decrease after the intervention (P < 0.001), and the comparison of the mean changes showed that it was significantly higher in the VR group than in the other two groups (VR group with oral P = 0.004, VR group with control P < 0.001) **(Table 4)**.

Table 4. Comparison of average plaque on teeth 26, 46, and 36 before and after intervention in the 3 study groups

Tooth number	Group	Before intervention (Mean ± SD)	Before intervention (Median (Q1-Q3)*)	After intervention (Mean ± SD)	After intervention (Median (Q1-Q3))	Wilkation statistical test	Changes (Mean ± SD)
26	Virtual reality training	3.2 ± 0.85	3 (3-4)	2.27 ± 0.91	2 (2-3)	P < 0.001	-0.93 ± 0.69
	Verbal training	2.43 ± 1.43	3 (1-3)	2.1 ± 13.11	2 (1-3)	P = 0.06	-0.3 ± 0.79
	Control group	2 ± 0.98	2 (1-3)	2.3 ± 1.37	2 (1-3.25)	P = 0.19	0.2 ± 1.24
46	Virtual reality training	2.13 ± 0.78	2 (2-2)	1.93 ± 0.87	2 (1-2)	P = 0.23	-0.2 ± 0.85

	Verbal training	2.07 ± 1.01	2 (1-3)	1 ± 2.17	2 (1-3)	P = 0.67	-0.07 ± 1.11
	Control group	2 ± 0.91	2 (1-2)	2.1 ± 0.96	2 (1.75-3)	P = 0.59	0.1 ± 0.96
36	Virtual reality training	2.23 ± 0.68	2 (2-3)	1.53 ± 0.94	2 (1-2)	P < 0.001	-0.7 ± 0.75
	Verbal training	1.93 ± 0.98	2 (1-3)	1.1 ± 83.02	2 (1-2)	P = 0.44	-0.1 ± 0.71
	Control group	1.83 ± 0.87	2 (1-2.25)	2.13 ± 1.11	2 (1-3)	P = 0.22	0.3 ± 1.21

*First quartile to the third quartile

Based on the data in the table above, the mean plaque in all teeth in the VR and oral groups showed a statistically significant decrease after the intervention compared to before the intervention (VR group P < 0.001 and oral group P = 0.014), and these changes in the VR group were higher than in the other two groups and the oral group also showed a significant difference with the control group (VR group with oral P = 0.002, VR group with control P < 0.001, oral group with control P = 0.01) **(Table 5)**.

Table 5. Comparison of the average total plaque of teeth before and after intervention in the 3 study groups.

Time / Group	Before intervention (Mean ± SD)	After intervention (Mean ± SD)	Result of Wilcoxon statistical test	Changes (Mean ± SD)
Virtual reality training	2.69 ± 0.62	1.92 ± 0.77	P < 0.001	-0.77 ± 0.46
Verbal training	2.45 ± 0.91	2.0 ± 16.95	P = 0.014	-0.29 ± 0.62
Control group	1.88 ± 0.79	2.06 ± 0.91	P = 0.29	0.18 ± 0.76

Based on the results obtained, both verbal training and training based on virtual reality simulators have been effective in reducing the plaque index; however, the benefits of health training based on computer systems are their standardization, transparency, and repeatability.

In face-to-face training, it is difficult to accurately transfer educational movements and topics and to understand and perform these movements equally with the trainer and the trainee. In addition, when training is solely based on a computer system, the person being trained can more easily focus on the educational topic as desired due to the absence of an observer and the emotional interactions encountered in face-to-face training, such as feelings of shame or embarrassment, which can be one of the most important reasons why virtual reality training is more effective than verbal training in our study. However, according to the results obtained in cases where there are insufficient facilities for training based on modern methods such as virtual reality, the effect of the therapist's words on the treatment process and the correction of incorrect health habits and teaching the correct way to do it are of great importance. Therefore, in addition to focusing on therapeutic measures, healthcare staff should always pay special attention to health education, even at the level of short oral education, especially in the field of oral health.

