

## Immersive Virtual Reality-Based Distraction in Post-Surgical Pain and Anxiety Management: A Systematic Review

Susi Dwi Utarti<sup>1\*</sup>, Masfuri<sup>2</sup>, Liya Arista<sup>2</sup>, Sri Yona<sup>2</sup>

<sup>1</sup> Master of Nursing Student, Faculty of Nursing, University of Indonesia, Depok, Indonesia

<sup>2</sup> Medical-Surgical Nursing, University of Indonesia, Depok, Indonesia

\*Corresponding Author Email: [susi.dwiutarti@gmail.com](mailto:susi.dwiutarti@gmail.com)

Copyright: ©2026 The author(s). This article is published by Media Publikasi Cendekia Indonesia.

### ARTICLES

Submitted: 08 October 2025

Accepted: 12 December 2025

#### Keywords:

Health Service Utilization, HIV, Men Who Have Sex with Men (MSM), Risky Sexual Behaviour, Social Support

OPEN ACCESS



This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License

Access this article online



Quick Response Code

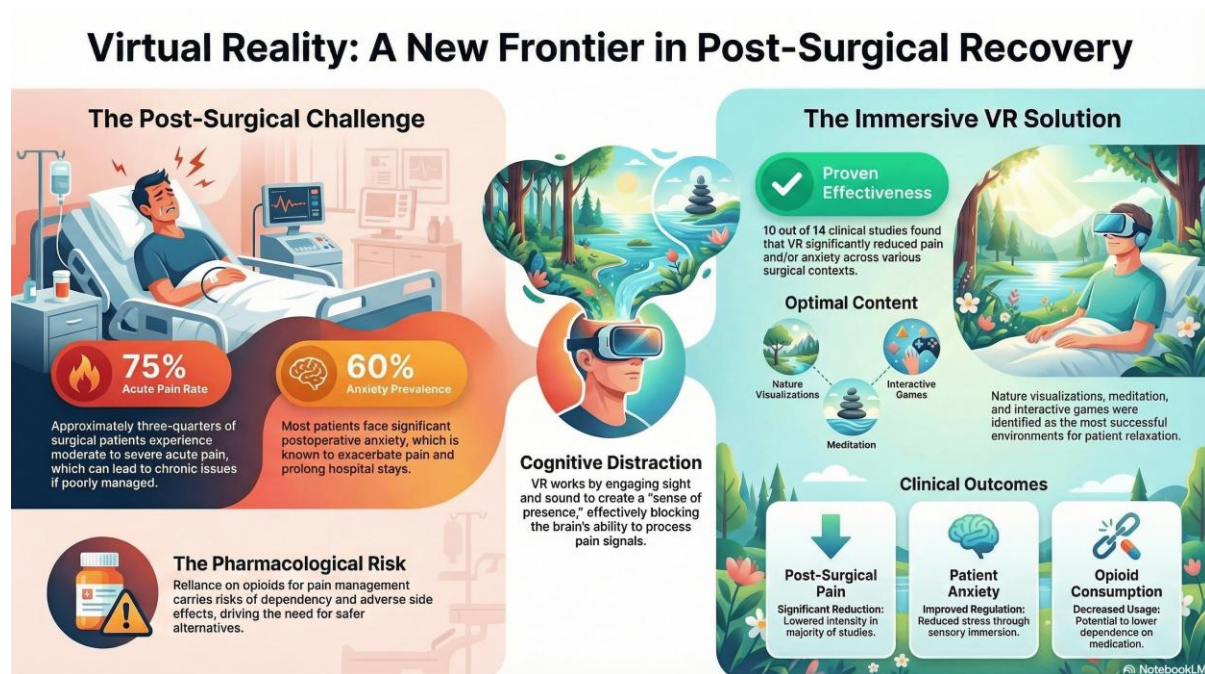
### ABSTRACT

The effective management of postoperative pain and anxiety remains a challenge in patient care. Immersive virtual reality (IVR)-based distraction has been proposed as a non-pharmacological intervention to help reduce these symptoms. This study aimed to evaluate the effectiveness of immersive VR-based distraction in reducing postoperative pain and anxiety. This systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines by identifying studies that assessed immersive VR-based distraction in postoperative patients. Studies published from 2015 to 2025 were searched in ClinicalKey Nursing, EbscoHost, ProQuest, ScienceDirect, Scopus, and Taylor and Francis databases. Fourteen randomized controlled trials (RCTs) were included, covering various surgical contexts such as orthopedic, abdominal, cardiac, and oral surgery. Most studies showed that immersive VR-based distraction effectively reduced postoperative pain and anxiety, although some reported no significant effect. Variations in outcomes were influenced by patient characteristics, duration and frequency of VR use, and the type of VR content. Studies were excluded if they involved non-postoperative populations, pediatric samples, non-immersive VR, or non-interventional designs. Overall, immersive VR-based distraction shows promise in reducing postoperative pain and anxiety, although variability in effectiveness highlights the need for further research on technical parameters and clinical implementation.

#### Key Messages:

- Immersive virtual reality (IVR)-based distraction is a promising non-pharmacological intervention for managing postoperative pain and anxiety
- While most studies demonstrate significant reductions in pain and anxiety, variability in outcomes underscores the importance of tailoring VR interventions
- The findings support the integration of immersive VR into multimodal pain and anxiety management protocols

