

Application of Virtual Reality in the Management of Preoperative Anxiety: A Systematic Review

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Abstract

Introduction. Preoperative anxiety, a common emotional response in patients awaiting surgery, is associated with adverse clinical outcomes, including postoperative complications and increased analgesic consumption. Although traditional anxiolytics are widely used, non-pharmacological approaches such as Virtual Reality (VR) are emerging as promising complementary strategies (Kallush et al., 2018). Thanks to its ability to create immersive environments, VR can reduce anxiety through mechanisms of distraction or familiarization with the surgical setting. To systematically assess the effectiveness of VR in reducing preoperative anxiety, with particular focus on clinical feasibility and the nursing role in its implementation.

Methods. A systematic review was conducted following the PRISMA guidelines, querying biomedical databases (PubMed, CINAHL, MEDLINE, Cochrane Library, Scopus, Science Direct) with MeSH terms and keywords. Fifteen studies (2019-2025) on adult patients undergoing elective surgery were included, excluding intraoperative applications or non-surgical contexts.

Results. Out of 1,507 participants, 11/15 studies demonstrated a significant reduction in preoperative anxiety with VR, especially in elective surgery. The most effective interventions varied based on the objective: 1) Procedural virtual tour (short duration) for anxiety. 2) Naturalistic environments with music for anxiety and pain. 3) Personalized 3D videos for active patient engagement.

Discussion. However, methodological heterogeneity and the lack of direct comparison with anxiolytics limit generalizability. VR is confirmed as a valid option for reducing preoperative anxiety, with potential economic (reduction in medication, operative times) and clinical (improved patient experience) benefits. Standardization of protocols, nursing training, and

the integration of multiple elements (e.g., 3D education + nature) represent future areas of development.

Keywords: Virtual Reality, Preoperative Anxiety, Perioperative Nursing, Preoperative Care, Patient Education

Introduction

Preoperative state anxiety constitutes a complex emotional response, characterized by apprehension, tension, and fear related to the imminence of surgery. This condition, often underestimated, not only compromises the patient's psychological well-being but is also associated with adverse clinical outcomes, including prolonged postoperative recovery, increased analgesic consumption, and a higher risk of complications. (Bandelow et al., 2017). Although traditional anxiolytics remain the most widespread therapeutic approach, recent literature highlights a growing interest in non-pharmacological strategies capable of acting synergistically with conventional therapies, reducing their side effects and enhancing their efficacy (Kallush et al., 2018).

Among the most promising innovations in the landscape of complementary therapies is virtual reality, an immersive technology that recreates simulated environments, allowing patients to experience progressive familiarization with the surgical setting.

In this scenario, the nursing figure emerges as a central actor in the perioperative care pathway. Through an empathetic and continuous relationship with the patient, the nurse not only provides clinical support but also becomes a key mediator in anxiety management, through communication strategies, reassurance, and preoperative education. (Dias et al., 2022; Xu et al. 2020).

The advent of virtual reality has its roots in the 1960s, with early pioneering experiments such as the Sensorama, a multisensory cinema booth, and the Telesphere Mask, the first wearable head-mounted display, which laid the foundations for an innovation destined to revolutionize many fields, including medicine. (<https://www.vr.org/about-us/history-of-vr/>)

Today, thanks to high-resolution VR headsets, haptic gloves, and sophisticated software, virtual reality has proven to be a useful tool in multiple applications, including: human simulation software, virtual robotic surgery, innovative

therapies for pain and psychological disorders, and also in nursing training during critical scenarios, improving decision-making readiness in high-stress situations. (Li et al., 2017).

Objective

This paper aims to systematically analyze the effectiveness of Virtual Reality (VR) interventions in the perioperative setting. The analysis is focused on the reduction of preoperative anxiety and specifically examines clinical feasibility and the nursing role in the implementation of such technologies.

Material and Methods

A systematic literature review was conducted, guided by the research question: "Can virtual reality alleviate preoperative anxiety in adults?" (research rationale).

The bibliographic search was carried out by consulting the main biomedical databases: PubMed (using MeSH terms and free-text keywords, with restriction to the Title/Abstract field to increase specificity), CINAHL, MEDLINE, Cochrane Library, and Science Direct. For the theoretical component, additional sources were examined, including Google Scholar and institutional academic resources.

