The effect of virtual reality in dentistry: A protocol for a systematic review and meta-analysis

Hossein Motahari-Nezhad

h.motahari.lib@gmail.com

Obuda University  https://orcid.org/0000-0002-1028-4460

Aslan Sadeghdaghighi
Semmelweis University

Amir-Hossein Ashourioun
Department of Oral and Maxillofacial Surgery, Semmelweis University, Budapest, Hungary

Method Article

Keywords: Virtual reality, dentistry, pain, anxiety

Posted Date: March 22nd, 2024

DOI: https://doi.org/10.21203/rs.3.pex-2592/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License
Abstract

This systematic review and meta-analysis protocol outlines an investigation into the effects of Virtual Reality (VR) in dentistry. As a growing technological tool, VR offers immersive environments for patient education, anxiety and pain management, and professional skill enhancement in dental practice. Despite its growing use, empirical evidence on VR’s efficacy remains fragmented and inconclusive. This review aims to consolidate current research, providing a comprehensive assessment of VR’s impact across all health outcomes in dental care.

Adhering to the PRISMA-P guidelines, the study will include English-language, two-arm randomized controlled trials, comparing VR interventions with non-VR controls. The review will consider all dental patients, regardless of demographics, and will encompass various dental treatment settings. A search strategy employing two databases including PubMed and the Cochrane Library will identify relevant studies, followed by a systematic screening and data extraction process conducted by independent reviewers. The review will conduct a risk of bias assessment and employ a random effects meta-analysis for evidence synthesis. A subgroup analysis and meta-regression will explore factors affecting VR’s effectiveness. Publication bias will be assessed using Trim and Fill, Begg and Egger methods, and the GRADE tool will evaluate the quality of evidence.

The review anticipates offering insights into the role of VR in enhancing patient-centered care. By synthesizing scattered evidence, it aims to identify specific health outcomes significantly impacted by VR applications. The findings are expected to guide future research and clinical practices, enhancing patient care in dentistry.

Introduction

In the ever-evolving landscape of dentistry, the incorporation of innovative technologies has become a fundamental element for enhancing patient care and treatment outcomes. Among these technologies, Virtual Reality (VR) has emerged as a significant tool, offering a wide array of applications in dental practice[1,2]. VR's immersive and interactive environment provides a unique platform for patient education [3], anxiety management, pain distraction [4], and skills training for dental professionals [5]. The integration of VR in dentistry is not only evidence to the field's technological advancement but also to its commitment to adopting patient-centered approaches.

The concept of using VR in dentistry is grounded in its ability to create a controlled, yet realistic, simulation of dental procedures and environments. This immersive simulation capability has been extensively studied for its potential to reduce patient anxiety and discomfort during dental treatments, a common challenge faced in dental clinics [6]. Moreover, VR's application in patient education allows for an interactive and engaging way to inform patients about their oral health and treatment plans, potentially improving patient compliance and treatment outcomes [2].
For dental professionals, VR also offers an instrumental tool for skill enhancement and training. The high-fidelity simulations provided by VR enable practitioners to refine their techniques in a risk-free environment, ensuring better preparedness for real-world scenarios. This aspect of VR is particularly relevant in the context of the increasing complexity of dental procedures and the need for continuous professional development in the field [7].

Despite its promising applications, the empirical evidence on the efficacy and impact of VR in dentistry remains scattered and inconclusive. No recent study has synthesized evidence on the impact of virtual reality in dentistry across all health outcomes into a single resource. Therefore, this systematic review and meta-analysis aims to synthesize existing research to provide a comprehensive understanding of the effects of VR in dental practice in all health outcomes, settings, and age groups. This study aims to provide a critical evaluation and direction for future research and clinical implementations in the field of dentistry by assessing the efficacy, advantages, and limits of virtual reality (VR) applications.

**Reagents**

**Equipment**

**Procedure**

**Methods**

The protocol used in this study was developed in accordance with the PRISMA-P (Reporting Items for Systematic Reviews and Meta-Analyses Protocols) declaration, which is widely recognized as the ideal framework for specifying items in systematic review and meta-analysis protocols [8].

**Eligibility criteria**

This study will include only English-language, full-text, two-arm randomized control trials that compare the effectiveness of virtual reality interventions in one arm with a non-virtual reality control group in the other. The detailed inclusion criteria, based on the PICOS framework [9], for this systematic review and meta-analysis are as follows:

Population: All dental patients, regardless of race, gender, and age.

Intervention: Virtual reality used in dentistry for managing treatments in patients with dental disorders.

Comparator: Any comparator (non-virtual reality) used in contrast to virtual reality.

Outcome: No restrictions on outcomes; all health outcomes from virtual reality-based interventions in dentistry will be considered.
Setting: The study will focus on dental treatment settings. The study will include patients in various dental settings, such as dental surgeries and other treatment types.

Study design: Randomized controlled trials (RCTs).