Other studies have been conducted to learn health skills in the field of oral health, including the study by Lim *et al*. [16]. The results showed that the average percentage of plaque and bleeding decreased significantly compared to the initial start, but there was no significant difference between the different oral health education groups. Regarding the effect of educational intervention on the process of plaque reduction, this study is consistent with our study, but it is contradictory regarding the lack of difference between different educational methods, which is due to the use of personal education methods, self-education books, videos, and a combination of 2 or more of these educational methods in this study [16].

Yamaguchi *et al*.'s study showed that the average caries removal score in the second and third sessions reached over 98, which was an increase of 3 points compared to the first session, and the average scores obtained in the assessment of pocket depth were measured at 1.2, 2.7, and 3.3 sessions, respectively, which is a significant increase compared to the values measured before the training sessions [28]. This study also shows the effectiveness of the virtual reality simulator in learning dental skills in the results consistent with the present study [28].

In the study of Jasinevicius *et al*. although no difference was observed in the quality of work of the two groups, the training time of the VR students was one-fifth of the CS group, which shows the effectiveness of VR in the training process, which is in line with our study [24].

In the study of Fakhruddin *et al*. which aimed to compare the pain and anxiety of children during pulpotomy of primary molar teeth using the technique of playing a video in virtual reality and without playing a video, it was shown that the use of virtual reality glasses has a significant effect on reducing pain and anxiety in children during pulpotomy of primary molar

teeth [29]. In addition, children who were used to this technique in the first session were eager to use it in the next session, and overall, children paid less attention to the dentist's work process during work, which is consistent with the results of the present study [29].

In the study by Harnacke *et al*. they observed a significant increase in health skills and improvement of gingivitis using computer-based training, especially in the Fones technique, which is consistent with the present study and shows the effectiveness of this new educational method [30].

VR environments have also been used in other areas of health and treatment in the training process of medical and nursing students and medical staff in other fields, which have been associated with positive results similar to our study [31, 32].

A pilot study by Maresky *et al*. aimed at using a VR environment in teaching first-year medical students to learn cardiac anatomy demonstrated the effectiveness of VR in teaching cardiac anatomy, showing that VR provides an anatomically correct and comprehensive VS environment that allows the learner to interact with cardiac anatomy, which is in line with our study in terms of the impact of virtual reality on the educational process [27].

What was obtained from the results of the present study and many other studies discussed is that the effectiveness of VR in the educational field, especially in the field of health and treatment, is undeniable; although, as mentioned in some studies, due to the lack of studies in this field and the cost and complexity of the process of building a virtual reality simulator, it may not be possible to use it with certainty as a substitute for traditional educational or therapeutic methods; but as a supplement and educational aid, it will definitely be helpful and may, in the near future, with increased research in this field, be a leader in education and even treatment in the field of health and wellness, especially in the field of oral hygiene; because, given the great impact of oral and dental problems on an individual's health and the heavy costs that dentistry imposes on people and the economy of society, the need for a fundamental change in the oral and dental health education process is strongly felt.

In virtual reality, by being in a virtual environment, the user, in addition to feeling physically present in the environment, is fully interacting with the environment without access to the real world. As a result, this interaction removes the limitations of the real world from the learner and allows the user to focus on educational matters completely without intermediaries in a simulated environment, regardless of the surrounding conditions. As in the present study, being in this new environment was more attractive to the students and the dropout rate for the follow-up session was much lower than in the other two groups.

Conclusion

This study aimed to compare the effectiveness of supragingival plaque removal after oral hygiene education using virtual reality (VR) software in female secondary school students. The findings of this study indicate that oral health education in general and VR education, in particular, can significantly reduce the average dental plaque in students compared to the control group. Therefore, by emphasizing the benefits of VR as an emerging educational technology and removing its potential barriers, an important step can be taken in promoting and improving oral health in society.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