To ensure a systematic and transparent review, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology was adopted. Inclusion criteria prioritized recent research (2019–2025) on adult patients undergoing surgical procedures, the use of virtual reality (VR) exclusively in the preoperative phase, and studies with complete data and full-text access. Excluded were surgical interventions outside the operating room setting (such as in dentistry), VR applications during the intraoperative phase, gray literature, and reviews.

The selection process involved the following phases: initial screening, exclusion of non-relevant studies, and search results: by

combining the search strings, 549 articles were identified. Of the 470 full-text articles retrieved and assessed, 455 were excluded, for a total of 15 studies considered in the review.

Results

The overall sample consisted of 1,507 participants. Although no geographic restrictions were applied, most of the evidence came from studies conducted in: Belgium, the Netherlands,

Hong Kong, Singapore, South Korea, Brazil, China, Germany, Iran, Turkey, and Australia.

Characteristics of the included studies are summarized in Table 1.

In the included studies, the experimental group (treated with the device under investigation) was compared with: hypnotherapy, standard care/routine clinical practice, control group (no treatment), conventional instructions, and tablet-based viewing.

Participants underwent: cardiac procedures

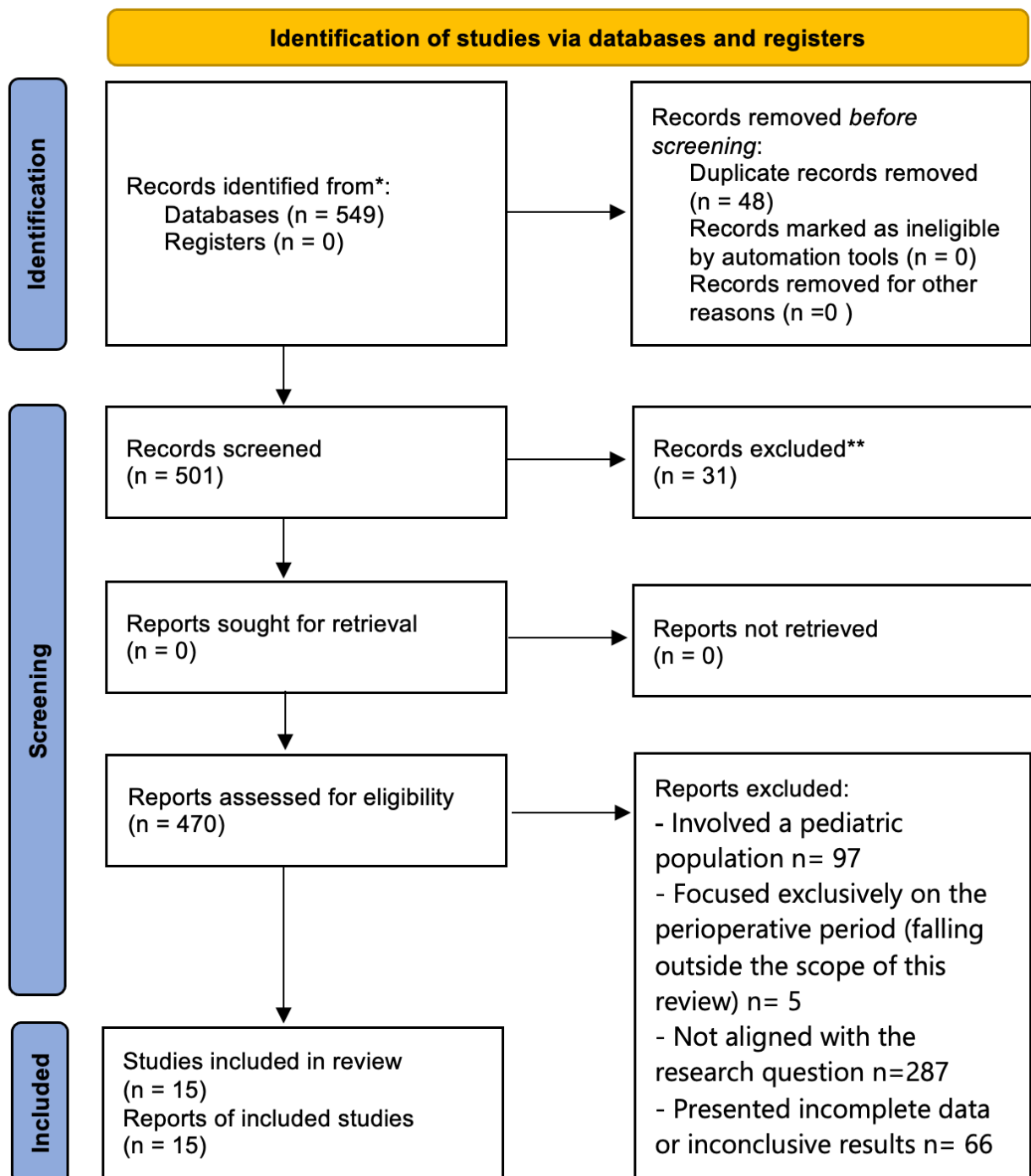


Figure 1. PRISMA 2020 flow diagram of study.

Table 1 (part 1). Characteristics, design, interventions, assessment tools, and main findings of the studies included in the review.

Autor/ Year	Setting/ Country	Design	Period	Role (participants and numbers)	Tools used	Goals	Principal results
1 Rosseaux et al. (2022)	Liege University Hospital, Belgium.	Prospective randomized controlled clinical trial.	October 2018 – January 2020.	A total of 100 patients (mean age 66; 24 women, 76 men) undergoing procedures such as coronary artery bypass grafting, mitral valve replacement, or multiple procedures were included.	Before and after each intervention, anxiety, pain, fatigue, and relaxation were assessed using the VAS scale (0–10), along with physiological parameters (heart rate, blood pressure, respiratory rate, pupil size, and oxygen saturation)	The primary objective was to evaluate the evolution of self-reported anxiety, pain, fatigue, and relaxation states in patients undergoing cardiac surgery, comparing the efficacy of hypnosis, virtual reality (VR), and a combination of the two (VRH) against a control group receiving standard care.	The study did not demonstrate an additional benefit of hypnosis, virtual reality, or their combination over standard care in improving postoperative anxiety, pain, or fatigue.
