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Effect of Preoperative Virtual Reality Technology on Anxiety in Patients Undergoing Odontectomy: A Systematic Review

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ABSTRACT: This study aims to assess the effectiveness of virtual reality (VR) interventions in alleviating preoperative anxiety among dental patients facing general anesthesia. The evaluation will seek to provide substantial evidence that can aid clinical decision-making regarding the implementation of VR as a preoperative anxiety reduction tool. This systematic review adheres to PRISMA 2020 guidelines and involved an extensive search of major databases, including PubMed, Cochrane Library, and ESCOhost, for relevant studies published from 2011 to 2025. The review encompasses original research, literature reviews, and clinical trials focused on non-pharmacological methods aimed at reducing anxiety in patients who are undergoing odontectomy. A systematic review involving 28 studies identified 11 eligible studies focused on preoperative anxiety in odontectomy. The findings highlight that preoperative anxiety is prevalent, affecting both the psychological and physiological stability of patients undergoing this dental procedure. Findings showed that VR interventions significantly reduced preoperative anxiety compared to control groups. Immersive VR was slightly more effective than non-immersive VR in engaging patients and alleviating anxiety. The effectiveness of anxiety reduction was noted to be greater for minor procedures compared to complex surgeries. Sensitivity analysis verified the robustness of these results. VR-based interventions, especially immersive VR, have proven effective in alleviating preoperative anxiety among dental patients undergoing general anesthesia. The effectiveness of these interventions is influenced by factors, the type of surgical procedure, and the specific VR content utilized. These results endorse the use of VR in managing anxiety within dental anesthesia.

1. INTRODUCTION

Oral and dental hygiene continues to be a significant public health issue in Indonesia ¹. National statistics from Riset Kesehatan Dasar (Riskesdas) indicate that over 57.6% of the Indonesian populace suffers from oral health issues, however a small fraction seeks or obtains adequate dental treatment. A prevalent dental issue is the impaction of the third molars, frequently referred to

as wisdom teeth, which often requires surgical treatment. If neglected, impacted wisdom teeth can result in significant issues, such as infection, pericoronitis, and harm to neighbouring teeth ^{2,3}.

Impacted third molars that do not erupt correctly are generally addressed with a surgical intervention referred to as odontectomy or the surgical extraction of the tooth. This is among the most commonly executed oral surgical interventions in dentistry. Nonetheless, odontectomy is linked to considerable preoperative anxiety, chiefly induced by expected pain, the utilisation of surgical tools, and the application of local anaesthesia. A total of 45.6% of individuals slated for third molar extraction were classified as nervous (31.0%) or highly apprehensive (14.6%) according to a preoperative anxiety evaluation, highlighting a significant prevalence of dental anxiety in patients undergoing this procedure ³⁻⁵.

Anxiety prior to surgery influences the psychological state of patients and elicits a spectrum of physiological responses, including raised blood pressure, increased heart rate, and amplified pain sensitivity. Such autonomic responses can complicate surgical treatment, lengthen the duration of the procedure, and impede recuperation after surgery. In addition, untreated anxiety might cause individuals to avoid or delay surgery, which may deteriorate their oral health status ⁶⁻⁸.

The pharmacological treatment of preoperative anxiety typically includes anxiolytic drugs like benzodiazepines. Nevertheless, extended utilisation of benzodiazepines has been linked to numerous detrimental effects, including profound drowsiness, medication interactions, increased fall risk, delirium, cognitive deficits, and dependency. As a result of these apprehensions, non-pharmacological approaches have garnered interest as safer and more sustainable options. This encompasses music therapy, audiovisual elements, virtual reality (VR), and video. Recent findings indicate that these methods can significantly alleviate anxiety, enhance patient comfort, and facilitate quicker postoperative recovery ^{9,10}.

The practical use of non-drug therapies to reduce anxiety in individuals undergoing medical treatments has proven to be helpful, particularly in dentistry settings ¹¹. Previous meta-analyses have shown that music markedly reduces anxiety in dental settings ¹². However, current research has not conclusively demonstrated the efficacy of music in mitigating pain during more intrusive and distressing dental treatments, such as tooth extractions ^{13,14}.