## GRAPHICAL ABSTRACT



## INTRODUCTION

Surgical procedures can significantly impact patients' physical and psychological well-being (1). After surgery, pain and anxiety are the two most common problems experienced by patients (2). According to research by Süner et al. (2019)(3), approximately 75% of patients undergoing surgery experience acute pain of moderate to severe severity. This percentage requires serious attention because suboptimal postoperative pain management can increase the risk of chronic pain, increase morbidity, functional impairment, reduce quality of life, prolong recovery time, prolonged opioid use, and increase healthcare costs (4,5). In addition to pain, approximately 60% of patients also experience anxiety after surgery (6). This anxiety can exacerbate postoperative pain, increase analgesic use, and negatively impact patients' quality of life. Furthermore, anxiety can prolong hospital stays and decrease patient satisfaction with the healthcare services received (7,8) Inadequate management of postoperative pain and anxiety can impact the recovery process and increase patient care costs.

Postoperative pain management aims to minimize the negative impact of pain and help patients return to normal function (9). Pain management can be achieved through various modalities, including pharmacological, non-pharmacological, interventional therapy, and surgical interventions (10). However, pain management using pharmacological modalities often carries the risk of dependency and side effects that patients cannot tolerate (10). This situation has led to the increasing preference for non-pharmacological pain management as a safer alternative (11).

One non-pharmacological method used in pain management is distraction techniques using immersive virtual reality (IVR) technology. Distraction functions as a mechanism to divert the patient's focus from the painful stimulus (12). Virtual reality technology offers an alternative for reducing pain intensity through interactive experiences in virtual environments that can divert attention and increase patient comfort (13). Furthermore, the application of VR in pain therapy has the potential to reduce dependence on opioid use (14), with the main advantage being minimal side effects, making it relatively safe for use in clinical practice (15).

Virtual reality technology works by engaging multisensory modalities such as visual and auditory to create an immersive experience that distracts patients from pain (16). Compared with conventional distraction methods such as watching television or listening to music, immersive VR provides a three-dimensional, interactive environment that enhances the sense of presence and more effectively

blocks external sensory input. This deeper level of immersion allows patients to shift their attention away from pain and anxiety more completely than standard distraction techniques.

In recent years, virtual reality technology has become increasingly used in pain and anxiety management. Several studies have explored the effectiveness of virtual reality in reducing pain and anxiety in patients undergoing surgery. Llerena et al. (2024)(7) found that virtual reality can reduce preoperative anxiety and postoperative pain in pediatric patients. Martinez-Bernal et al. (2023)(17) found that virtual reality reduced acute pain, fear, and anxiety during oral surgery. However, Rousseaux et al., (2022)(18) found that virtual reality did not significantly reduce postoperative pain in cardiac surgery patients. These inconsistent findings suggest that the effectiveness of immersive VR in postoperative care remains unclear.