2 Chiu et al. (2023)	Pre-anesthetic evaluation clinic, Hong Kong	Prospective, randomized, blinded clinical trial	From July to December 2022	The study involved 74 participants aged 18 years or older awaiting their first elective surgery under general anesthesia.	Preoperative anxiety was measured using the APAIS scale. Secondary outcomes such as stress, preparedness, and pain were assessed using the VAS scale, as well as postoperative length of stay and satisfaction levels. Simulation sickness was evaluated using the Simulation Sickness Questionnaire.	The primary objective was to examine the efficacy of a virtual reality-based intervention with preoperative education in reducing preoperative anxiety compared to standard care.	The findings of this study indicate that a preoperative virtual reality-based intervention can effectively reduce anxiety and stress in patients awaiting elective surgery, while also improving their preparedness and satisfaction.
3 Chan et Al. (2020)	KK Women's and Children's Hospital, Singapore	Prospective cohort study	March 2019 – January 2020	108 patients undergoing elective minor gynecological surgeries.	Patients were assessed before and after the VR intervention using the HADS scale. Data on satisfaction and quality of life were also collected using the EuroQol 5 Dimensions 3-Level (EQ-5D-3L)	The study aimed to systematically evaluate the efficacy of two different virtual reality-based approaches in controlling preoperative anxiety, as well as their potential impact on reproductive outcomes.	The VR intervention demonstrated clinical efficacy, with a high level of patient satisfaction. The perceived improvement in discomfort and quality of life suggests a complementary role for VR in psychological preparation for surgery, especially for patients with high anxiety without the use of anxiolytic medications.
4 Pirard et al. (2025)	Cliniques universitaires Saint-Luc, Bruxelles	Double-blind randomized controlled clinical trial.	February 2017 – June 2019	The study involved 342 patients (aged between 18 and 42 years) candidates for medically assisted procreation techniques (IVF and ICSI).	Anxiety assessment was conducted using validated tools: the Visual Analogue Scale for anxiety (VAS) and the Spielberger State-Trait Anxiety Inventory (STAI).	The study aimed to systematically evaluate the efficacy of two different virtual reality-based approaches in controlling preoperative anxiety, as well as their potential impact on reproductive outcomes.	Although both VRD and VRH sessions before sedation in the operating room significantly reduced women's anxiety, the type of suggestions used during the VR hypnosis session did not influence the pregnancy rate.