Moreover, despite the increasing clinical attention toward non-pharmacological methods, current evaluations predominantly concentrate on certain interventions or demographic cohorts, resulting in an absence of thorough synthesis for odontectomy. The current research assesses the efficacy of VR distraction in adult dental patients. This comprehensive review seeks to thoroughly delineate the spectrum of current non-pharmacological strategies employed to alleviate preoperative anxiety in odontectomy. It aims to (1) ascertain patient-related elements that lead to this worry, and (2) consolidate existing knowledge regarding the varieties, methods, and therapeutic results of non-pharmacological therapies utilised in this scenario. The results of this evaluation are anticipated to guide forthcoming research trajectories and bolster the establishment of evidence-based clinical methodologies in oral surgery.

2. MATERIALS AND METHODS

2.1 Study design and framework

This systematic and comprehensive literature focuses on non-pharmacological interventions to reduce preoperative anxiety in patients undergoing odontectomy over a 15-year period. This review utilized the methodological framework established by Arksey & O'Malley, (2002) ¹⁵, augmented by the analytical recommendations of Levac et al., (2010) ¹⁶. We followed the Preferred Reporting Items for Systematic Review and Meta-Analysis extension for Scoping Reviews (PRISMA 2020) to ensure reporting quality and registered the protocol with the Open Science Framework.

2.2 Literature search strategy

A systematic literature search was conducted using three prominent electronic databases: PubMed, Cochrane Library, and EBSCOhost. This search covered publications from January 2011 to April 2026, enabling the inclusion of the latest studies relevant to the topic, ensuring a comprehensive understanding of recent advancements and findings.

The search strategy was designed to be comprehensive, utilizing a mixture of keywords and controlled vocabulary across four pivotal domains to identify pertinent studies. The domains included population keywords such as "odontectomy," "Anesthesia, General"[Mesh] OR (General Anesthesia*[Title/Abstract]); outcome keywords focused on ("Virtual Reality"[Mesh] OR ((Virtual Realit*[Title/Abstract]) OR (VR[Title/Abstract])); and filters for study types to extract primary research studies and

systematic reviews. Boolean operators (AND, OR) enabled the logical combination of these terms, with syntax tailored to fit the specific requirements of each database. To counteract publication bias, the strategy did not impose restrictions on study design, apart from the language limitations and relevancy criteria established for the search.

2.3 Inclusion criteria

Inclusion criteria were established using the PICO framework for studies involving pediatric patients under 18 years undergoing elective surgery with general anesthesia. Eligible studies must include VR-based interventions, both active and passive, compared against standard treatments or placebos. Outcomes should measure pre-induction anxiety through validated tools, along with secondary outcomes related to anesthesia compliance and parental satisfaction. Only randomized clinical trials published in peer-reviewed formats are considered, with no restrictions on language or publication timeframe.

2.4 Exclusion criteria

Studies were excluded based on criteria such as duplicate results, surgeries not involving general anesthesia, study protocols, or unclear outcome measures.

2.5 Study selection process

The study selection process was conducted systematically in two phases. The first phase involved independent evaluation of titles and abstracts by two reviewers based on established inclusion and exclusion criteria, addressing any discrepancies through discussion or consensus with a third reviewer. The second phase focused on the full-text review, where the same reviewers assessed the full texts of eligible studies, resolving disagreements through consensus discussions. The entire process was documented with a PRISMA flow diagram to ensure transparency and adherence to guidelines (Figure 1).