The varied research results indicate the need for a systematic review to evaluate the effectiveness of virtual reality therapy, especially in pain and anxiety management in postoperative patients. This systematic review aims to comprehensively assess the effectiveness of immersive virtual reality-based distraction in reducing pain and anxiety in post-surgical patients. The results are expected to provide a scientific basis for developing more effective, evidence-based care practices.

## **METHODS**

This systematic review was structured following the Preferred Reporting Items for Systematic Review and Metaanalysis (PRISMA) guidelines (19). The primary focus of this review was to evaluate the effect of immersive virtual reality-based distraction interventions on reducing postoperative pain and anxiety. The initial step was to formulate a PICO (Population, Intervention, Comparison, Outcome) question: "Is immersive virtual reality-based distraction effective in reducing pain intensity and anxiety in postoperative patients?" The authors included RCTs that met the following criteria: (1) participants were male and female adult postoperative patients; (2) the intervention was virtual reality distraction; (3) the comparison group received standard care or a non-virtual reality intervention; (4) the study was published in English; and (5) the study outcomes included measures of pain and/or anxiety. Studies with pediatric participants or studies focusing on preoperative and intraoperative interventions were excluded from this review. Additional exclusion criteria included non-RCT study designs (such as case reports, protocols, and observational studies), articles not available in full text, studies not written in English, and studies that did not assess postoperative pain or anxiety outcomes.

The authors searched English-language databases including ClinicalKey Nursing, EbscoHost, ProQuest, ScienceDirect, Scopus, and Taylor and Francis from 2015 to 2025. MEDLINE-indexed records were accessed through the EBSCOhost platform; therefore, PubMed was not searched separately. Studies were identified using the following keywords: "postoperative" or "post-surgical" or "surgery" or "surgical" or "post-surgery" and "immersive virtual reality" or "virtual reality" or "VR distraction" or "VR therapy" or "VR-based distraction" and "pain" or "pain management" or "postoperative pain" or "analgesia" and "anxiety" or "postoperative anxiety." There were no country restrictions when searching articles. Duplicate records were removed using Mendeley Desktop. Title and abstract screening, followed by full-text assessment, was conducted manually by two independent reviewers (SDU and SY). Any discrepancies were resolved through discussion. Data extraction was performed manually using a standardized Excel spreadsheet, which included study characteristics, sample details, VR intervention parameters, and outcomes related to pain and anxiety.

### **Study Quality Assessment**

In this systematic review, the quality of 14 studies was assessed using the Joanna Briggs Institute's Critical Appraisal Checklist for RCTs. (JBI) consists of 13 questions (20). Each "yes" answer was given a score of one. The JBI quality scores of the included RCTs ranged from 9 to 11 out of a maximum score of 13. The quality appraisal was conducted independently by two reviewers (SDU and SY).

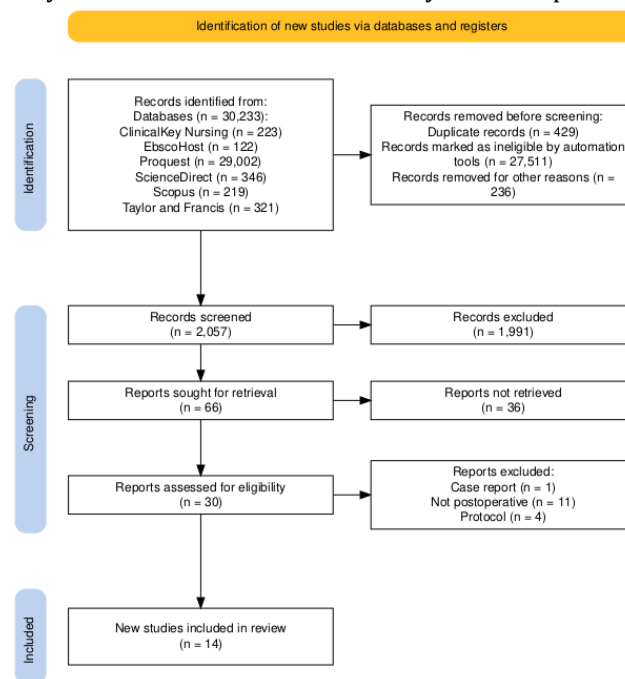
### **Data Extraction**

Data extraction was performed independently by two reviewers (SDU and SY). The extracted information included study characteristics (authors and year), participant characteristics (country, sample

size, type of surgery), intervention characteristics (content, duration, and frequency of virtual reality use), measurement tools, timing of outcome measurement, study outcomes, and study quality. Any discrepancies in the extracted data were resolved through discussion.