5 Yang et Al. (2024)	Samsung Medical Center, Seoul	Open-label randomized controlled trial.	January 1, 2022 – February 28, 2023	88 patients with hepatocellular carcinoma (HCC) candidates for liver resection.	Anxiety was assessed using validated scales (STAI-X-1, STAI-X-2, and VAS) before and after the educational intervention, while knowledge of the procedure was measured using a specific questionnaire.	This study aimed to evaluate the impact of a virtual reality (VR) education program on anxiety and knowledge in patients with HCC undergoing liver resection.	The VR education program significantly improved knowledge and reduced anxiety among HCC patients compared to conventional methods.
6 Baytar et al. (2021)	Ecevit University Medicine Faculty Hospital, Zonguldak, Turchia	Prospective observational cohort study	October 1, 2020 – December 31, 2020	The study involved 40 adult patients (aged 18 to 65 years) with ASA physical status I-II.	Psychological parameters (STAI-S) as well as hemodynamic parameters were assessed before and after exposure to the virtual stimulus.	To evaluate the effects of an immersive virtual reality video on preoperative anxiety in patients candidates for elective septorhinoplasty.	This research confirms the potential of virtual reality as a complementary technique in preoperative preparation, particularly for elective surgical procedures.
7 Noben et al. (2019)	Máxima Medical Center, Netherlands	Randomized controlled trial.	November 2016 – January 2018.	It involved 80 women scheduled for elective cesarean section.	The primary outcome was the change in the Visual Analogue Scale for Anxiety (VAS-A) score upon admission. The Tilburg Pregnancy Distress Scale and the Childbirth Perception Scale were also administered.	This study aimed to evaluate whether a virtual reality video, added to standard preoperative information, could reduce anxiety levels before a scheduled cesarean delivery (CD).	The results showed no significant reduction in anxiety. However, in the subgroup of women with a previous emergency CD, a trend toward decreased anxiety emerged. 85% of women and 79% of partners in the VR group reported feeling more prepared after watching the video.
8 Aardoom et al. (2022)	Department of Cardiology, Leiden University Medical Center, Netherlands	Feasibility study.	January 6, 2020 – February 27, 2020.	The study involved 8 patients with a mean age of 67 years, awaiting elective cardiac catheterization	Presence Questionnaire and Immersive Tendencies Questionnaire for the degree of immersion; Client Satisfaction Questionnaire-8. To assess the usability of Pre- View, participants were asked to complete the System Usability Scale.	This study examined the efficacy of Pre-View, a reality app designed to guide patients through the entire cardiac catheterization pathway, with the aim of improving their psychological preparation.	In terms of perceived efficacy, all participants reported feeling better informed about the care process, with 88% stating that they felt better prepared for the procedure thanks to the app, and 75% acknowledging the potential of VR in reducing postoperative anxiety and stress.