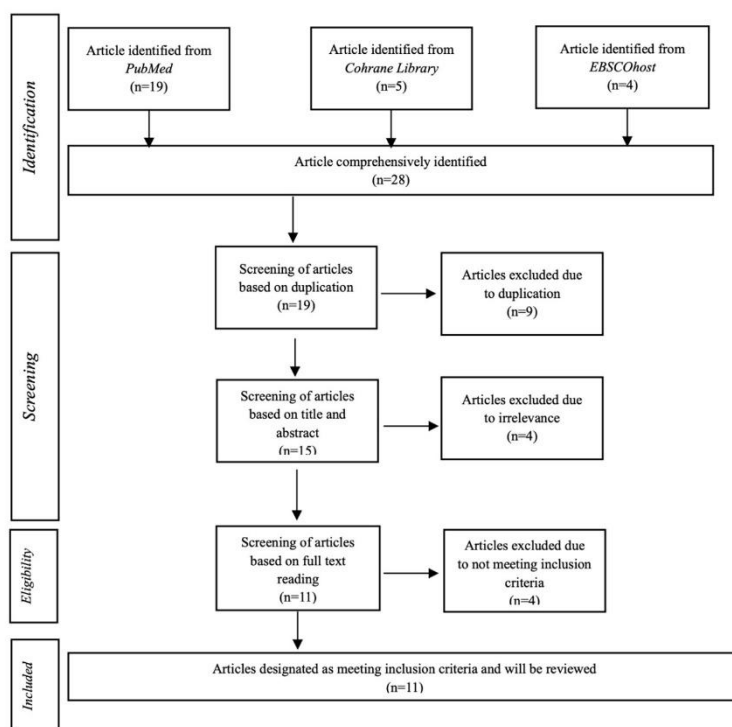


Figure 1. The research item identification and section procedure diagram

2.6 Data extraction

Data extraction from the selected studies was conducted using standardized tables, which included details on authors, publication year, and country, as well as participant characteristics, sample details, intervention types and protocols, measurement scales, and primary outcomes. The process involved two independent reviewers (SJZ and RXH), along with a

third researcher (BR) who aided in standardizing the extracted data. If further information was required, the corresponding authors of the studies were contacted for clarification.

2.7 Data analysis and synthesis

The extracted data underwent thematic synthesis, categorizing studies based on the specific non-pharmacological intervention being examined, particularly VR. Each category's findings were summarized descriptively, focusing on efficacy, mechanisms for anxiety reduction, and methods for outcome measurement. The analysis included both subjective measures, such as psychometric scales, and objective physiological markers, ensuring a comprehensive understanding of the effects of the interventions. Due to the diversity in interventions, outcomes, and study designs, a narrative synthesis was utilized instead of a meta-analytic pooling approach. Furthermore, critical appraisal of gaps and inconsistencies within the existing literature highlighted priorities for future research and considerations for potential clinical application.

3. RESULTS

Study selection and characteristics

A systematic review incorporated 11 studies that met the inclusion criteria. Sample sizes ranged from 40 to 225 participants, indicative of varying study scopes and resources. Participants were mainly adults aged 18 to 60 undergoing odontectomy, with no studies focused solely on pediatric or geriatric groups. The studies were geographically diverse, primarily originating from middle- to high-income countries, reflecting different healthcare infrastructure levels. A summary of these studies is presented in Table 1.

Table 1 Included research summary

Author	Year	Title	Mode of intervention	Intervention duration	Outcomes
Ciro Esposito <i>et al</i> ¹⁷	2022	Efficacy of a virtual reality program in pediatric surgery to reduce anxiety and distress symptoms in the preoperative phase: a prospective randomized clinical trial.	VR exposure	Start 1 h before surgery, lasted approximately 15 min	Children's subjective ratings of the virtual reality experience, anesthesiologist's observational ratings
Jin-Woo Park <i>et al</i> ¹⁸	2019	The effect of mirroring display of virtual reality tour of the operating theatre on preoperative anxiety: a randomized controlled trial	VR exposure	Start 1 h prior to surgery, lasted approximately 15 to 20 min	Children's anesthesia compliance, parents/guardians' preoperative anxiety, satisfaction with the overall anesthesia preparation process.
Jung-Hee Ryu <i>et al</i> ¹⁹	2018	The effect of gamification through a virtual reality on preoperative anxiety in pediatric patients undergoing general anesthesia: a	VR exposure	Start before the child receive general anesthesia until anesthesia induction	Compliance during anesthesia induction, preoperative behavioral performance, parental satisfaction scores.