**Search strategies**

Two electronic databases, PubMed and the Cochrane Library, will be utilized to identify eligible studies. The following search syntaxes will be employed:

PubMed:

("Virtual Reality"[Mesh] OR "Virtual reality"[Title/abstract]) AND (dentistry[Title/Abstract] OR teeth[Title/Abstract] OR tooth[Title/Abstract] OR dental[Title/Abstract])

No time limitations will be applied to the searches. Additionally, in PubMed, after executing the search syntax, the article type will be specifically limited to 'Randomized Controlled Trials'.

Cochrane Library:

"virtual reality" in Title Abstract Keyword AND "dentistry" OR "teeth" OR "tooth" OR dental in Title Abstract Keyword.

**Selection of studies**

After conducting the searches in the two electronic databases, all retrieved studies will be stored in an Excel file. Duplicate entries will then be identified and removed using their DOI numbers. Following the removal of duplicates, the screening process will be carried out in two distinct steps.

In the first step, the titles and abstracts of the articles will be reviewed, and any studies that do not meet all the inclusion criteria will be excluded. Subsequently, the studies that pass this initial screening will undergo a thorough full-text review to ascertain whether they fulfill the aforementioned inclusion criteria.

The inclusion criteria, based on the PICOS framework as detailed earlier, will guide the identification of the final eligible studies. Moreover, the reference lists of these studies will also be reviewed to find any additional eligible studies [10].

Throughout both stages of the screening process (title/abstract and full-text review), two reviewers (HM-N and AS) will independently evaluate the studies. A PRISMA flow diagram will be used to illustrate the search and screening process. Additionally, the list of studies excluded during the full-text screening phase will be provided, along with the reasons for their exclusion.

**Data extraction**
Data extraction will be conducted by two independent reviewers (HM-N and AS). The following data points will be extracted from the final eligible studies: publication year, first author's name and country, characteristics of the population including clinical characteristics, gender, and age, details of the intervention and its follow-up times, type of comparator, dental health outcomes along with the effect size, type of effect size, and its 95% confidence intervals or standard error, and the total number of participants as well as the number in each arm. If the effect size is not reported in the study, it will be calculated based on the type of outcome, where possible. A table will be used to demonstrate the characteristics of the included studies.

**Risk of bias assessment**

ROB 2 [11] tool will be used to assess the risk of bias of the final included studies by two reviewers independently.

**Evidence synthesis**

The final included studies will be categorized into different groups based on their reported outcomes, with each study reporting similar outcomes being placed in the same group. For each group, a random effects meta-analysis will be performed using the DerSimonian and Laird method, utilizing R programming software. To pool the effect sizes for each outcome, only studies reporting the same type of effect size will be included. In cases where different effect sizes are reported, efforts will be made to calculate comparable effect sizes when possible. Studies with incompatible effect sizes that cannot be calculated will be excluded from the meta-analysis. To assess heterogeneity in each meta-analysis, the I-squared statistic will be used. If the I-squared value exceeds 50%, a simple meta-regression based on age groups will be conducted to determine if age is a source of heterogeneity. Additionally, a subgroup analysis according to the risk of bias levels will be carried out in each meta-analysis to examine any significant differences between the overall pooled effect size and subgroups. Tools such as the Trim and Fill method [12], along with Egger and Begg tests [13], will be employed to detect publication bias in each meta-analysis.

**Quality of evidence**

The GRADE tool will be employed to evaluate the quality of evidence for each outcome [14,15]. Five criteria will be considered when assessing the quality of evidence in each meta-analysis: risk of bias, publication bias, inconsistency, imprecision, and indirectness. The final level of certainty for each outcome, categorized as High, Moderate, Low, or Very Low, will be determined based on the total number of downgrades [16].

**Troubleshooting**

**Time Taken**
**Anticipated Results**

This protocol was established prior to the commencement of data collection. The search, screening, and data extraction processes will begin in April 2024, following the guidelines outlined in this protocol.

**Discussion**

The anticipated discussion will focus on interpreting the effectiveness of VR in dental settings, considering the variability of outcomes. It will delve into how VR contributes to patient-centered care and the professional development of dental practitioners. Additionally, it will speculate on the implications of VR technology in the future of dentistry and outline areas for further research.

**Strengths**

Adherence to the PRISMA-P guidelines ensures a rigorous and transparent approach to the systematic review and meta-analysis.

Inclusion of randomized controlled trials strengthens the reliability and validity of the findings.

Planned subgroup analyses and meta-regressions will provide a detailed understanding of factors influencing VR's effectiveness in dentistry.

**Limitations**

The language limitation to English-only publications might omit significant studies in other languages.

Variability in VR intervention types and settings may lead to heterogeneity in the results, impacting the generalizability of the findings.

**Conclusions**

The systematic review and meta-analysis are expected to offer an evaluation of VR's role in dentistry, providing critical insights into its effectiveness across different health outcomes. The study aims to fill gaps in the existing literature by synthesizing scattered evidence into a unified understanding. It is anticipated that the findings will not only highlight the benefits and limitations of VR in dentistry but also pave the way for future research and implementation strategies, enhancing patient care. To summarize, the outcomes of our research will assist in determining specific health outcomes where the application of virtual reality has yielded significant clinical results in dentistry.

**References**