References

1. Marsh P. Microbiological aspects of the chemical control of plaque and gingivitis. J Dent Res. 1992;71(7):1431-8. doi:10.1177/00220345920710071501
2. Vyas T, Bhatt G, Gaur A, Sharma C, Sharma A, Nagi R. Chemical plaque control - A brief review. J Family Med Prim Care. 2021;10(4):1562-8. doi:10.4103/jfmpc.jfmpc_2216_20
3. Cenzato N, Occhipinti C, D'amici E, Savadori P, Baldini B, Maspero C. Microbiological analysis of plaque and its composition in three patient groups under different orthodontic treatments. Dent J. 2024;12(6):168. doi:10.3390/dj12060168
4. Stuart LF. The history of oral hygiene products: How far have we come in 6000 years? Periodontol 2000. 1997;15:7-14. doi:10.1111/j.1600-0757.1997.tb00099.x
5. Rosema NA, Timmerman MF, Versteeg PA, van Palenstein Helderman WH, Van der Velden U, Van der Weijden G. Comparison of the use of different modes of mechanical oral hygiene in the prevention of plaque and gingivitis. J Periodontol. 2008;79(8):1386-94. doi:10.1902/jop.2008.070654

6. Simon H. Periodontal disease. USA Cynthiachevins Pub. 2002;5(3):1-5.
7. Erbe C, Temming T, Ohlendorf D, Schmidtmann I, Mundethu A, Ferrari-Peron P, et al. Comparison of different plaque indices with regard to sensitivity and specificity for the quantification of plaque during orthodontic therapy. Sci Rep. 2022;12(1):20947. doi:10.1038/s41598-022-24817-y
8. Ramezaninia J, Naghibi Sistani MM, Ahangari Z, Gholinia H, Jahanian I, Gharekhani S. Comparison of the effect of toothbrushing education via video, lecture and pamphlet on the dental plaque index of 12-year-old children. Children. 2018;5(4):50. doi:10.3390/children5040050
9. D'Elia G, Floris W, Marini L, Corridore D, Rojas MA, Ottolenghi L, et al. Methods for evaluating the effectiveness of home oral hygiene measures—A narrative review of dental biofilm indices. Dent J. 2023;11(7):172. doi:10.3390/dj11070172
10. Sälzer S, Slot DE, Dörfer CE, Van der Weijden GA. Comparison of triclosan and stannous fluoride dentifrices on parameters of gingival inflammation and plaque scores: A systematic review and meta-analysis. Int J Dent Hyg. 2015;13(1):1-7. doi:10.1111/idh.12072
11. Soldo M, Matijević J, Malčić Ivanišević A, Čuković-Bagić I, Marks L, Nikolov Borić D, et al. Impact of oral hygiene instructions on plaque index in adolescents. Cent Eur J Public Health. 2020;28(2):103-7. doi:10.21101/cejph.a5066
12. Deery C, Heanue M, Deacon S, Robinson P, Walmsley A, Worthington H, et al. The effectiveness of manual versus powered toothbrushes for dental health: A systematic review. J Dent. 2004;32(3):197-211. doi:10.1016/j.jdent.2003.11.006
13. Petker W, Weik U, Margraf-Stiksrud J, Deinzer R. Oral cleanliness in daily users of powered vs. manual toothbrushes – A cross-sectional study. BMC Oral Health. 2019;19:96. doi:10.1186/s12903-019-0790-9
14. de Jager M, Rmaile A, Darch O, Bikker JW. The effectiveness of manual versus high-frequency, high-amplitude sonic powered toothbrushes for oral health: A meta-analysis. J Clin Dent. 2017;28(1 Spec No A):A13-28.
15. Rafatjou R, Razavi Z, Tayebi S, Khalili M, Farhadian M. Dental health status and hygiene in children and adolescents with type 1 diabetes mellitus. J Res Health Sci. 2016 Summer;16(3):122-6.
16. Lim L, Davies W, Yuen K, Ma M. Comparison of modes of oral hygiene instruction in improving gingival health. J Clin Periodontol. 1996;23(7):693-7. doi:10.1111/j.1600-051X.1996.tb00595.x
17. Goyal S, Thomas BS, Bhat KM, Bhat GS. Manual toothbrushing reinforced with audiovisual instruction versus powered toothbrushing among institutionalized mentally challenged subjects–A randomized cross-over clinical trial. Med Oral Patol Oral Cir Bucal. 2011;16(3):e359-64. doi:10.4317/medoral.16.e359
18. Rajab LD, Assaf DH, El-Smadi LA, Hamdan AA. Comparison of effectiveness of oral hygiene instruction methods in improving plaque scores among 8-9-year children: A randomized controlled trial. Eur Arch Paediatr Dent. 2022;23(2):289-300. doi:10.1007/s40368-021-00680-9
19. Robinson JK, Gaber R, Hultgren B, Eilers S, Blatt H, Stapleton J, et al. Skin self-examination education for early detection of melanoma: A randomized controlled trial of Internet, workbook, and in-person interventions. J Med Internet Res. 2014;16(1):e7. doi:10.2196/jmir.2883
20. Farahani MF, Purfarzad Z, Ghorbani M, Zare ZG, Ghorbani F. The impact of multimedia software support on the knowledge and self-care behaviors of patients with type 2 diabetes: A Randomized Clinical Trial. Int J Caring Sci. 2016;5(2):111. doi:10.15171/jcs.2016.012
21. Burdea GC, Coiffet P. Virtual reality technology. 2nd ed. New York. John Wiley & Sons; 2003.
22. Li C, Du C, Ge S, Tong T. An eye-tracking study on visual perception of vegetation permeability in virtual reality forest exposure. Front Public Health. 2023;11:1089423. doi:10.3389/fpubh.2023.1089423
23. Azarby S, Rice A. Understanding the effects of virtual reality system usage on spatial perception: The potential impacts of immersive virtual reality on spatial design decisions. Sustainability. 2022;14(16):10326. doi:10.3390/su141610326
24. Jasinevicius TR, Landers M, Nelson S, Urbankova A. An evaluation of two dental simulation systems: Virtual reality versus contemporary non-computer-assisted. J Dent Educ. 2004;68(11):1151-62. doi:10.1002/j.0022-0337.2004.68.11.tb03860.x
25. Dyer E, Swartzlander BJ, Gugliucci MR. Using virtual reality in medical education to teach empathy. J Med Libr Assoc. 2018;106(4):498. doi:10.5195/jmla.2018.518