		prospective, randomized, and controlled trial			
Lina Vogt <i>et al</i> ²⁰	2021	Virtual reality tour to reduce perioperative anxiety in an operating setting before anesthesia: randomized clinical trial	VR exposure	Start 1 h before surgery, lasted approximately 15 min	Overall patient rating of VORT, satisfaction with preoperative preparation, the reduction of preoperative anxiety.
Yijie Wu <i>et al</i> ²¹	2019	Virtual reality in preoperative preparation of children undergoing general anesthesia: a randomized controlled study	VR exposure	Start before surgery, lasted approximately 15 to 20 min	Children's compliance during induction, postoperative pain, emergence delirium, parental anxiety levels, parental satisfaction
J.-H. Ryu <i>et al</i> ²²	2019	The effect of an immersive virtual reality tour of the operating theater on emergence delirium in children undergoing general anesthesia: a randomized controlled trial.	VR exposure	Provided once before the surgery	Compliance during anaesthesia induction, procedural behaviour rating scale
Sarah Samnakay <i>et al</i> ²³	2024	3-dimensional virtual reality versus 2-dimensional video for distraction during the induction of anesthesia in children to reduce anxiety: a randomized controlled trial.	VR exposure	Start before child enters the preoperative preparation room and until anesthesia induction	State anxiety in children, The child's cooperation during anesthesia induction
Jung-Hee Ryu <i>et al</i> ²⁴	2017	Randomized clinical trial of immersive virtual reality tour of the operating theatre in children before anaesthesia.	VR exposure	Start 1 h prior to surgery, lasted approximately 4 min	Incidence and severity of emergence delirium, postoperative behavioral disturbances.
Michael J. Jung <i>et al</i> ²⁵	2021	Pediatric distraction on induction of anesthesia with	VR exposure	Start before anesthesia induction, lasted approximately 15 to 20 min	Post-induction parental anxiety, pediatric induction compliance, parental satisfaction.

		virtual reality and perioperative anxiolysis: a randomized controlled trial.			
Robin Eijlers <i>et al</i> ²⁶	2019	Systematic review and meta-analysis of virtual reality in pediatrics: effects on pain and anxiety.	VR exposure	Start before surgery and until the surgery began, lasted approximately 15 to 20 min	Postoperative analgesic rescue dosage, parental anxiety levels
Chiu P.L. <i>et al</i> ²⁷	2023	Virtual reality-based intervention to reduce preoperative anxiety in adults undergoing elective surgery: a randomized clinical trial.	VR exposure	Start before surgery, lasted approximately 20 to 30 min	Preoperative stress, preparedness, postoperative pain, patient satisfaction, length of hospital

The studies reviewed focused on various non-pharmacological interventions designed to mitigate preoperative anxiety specifically related to odontectomy procedures. Among these interventions, VR technology was assessed through two observational studies and one randomized clinical trial. VR serves as an immersive distraction tool by providing simulated environments that are not connected to the surgical experience. This technique was primarily utilized during the surgery itself, particularly to divert patients' attention and alleviate anxiety when local anesthesia was administered. In addition to VR, another method investigated was binaural beat music, which works by targeting brainwave entrainment to promote relaxation. This approach was examined in a separate observational trial. Overall, the inclusion of these innovative interventions aims to enhance patient comfort and reduce anxiety levels in the surgical context.

A variety of methods, both subjective and objective, have been employed to evaluate anxiety levels, particularly in dental settings. The Visual Analog Scale (VAS) is a notable subjective tool, allowing patients to quantify their anxiety intensity on a continuous scale. Another widely used instrument is the State-Trait Anxiety Inventory (STAI), which differentiates between transient state anxiety and long-lasting trait anxiety. Furthermore, there are dental-specific anxiety scales tailored for this context, such as Corah's Dental Anxiety Scale (CDAS) and the Modified Dental Anxiety Scale (MDAS). Each of these assessment tools is vital for accurately measuring anxiety levels in patients undergoing dental treatments, ensuring that their psychological needs are taken into account during care.