Table 1 (part 2). Characteristics, design, interventions, assessment tools, and main findings of the studies included in the review.

Autor/ Year	Setting/ Country	Design	Period	Role (partecipants and numbers)	Tools used	Goals	Principal results
9 Vogt et al. (2021)	Department of Anesthesiology, RWTH Aachen University Hospital, Germany	Randomized controlled trial.	September 2020 – January 2021	84 patients undergoing elective surgery under general anesthesia.	The State-Trait Operation Anxiety (STOA) scale was used to assess perioperative state anxiety before and after the intervention. Additionally, user evaluations of VORT's usefulness were assessed with a rating questionnaire.	To examine the effect of a virtual operating room tour (VORT) on perioperative anxiety, comparing it with standard preparation (STOPP).	The results suggest that VORT, while not directly alleviating anxiety, addresses a need for clarity and preparation, critical elements for the patient experience. Patients rated the experience very positively, regardless of age or pre-existing anxiety level, suggesting that its value lies primarily in meeting the need for information and reducing uncertainty.
10 Liu et al. (2023)	Tertiary public hospital in Chengdu, China.	Single-blind, monocentric clinical trial.	November 2022 – February 2023	A total of 114 patients (aged 18–86 years) candidates for carotid artery stenting were enrolled."	The primary outcome, measured with the State Anxiety Inventory, was assessed before and after the intervention and at 24 hours post-intervention. Secondary outcomes included self-efficacy (SEMCD-6), sleep quality (monitored with a wristband), and satisfaction (VR Suitability and Satisfaction Questionnaire).	The study evaluated the efficacy of a virtual reality (VR) psychological intervention in reducing preoperative anxiety.	The use of a virtual reality psychological intervention was helpful in reducing patients' anxiety before CAS and improving their self-efficacy.
11 Bidgoli et al. (2023)	University-affiliated hospital in Kashan, Iran.	Prospective controlled observational study.	April to September 2022	105 individuals awaiting general surgery procedures.	It was administered a demographic questionnaire followed by the Spielberger State-Trait Anxiety Inventory. and the Mini-Mental Status Examination (MMSE), a cognitive screening test.	This study specifically focused on the comparative analysis between two different modalities of approach to the surgical environment – the traditional in-person one and the virtual reality-mediated one – comparing them with the standard preparation protocol.	Both familiarization modalities – physical and virtual – did not produce a statistically significant reduction in anxiety levels
12 Ugras et al. (2023)	General Surgery Unit of a university hospital in Mersin Province, Turkey.	Prospective, parallel, two-arm, randomized controlled trial.	June 2018 – May 2019	86 patients aged 18 to 65 years awaiting colorectal and abdominal wall surgery.	Anxiety was assessed using the ASSQ (Anxiety Specific to Surgery) questionnaire and by measuring physiological parameters.	To investigate the effects of a virtual reality (VR) application on preoperative anxiety (PA).	VR applications can effectively reduce both psychological and physiological responses to preoperative anxiety.
13 Mathari et al. (2024)	Department of Cardiothoracic Surgery, Amsterdam University Medical Center, Amsterdam, Netherlands.	Prospective, randomized, controlled, monocentric clinical trial.	April 2023 – July 2024	121 participants undergoing cardiac surgery.	Anxiety was measured using the STAI and APAIS, while satisfaction was assessed postoperatively through a customized questionnaire.	Evaluation of patient education on preoperative anxiety and satisfaction compared to traditional methods using virtual reality in cardiac surgery.	Although VR did not reduce preoperative anxiety, it significantly improved patient satisfaction; indeed, the experience proved effective in enhancing the perception of the information received, making it clearer and more engaging.
14 Schmid et al. (2024)	Gold Coast University Hospital (GCUH)	Monocentric, double-arm, single-blind randomized controlled clinical trial	May 2019 – December 2021	80 participants undergoing oncological gynecological surgery.	A novel six-level visual facial anxiety scale was used to assess preoperative fear, which correlated well with the Spielberger STAI questionnaire score. For the evaluation of secondary outcomes, specific patient characteristics were collected, such as age, type of procedure (laparotomy/laparoscopy/ other), and type of suspected tumor or anatomical site of the pathology.	The aim of this randomized controlled trial was to familiarize patients with the perioperative suite environment using VR technology and to assess whether this approach could reduce preoperative anxiety.	The results demonstrated that VR significantly reduced anxiety levels, both immediately after the intervention and in the period preceding surgery. In the VR group, the median anxiety score decreased from 3 to 2, while in the control group it remained stable at 4.
15 Hooglugt et al. (2022)	Amsterdam University Medical Center, Paesi Bassi.	Prospective, monocentric, randomized controlled trial	March 2019 – October 2020.	60 patients undergoing percutaneous closure of PFO or ASD.	The primary outcome was the change in pre-procedural anxiety, assessed using the STAI and APAIS questionnaires, completed during the outpatient visit (baseline) and one week before the procedure (follow-up).	This study was conducted to evaluate the effect of Virtual Reality (VR) as a means to educate patients in reducing pre-procedural anxiety in adult patients undergoing percutaneous closure of a patent foramen ovale (PFO) or atrial septal defect (ASD).	During follow-up, anxiety increased in the control group but remained unchanged in the intervention group. Patient education using virtual reality is effective in reducing pre-procedural anxiety in patients undergoing percutaneous closure of PFO or ASD.

(surgery, PFO/ASD closure, and catheterization), gynecological interventions (minor surgery, oocyte retrieval, cesarean section, oncology), general surgery (hepatocellular carcinoma, colorectal and abdominal wall procedures), septorhinoplasty, and carotid artery stenting.

In 11 out of 15 studies, the effectiveness of the intervention in reducing preoperative anxiety was demonstrated, especially in elective surgical settings. Assessments were conducted using validated scales, which allowed for the objectification of clinical parameters such as anxiety and perioperative pain.

The results show heterogeneous efficacy: while some studies demonstrate a significant reduction in anxiety, others report null outcomes, often due to methodological biases (e.g., non-representative samples) or a lack of standardization in VR scenarios. Several authors emphasize the need for further evidence to consolidate the findings.