26. Poyato-Ferrera M, Segura-Egea J, Bullón-Fernández P. Comparison of modified Bass technique with normal toothbrushing practices for efficacy in supragingival plaque removal. Int J Dent Hyg. 2003;1(2):110-4. doi:10.1034/j.1601-5037.2003.00018.x
27. Maresky H, Oikonomou A, Ali I, Ditkofsky N, Pakkal M, Ballyk B. Virtual reality and cardiac anatomy: Exploring immersive three-dimensional cardiac imaging, a pilot study in undergraduate medical anatomy education. Clin Anat. 2019;32(2):238-43. doi:10.1002/ca.23292
28. Yamaguchi S, Yoshida Y, Noborio H, Murakami S, Imazato S. The usefulness of a haptic virtual reality simulator with repetitive training to teach caries removal and periodontal pocket probing skills. Dent Mater J. 2013;32(5):847-52. doi:10.4012/dmj.2013-174
29. Fakhruddin KS, El Batawi H, Gorduysus MO. Effectiveness of audiovisual distraction eyewear and computerized delivery of anesthesia during pulp therapy of primary molars in phobic child patients. Eur J Dent. 2015;9(4):470-5. doi:10.4103/1305-7456.172637
30. Harnacke D, Mitter S, Lehner M, Munzert J, Deinzer R. Improving oral hygiene skills by computer-based training: A randomized controlled comparison of the modified Bass and the Fones techniques. PloS one. 2012;7(5):e37072. doi:10.1371/journal.pone.0037072
31. Mistry D, Brock CA, Lindsey T. The present and future of virtual reality in medical education: A narrative review. Cureus. 2023;15(12):e51124. doi:10.7759/cureus.51124
32. Marougkas A, Troussas C, Krouska A, Sgouropoulou C. Virtual reality in education: A review of learning theories, approaches and methodologies for the last decade. Electronics. 2023;12(13):2832. doi:10.3390/electronics12132832