Numerous studies have sought to enhance the reliability of self-reported data by incorporating objective physiological markers reflective of autonomic arousal and stress responses. Key markers utilized include systolic and diastolic blood pressure measurements, heart rate (or pulse rate) monitoring, respiratory rate tracking, and salivary cortisol level analysis. Salivary cortisol, in particular, is essential as a biomarker that indicates the activation of the hypothalamic-pituitary-adrenal (HPA) axis in response to stress, allowing for an objective quantification of physiological changes associated with stress. By employing a combination of subjective self-reports and these objective measures, certain studies have not only improved reliability but also provided a more comprehensive perspective on anxiety modulation, illustrating the multidimensional nature of stress measurement and its implications in psychological research.

VR has emerged as a promising intervention in clinical settings, particularly in managing pain and anxiety during procedures. Research by Yamashita *et al.*, (2019) ²⁸ demonstrated that VR can significantly reduce anxiety levels and lower heart rates in patients undergoing extraction procedures with local anesthesia. However, the study's conclusions were constrained due to small sample sizes and variability in VR content and its duration. Complementarily, Mladenovic & Djordjevic, (2021) ²⁹, underscored the feasibility of VR for anxiety and pain reduction, although they pointed out challenges such as high costs and

limited access to technology. Furthermore, a study by Yamashita et al., (2020) ³⁰ revealed that VR utilized during dental treatments not only alleviated anxiety but also resulted in objective improvements in autonomic balance, with no instances of cybersickness reported. Overall, while the preliminary outcomes for VR in clinical settings are encouraging, further research is needed to address the limitations and barriers identified.

4. DISCUSSION

Preoperative anxiety is a common and clinically significant concern in odontectomy, particularly prior to third molar surgery. This review highlights the substantial occurrence of anxiety, assessed through validated tools such as the VAS, STAI, MDAS, and CDAS. The implications of anxiety extend beyond mere emotional distress; it is intimately linked to physiological disruptions involving the autonomic nervous system and activation of the HPA axis. These responses may manifest as increased heart rate, elevated blood pressure, and heightened cortisol levels ³¹. Such physiological changes pose risks to intraoperative hemodynamic stability, raise the need for analgesics, and may delay postoperative recovery. Consequently, this underscores the imperative for effective strategies aimed at managing anxiety in patients undergoing odontectomy to enhance surgical outcomes and overall patient well-being ^{32–34}.

Recent studies have confirmed the effectiveness of VR in alleviating pain and anxiety during medical procedures, especially in pediatric and adolescent populations. Among various VR modes, immersive VR tends to show greater benefits, as noted in research. It significantly reduces preoperative anxiety in adults and effectively manages pain in pediatric contexts. The analgesic and anxiolytic properties of VR are largely attributed to its ability to distract patients from painful or anxiety-inducing stimuli. This study compares immersive and non-immersive VR effectiveness; immersive VR offers a more immersive and interactive experience, allowing patients to engage fully in a virtual environment. In contrast, non-immersive VR, which displays content on screens, is less engaging but still beneficial, particularly in settings with limited resources or when simpler interventions are necessary. The superior interactivity and sensory engagement of immersive VR make it a more effective tool for reducing surgical anxiety through distraction ^{28,30,35}.

This study highlights the influence of VR content type on intervention effectiveness in managing patients' anxiety. VR that includes animation and gamified elements is more effective at engaging patients and alleviating anxiety than static scenarios or video content. The interactive nature of gamified experiences creates a more enjoyable environment, aiding in fear management associated with surgery. Conversely, simple scenario-based VR presentations demonstrate less efficacy. The effectiveness of VR interventions also varies with the type of medical procedure, showing greater benefits in dental contexts and with non-interactive VR. While results are promising, challenges such as high equipment costs and limited research with small sample sizes persist. VR interventions have been found to significantly reduce anxiety in patients undergoing mild, non-invasive outpatient surgeries, though they are less effective for more complex procedures, likely due to the greater psychological burden involved.