Discussion

Virtual reality has proven to be a promising tool in the management of preoperative anxiety, although its efficacy varies depending on the clinical context, type of intervention, and patient characteristics. The studies analyzed reveal conflicting results, suggesting that VR is not a one-size-fits-all solution but rather a technology whose success depends on proper implementation and personalization.

This concluding section critically analyzes the emerging data, focusing on five main outcomes that emerged.

Actual effectiveness in reducing preoperative anxiety

The intervention proved effective in reducing anxiety in 11 out of 15 studies, particularly in elective surgical settings. In the study by Chiu et al. (2023), concerning elective surgery, a 30% reduction in APAIS scores was recorded ($p < 0.001$). In the study by Chan et al. (2020), in the gynecological setting, a decrease in anxiety scores on the HADS scale was observed, from 7.2 to 4.6 ($p < 0.0001$). However, some studies did not find significant benefits compared to standard care. This is the case with the studies by Rosseaux et al. (2022) (cardiac surgery) and Noben et al. (2019) (cesarean section), which

found no additional benefits over standard care; Mathari et al. (2024) (cardiac surgery) and Bidgoli et al. (2023) (physical/virtual tour) showed no significant differences.

Why do some studies fail? Populations with complex needs: patients in high-stress settings (e.g., cardiac surgery or cesarean section) may derive less benefit from non-pharmacological tools compared to other groups. Rosseaux et al. (2022) specified that VR in cardiac surgery is not sufficient to overcome postoperative physical stress. Bidgoli et al. (2023) argued that familiarization with the operating room (physical or virtual) does not modify anxiety unless accompanied by psychological support.

Content and patient experience

Users involved in the studies experienced different types of virtual environments, classified into two macro-categories:

- **Relaxing/natural environments:** relaxing landscapes such as beaches, forests, mountains with music and breathing techniques (Chan et al. 2020), immersive videos of oceans and nature (Baytar et al. 2021), virtual walks on the beach or in the woods (Ugras et al. 2023). These scenarios primarily act as a distraction, reducing anxiety through sensory relaxation.
- **Medical-surgical environments:** operating room tours with procedural explanations (Chiu et al. 2023), interactive 3D liver models for preoperative education (Yang et al. 2024), virtual pathway related to cardiac catheterization without the procedure (Aardoom et al. 2022). These approaches aim to reduce uncertainty by improving patient preparation through gradual exposure.

Differences: Natural environments are more effective for patients with generalized anxiety (Chan et al. 2020). Procedural tours work better when anxiety is related to lack of information (Liu et al. 2023).

Mechanisms influencing the effect of VR

- **Duration:** Short sessions (5–10 min) are sufficient for distraction (Noben et al. 2019); long sessions (15–20 min) are necessary for education (Pirard et al. 2025).
- **Interactivity:** VR with active interaction increases engagement (the user is involved; an

example was the quiz during VR in Aardoom et al. 2022); passive VR (such as 360° videos) is less effective in reducing anxiety in the long term (Bidgoli et al. 2023).

- **Target population:**

- Patients with high anxiety (STAI-T > 40) benefit more from VR (Liu et al. 2023, Chan et al. 2020) compared to those at low risk (Rosseaux et al. 2022).

- Women show higher anxiety (Mathari et al. 2024 and Schmid et al. 2024 report that women show significantly higher levels of preoperative anxiety than men, even after VR interventions).

- Age: elderly patients are less receptive (Yang et al. 2024 excludes >70 years due to risk of motion sickness); they may require low-immersion content such as 2D videos with clear audio, avoiding rapid movements; furthermore, one could focus on family members/caregivers, involving them in the VR experience (Hooglugt et al. 2022: partner watching the video together). Young patients and ASA I respond better (Chiu et al. 2023).

- Surgical context: elective vs. urgent surgery: VR is more effective in planned procedures (Chiu et al. 2023 vs. Rosseaux et al. 2022) and procedure complexity: oncology patients (Schmid et al. 2024) or cardiac patients (Hooglugt et al. 2022) benefit more from virtual preparation.

- Optimal settings identified: preoperative area (Chiu et al. 2023), waiting room (Chan et al. 2020), home setting (Aardoom et al. 2022).

Impact on clinical outcomes (pain, satisfaction, stress)

Impact on pre- and postoperative pain

Although VR has been studied primarily for preoperative anxiety, several of the analyzed studies evaluate its impact on pain (also assessing analgesic medication consumption), with conflicting but promising results.