There are notable gaps in current literature regarding the application of nonpharmacological strategies in dental interventions, particularly concerning pediatric, geriatric, and medically compromised patients. Most research has focused on healthy adults in controlled clinical settings, limiting the general applicability of the findings. There is a lack of evidence on the long-term effects of interventions for dental avoidance or phobia, and challenges in resource-limited environments may impede the adoption of technologies like virtual reality. The study emphasizes the importance of incorporating nonpharmacological methods into future clinical guidelines, offering specific recommendations for their use in varying patient populations and oral surgery settings. This would help standardize preoperative anxiety management in common odontectomies, positively affecting patients' psychological well-being and physiological stability, thereby enhancing outcomes and satisfaction.

Despite employing rigorous methodological standards, the findings of the analysis face several limitations affecting their accuracy and generalizability. Notably, there is substantial heterogeneity among the included studies, attributed to variations in participant characteristics, intervention content, and implementation methods. Although a random-effects model was utilized to mitigate this issue, residual heterogeneity may still undermine the consistency and stability of results. Furthermore, some studies exhibited uneven participant allocation between intervention and control groups, introducing potential selection bias that could impact result interpretation. The inclusion of studies with small sample sizes raises concerns about statistical power and extensibility of conclusions. Additionally, some studies lacked complete clinical data or contained methodological flaws, further complicating the validity of the results.

5. CONCLUSION

VR has emerged as an effective intervention for reducing preoperative anxiety in children, demonstrating superiority over traditional treatments. It provides a valuable non-pharmacological method for preparing children for surgery by alleviating anxiety and promoting cooperation. With ongoing advancements in technology, VR holds significant promise for clinical applications, particularly in addressing preoperative anxiety in dental patients.

REFERENCES

- [1] Chairunisa F, Ramadhani A, Takehara S, et al. Oral Health Status and Oral Healthcare System in Indonesia: A Narrative Review. *J Int Soc Prev Community Dent.* 2024;14(5):352-361. doi:10.4103/jispcd.jispcd_73_24
- [2] Mursyid F, Septiawan D, Lisetiawati L. A relationship between preoperative anxiety and postoperative pain in odontectomy patients under general anesthesia at Moewardi Regional General Hospital. *Maj Kedokt Gigi Indones.* 2024;10(3):1-13. doi:10.22146/majkedgind.95909
- [3] Chithra.A D. Effect of preoperative anxiety on postoperative pain in patients undergoing mandibular third molar extraction-A prospective study. *African J Biomed Res.* 2024;27(4):2863-2869. doi:10.53555/ajbr.v27i4s.3640
- [4] Saruhan Köse N, Tekin G, Çalışkan G, Koşar YÇ, Dereci Ö. Comparison of Preoperative and Postoperative Anxiety Levels in Patients Undergoing Tooth Extraction. *Med Sci Monit.* 2025;31(5):1-7. doi:10.12659/MSM.949360
- [5] Qiao F, Zhang M, Zhang T, Zhu D. Dental anxiety is related to postoperative symptoms in third molar surgery. *Front Psychiatry.* 2022;13(8):1-9. doi:10.3389/fpsyt.2022.956566
- [6] Hu JY, Zhou QM, Li WJ, et al. Effects of Preoperative Anxiety Status on Haemodynamic Changes during and after Tooth Extraction in Middle-aged and Elderly Patients with Hypertension: a Prospective Repeated-Measures Cohort Study. *Chinese J Dent Res.* 2022;24(4):267-274. doi:10.3290/j.cjdr.b2440843
- [7] Fernandez-Aguilar J, Guillén I, Sanz MT, Jovani-Sancho M. Patient's pre-operative dental anxiety is related to diastolic blood pressure and the need for post-surgical analgesia. *Sci Rep.* 2020;10(1):1-9. doi:10.1038/s41598-020-66068-9
- [8] Mello FW, Melo G, Kammer PV, Speight PM, Rivero ERC. Prevalence of odontogenic cysts and tumors associated with impacted third molars: A systematic review and meta-analysis. *J Cranio-Maxillofacial Surg.* 2019;47(6):996-1002. doi:10.1016/j.jcms.2019.03.026
- [9] Chang Y, Xie X, Liu Y, Liu M, Zhang H. Exploring clinical applications and long-term effectiveness of benzodiazepines: An integrated perspective on mechanisms, imaging, and personalized medicine. *Biomed Pharmacother.* 2024;173(11):116329. doi:10.1016/j.biopha.2024.116329
- [10] López-Valverde N, López-Valverde A, Macedo de Sousa B, Blanco Rueda JA. Efficacy of music therapy on stress and anxiety prior to dental treatment: a systematic review and meta-analysis of randomized clinical trials. *Front Psychiatry.* 2024;15(2):1-14. doi:10.3389/fpsyt.2024.1352817
- [11] Cronin C, Turner JA, Kim Dunleavy AK, et al. Dealing with Anxious Patients: A Systematic Review of the Literature on Nonpharmaceutical Interventions to Reduce Anxiety in Patients Undergoing Medical or Dental Procedures. *J Altern Complement Med.* 2021;27(9):1-14.
- [12] Weijden FN van der, Hussain AM, Tang L, Slot DE. The effect of playing background music during dental treatment on dental anxiety and physiological parameters: A systematic review and meta-analysis. *Psychol Music.* 2021;50(2):1-20. doi:10.1177/0305735621998439
- [13] Wang R, Huang X, Wang Y, Akbari M, Wang Y. Non-pharmacologic Approaches in Preoperative Anxiety , a Comprehensive Review. *Front Public Heal.* 2022;10(4):854673. doi:10.3389/fpubh.2022.854673
- [14] Sui N, Wong M, Wai A, et al. Non-Pharmacological Interventions for Reducing Fear and Anxiety in Patients Undergoing Third Molar Extraction under Local Anesthesia : Systematic Review and Meta-Analysis. *Int J Environ Res Public Health.* 2022;19(18):11162.
- [15] Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol.* 2002;8(1):19-32.
- [16] Levac D, Colquhoun H, Brien KKO. Scoping studies : advancing the methodology. *Implement Sci.* 2010;5(69):1-9.
- [17] Esposito C, Autorino G, Iervolino A, et al. Efficacy of a Virtual Reality Program in Pediatric Surgery to Reduce Anxiety and Distress Symptoms in the Preoperative Phase: A Prospective Randomized Clinical Trial. *J Laparoendosc Adv Surg Tech.* 2022;32(2):197-203. doi:10.1089/lap.2021.0566
- [18] Park JW, Nahm FS, Kim JH, Jeon YT, Ryu JH, Han SH. The Effect of Mirroring Display of Virtual Reality Tour of the Operating Theatre on Preoperative Anxiety: A Randomized Controlled Trial. *IEEE J Biomed Heal Informatics.* 2019;23(6):2655-2660. doi:10.1109/JBHI.2019.2892485
- [19] Ryu JH, Park JW, Nahm FS, et al. The effect of gamification through a virtual reality on preoperative anxiety in pediatric patients undergoing general anesthesia: A prospective, randomized, and controlled trial. *J Clin Med.* 2018;7(9):1-14. doi:10.3390/jcm7090284
- [20] Vogt L, Klasen M, Rossaint R, Goeretz U, Ebus P, Sopka S. Virtual reality tour to reduce perioperative anxiety in an operating setting before anesthesia: Randomized clinical trial. *J Med Internet Res.* 2021;23(9):1-2. doi:10.2196/28018