Regarding preoperative pain, an indirect reduction emerged. In the study by Chan et al. (2020) on gynecological surgery, VR improved the subjective perception of pain (measured with the VAS scale) through anxiety reduction; lower dosages of postoperative NSAIDs and opioids were also recorded, although these data were not statistically significant. Similarly, in Ugras et al.

(2023), VR normalized physiological parameters such as reduced heart rate and increased oxygen saturation, suggesting an effect on the autonomic nervous system that may modulate pain sensitivity. This translated into a reduced need for additional analgesic medications in correlation with stress reduction.

Regarding postoperative pain, the results are mixed. On one hand, no direct effect was found: Rosseaux et al. (2022) in cardiac surgery showed no differences in morphine use, other analgesics, or postoperative pain between the VR group and the control group, and Chiu et al. (2023) demonstrated that VR did not influence postoperative analgesic consumption. On the other hand, indirect positive effects also emerged: Ugras et al. (2023) showed a reduction in postoperative blood pressure and heart rate, markers of reduced pain-related stress. Furthermore, Liu et al. (2023) in carotid stenting found an improvement in self-efficacy (SEMCD-6) in the VR group, which may translate into better pain management; in the same study, the measurement of tramadol use in the first 24 hours revealed a trend toward lower use in the VR group (-15%, $p=0.07$).

Increased satisfaction in all articles

Why is it important? VR as a patient engagement tool: increasing satisfaction can improve adherence to care (postoperative follow-up).

Why does VR increase satisfaction?

- Improved perception of care: Virtual operating room tours reduce uncertainty, giving patients a sense of control over the process. In the study by Yang et al. (2024), patients appreciated the 3D visualization of their own liver, perceiving greater personalization of care, while in the study by Noben et al. (2019) (cesarean section), VR did not reduce anxiety, but 85% of women felt "more prepared."

Furthermore, VR demystifies complex procedures (e.g., cardiac catheterization in Aardoom et al. 2022), increasing trust in the healthcare team. Finally, the time spent in VR is interpreted as additional care (Schmid et al. 2024: patients report feeling "more listened to").

Although in the analysis by Bidgoli et al. (2023), satisfaction was also high in the group with a physical operating room tour, suggesting that the attention provided by nurses (not just the time spent using the device) matters.

- Technological novelty: The use of VR headsets is perceived as innovative and reassuring. In the study by Mathari et al. (2024), 91% of patients rated the experience as "excellent," and in Chan et al. (2020), 82% of patients defined VR as "fun" or "relaxing," despite the invasive procedure.
- Reduction of hospital stigma: Natural environments in VR create a positive association with the clinical setting (Baytar et al. 2021).

Reduction of preoperative stress.

Only 1/3 of the studies, i.e., 5 out of 15, explicitly measured stress, but positive results nonetheless emerged: Chiu et al. (2023) observed a marked decrease in perceived stress (-10.68 points on the VAS scale) with effects lasting up to the time of surgery. Ugras et al. (2023) recorded objective improvements: heart rate, blood pressure, and oxygen saturation stabilized after only 10 minutes of VR with natural environments. Liu et al. (2023) highlighted how VR combines stress reduction and increased self-efficacy, suggesting a dual mechanism of action (distraction + empowerment).

Nurse education on the use of VR in the preoperative setting

Training nursing staff in the use of virtual reality emerges as a critical factor for the effective implementation of these protocols, although few studies systematically address this aspect. From the review of the analyzed articles, two key points emerge:

1. Need for specific training: Several studies emphasize that the nurses involved in the studies received dedicated training sessions.
- Chiu et al. (2023): nurses were trained for 30 minutes on how to configure the headsets, adjust interpupillary distance, and manage technical issues.
 - Aardoom et al. (2022): staff were trained to use the Pre-view app for cardiac catheterization, with a focus on interaction with elderly patients.
 - Schmid et al. (2024): a standardized procedure was created to ensure correct VR administration in gynecological oncology.

- In Noben et al. (2019), nurses played a key role in reassuring women during the VR tour of cesarean section, demonstrating that communication skills are as important as technical ones.
- In Ugras et al. (2023), the lack of a standardized protocol led to differences in VR application among nurses, with possible effects on outcomes.

However, no study evaluated the impact of different levels of training on patient outcomes, and there was no standardization: each study adopted ad hoc training protocols that are not replicable.

Required skills: Technical: device configuration, troubleshooting (e.g., headset calibration). Psychological support: guiding patients through the VR experience, especially in cases of high anxiety or discomfort. Hygiene: management of disposable covers and device disinfection (a critical issue emerged in Chiu et al. 2023 and Liu et al. 2023).

In summary, nurse education on VR is fundamental but underestimated in the literature. Structured training (technical + psychological), evaluation of the impact of nursing skills on outcomes, and standardized guidelines to ensure uniformity are needed.

Study limitations

Self-assessment bias (use of subjective scales without physiological markers such as cortisol or heart rate in many studies), non-representative samples with limited generalizability, lack of standardization, and no study directly comparing VR with anxiolytics (although Chan et al. 2020 suggests a complementary role).

Why invest in virtual reality in the medical-surgical setting? This represents a strategic choice that combines therapeutic innovation with healthcare sustainability, acting on three main fronts: patient well-being, clinical efficiency, and cost reduction.

The starting point is the management of preoperative anxiety, which affects a significant percentage of patients, increasing the risk of complications such as hypertension and postoperative nausea, and consequently prolonging recovery times. VR presents itself as a non-pharmacological solution, demonstrating in clinical studies an efficacy comparable to

midazolam but without its systemic side effects. The adoption of VR can lead to a reduction in the use of anxiolytics, generating a positive chain reaction: calmer patients at the time of anesthetic induction translate into fewer delays in the operating room, faster turnover, and significantly greater patient satisfaction.

A second pillar is the reduction of acute pain and opioid consumption. The opioid dependence crisis makes the search for effective alternatives crucial. VR, acting through a powerful immersive distraction mechanism, can reduce pain perception by 20–50%, consequently decreasing the demand for potent analgesics. Lower opioid use means not only a better safety profile for the patient, with reduced adverse effects such as nausea and constipation, but also lower direct costs for medications and potentially shorter hospital stays.

The model is also sustainable from an economic perspective. A cost-benefit analysis estimates that the initial investment for a medical-grade headset and dedicated software could pay for itself within 1–2 years. Savings derive from multiple sources: reduced use of anxiolytic and analgesic medications, a 10% reduction in operating room time allowing for more procedures to be performed, and a decrease in costly postoperative complications, with a reduction in readmissions. Therefore, VR is not a cost but an investment that self-finances through improved clinical efficiency. It is appropriate to add that the final economic outcome depends on the organizational ability to implement it efficiently and on a large scale.

Conclusions

The most effective virtual reality intervention appears to depend on the specific objective to be achieved. When the primary goal is to reduce preoperative anxiety, a short procedural virtual tour may represent the most appropriate approach, whereas naturalistic videos combined with music or other auditory stimulation may be more suitable when the aim also includes reducing perceived pain. Personalized three-dimensional content may instead offer greater potential for actively engaging patients in their care. None of the studies included in this review evaluated an integrated protocol combining procedural tours, natural environments, and personalized 3D educational content, suggesting

a relevant area for future investigation.

Several limitations should be considered when interpreting the available evidence, including the frequent use of subjective self-assessment scales without complementary physiological measures, non-representative samples, limited generalizability, substantial heterogeneity among VR interventions, and the absence of direct comparisons between VR and pharmacological anxiolytic strategies. Nevertheless, the findings suggest that virtual reality may represent a promising non-pharmacological approach to the management of preoperative anxiety, with potential benefits for patient experience, perioperative pain, stress, satisfaction, and engagement. Its implementation may also contribute to reducing reliance on anxiolytic and analgesic medications and improving organizational efficiency, although the economic sustainability of VR programs depends on local workflows, implementation strategies, equipment costs, and the ability of healthcare organizations to integrate the technology effectively into routine practice.

Future research should therefore focus on longitudinal evaluation of postoperative recovery and medication use, personalization of VR content according to individual psychological characteristics, and the development of standardized protocols defining the duration, content, timing, and clinical indications of VR interventions. Emerging technologies such as biofeedback, generative artificial intelligence, and mixed reality may further increase personalization and interactivity by allowing virtual environments to respond dynamically to physiological parameters and patient behavior. Overall, moving from isolated experimental applications toward structured and reproducible perioperative VR pathways will require further clinical evidence, standardized implementation models, and appropriate professional training.

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