- [21] Wu Y, Chen J, Ma WL, Guo L, Feng H. Virtual reality in preoperative preparation of children undergoing general anesthesia: a randomized controlled study. *Anaesthesiologie*. 2022;71(Icc):204-211. doi:10.1007/s00101-022-01177-w
- [22] Ryu JH, Oh AY, Yoo HJ, Kim JH, Park JW, Han SH. The effect of an immersive virtual reality tour of the operating theater on emergence delirium in children undergoing general anesthesia: A randomized controlled trial. *Paediatr Anaesth*. 2019;29(1):98-105. doi:10.1111/pan.13535
- [23] Samnakay S, von Ungern-Sternberg BS, Evans D, et al. 3-Dimensional Virtual Reality Versus 2-Dimensional Video for Distraction During the Induction of Anesthesia in Children to Reduce Anxiety: A Randomized Controlled Trial. *Anesth Analg*. 2025;141(3):629-638. doi:10.1213/ANE.00000000000007119
- [24] Ryu JH, Park SJ, Park JW, et al. Randomized clinical trial of immersive virtual reality tour of the operating theatre in children before anaesthesia. *Br J Surg*. 2017;104(12):1628-1633. doi:10.1002/bjs.10684
- [25] Jung MJ, Libaw JS, Ma K, Whitlock EL, Feiner JR, Sinskey JL. Pediatric Distraction on Induction of Anesthesia with Virtual Reality and Perioperative Anxiolysis: A Randomized Controlled Trial. *Anesth Analg*. 2021;132(3):798-806. doi:10.1213/ANE.00000000000005004
- [26] Eijlers R, Utens EMWJ, Staals LM, et al. Systematic Review and Meta-analysis of Virtual Reality in Pediatrics: Effects on Pain and Anxiety. *Anesth Analg*. 2019;129(5):1344-1353. doi:10.1213/ANE.00000000000004165
- [27] Chiu PL, Li H, Yap KYL, Lam KMC, Yip PLR, Wong CL. Virtual Reality-Based Intervention to Reduce Preoperative Anxiety in Adults Undergoing Elective Surgery: A Randomized Clinical Trial. *JAMA Netw Open*. 2023;6(10):2-3. doi:10.1001/jamanetworkopen.2023.40588
- [28] Yamashita K, Kibe T, Ohno S, Kohjitani A, Sugimura M. The Effects of Music Listening During Extraction of the Impacted Mandibular Third Molar on the Autonomic Nervous System and Psychological State. *J Oral Maxillofac Surg*. 2019;77(6):1-8. doi:10.1016/j.joms.2019.02.028
- [29] Mladenovic R, Djordjevic F. Effectiveness of virtual reality as a distraction on anxiety and pain during impacted mandibular third molar surgery under local Anesthesia. *J Stomatol Oral Maxillofac Surg*. 2021;122(4):15-20. doi:10.1016/j.jormas.2021.03.009
- [30] Yamashita Y, Shimohira D, Aijima R, Mori K, Danjo A. Clinical Effect of Virtual Reality to Relieve Anxiety During Impacted Mandibular Third Molar Extraction Under Local Anesthesia. *J Oral Maxillofac Surg*. 2020;78(4):1-6. doi:10.1016/j.joms.2019.11.016
- [31] Hoffmann B, Erwood K, Ncomanzi S, Fischer V, O'Brien D, Lee A. Management strategies for adult patients with dental anxiety in the dental clinic: a systematic review. *Aust Dent J*. 2022;67(1):1-13. doi:10.1111/adj.12926
- [32] Kong X, Song N, Chen L, Li Y. Non-pharmacological interventions for reducing dental anxiety in pediatric dentistry: a network meta-analysis. *BMC Oral Health*. 2024;24(1):1-12. doi:10.1186/s12903-024-04919-x
- [33] Li Y, Peng S, Xia X, Yin L, Liao L. Nonpharmacological interventions for decreasing anxiety during anesthesia induction in children: a systematic review and Bayesian network meta-analysis. *BMC Anesthesiol*. 2025;25(1):1-13. doi:10.1186/s12871-025-03077-z
- [34] Machete ML, Madiba TK, Motloba PD. Comparability of the single-item Visual Analog Scale (VAS-A) to the multi-item Modified Dental Anxiety Scale (MDAS) – A systematic review and meta-analysis. *South African Dent J*. 2025;80(2):83-87. doi:10.17159/sadj.v80i02.20196
- [35] Choi SH, Won JH, Cha JY, Hwang CJ. Effect of audiovisual treatment information on relieving anxiety in patients undergoing impacted mandibular third molar removal. *J Oral Maxillofac Surg*. 2015;73(11):2087-2092. doi:10.1016/j.joms.2015.06.175