## RESULTS

The initial search strategy yielded 30,233 articles. Of these, 28,176 articles were excluded due to duplication and not meeting the criteria. Furthermore, based on title and abstract screening, 1,991 articles were excluded because they were out of scope, including studies that did not involve immersive virtual reality, were not conducted in postoperative settings, did not assess pain or anxiety outcomes, or did not use interventional designs. After that, 36 articles were excluded because they were not available in full text. Furthermore, 16 other articles were excluded because they were case reports (n = 1), protocols (n = 4), or interventions not conducted in postoperative settings (n = 11). After completing this screening process, 14 RCTs were included in this systematic review. The entire study selection process is illustrated in Figure 1.



**Figure 1. PRISMA Flowchart**

The quality of the 14 included RCTs was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for RCTs. The JBI scores ranged from 9 to 11 out of a maximum of 13. No studies were excluded based on their quality appraisal scores.

In this systematic review, a total of 1,098 patients were included across 14 studies analyzed. The sample size of each study ranged from 17 to 181 participants (Table 1). All VR interventions were conducted in a hospital setting, with one study continuing the intervention in the patient's home and another in a rehabilitation center. The studies were conducted in various countries, including the United States, the Netherlands, China, Turkey, Iran, Israel, Saudi Arabia, Romania, Australia, and Egypt. The VR intervention content used included nature visualization, relaxation music, meditation, games, and walking videos, and submarines. The duration of each intervention session ranged from 5 to 30 minutes.

The research instruments used to measure pain and anxiety included the Visual Analog Scale (VAS), Numeric Pain Rating Scale (NPRS), Hospital Anxiety and Depression Scale (HADS), Faces Anxiety Scale (FAS), and State-Trait Anxiety Inventory (STAI) (Table 1). Of the 14 articles, four specifically assessed the effectiveness of VR on pain alone, while the other ten evaluated the effectiveness of VR in reducing pain and anxiety. Of the 14 studies, seven demonstrated a significant effect of VR in reducing post-surgical pain and anxiety (18,21–26). Several other studies have also shown the effectiveness of VR on post-surgical pain, although its effect on anxiety was not specifically studied (27–29). However, different results were

shown by research by Yesilot et al. (2022)(30) that VR was effective in reducing pain, but not significantly in reducing anxiety. Conversely, research by Lier et al. (2024)(31) showed that VR was not effective in reducing post-surgical pain, but was effective in reducing anxiety. Meanwhile, research by Rhodes et al. (2024)(32) showed that VR was not effective in reducing pain or anxiety in post-surgical patients. These findings are in line with the results of the study by McCune et al. (2023)(33) which stated that VR did not provide a significant reduction in pain intensity (Table 1).

**Table 1. Data Extraction**

Researcher, year, country	Sample (n)	Virtual environment	Design	Intervention	Assessment tools	Variables	Measurement time variables	Results	JBI score
Rhodes et al. (2024) (32) United States	181 patients orthopedic surgery for acute trauma	Immersive VRH with river visualization	RCT with three group	VR hypnosis 1-2 sessions preoperatively and 2-5 sessions postoperatively, 30 minutes per session	GRS MOS	Pain Anxiety Sleep quality	2-5 times during recovery. Timing not specified	No significant difference in reducing pain (p = 0.71) and anxiety (p = 0.81) postoperatively.	10/ 13
Lier et al. (2024) (31) Netherlands	100 patients major surgery	I: HMD with 2D display, nature videos II: HMD with 360° 3D display, nature videos, and meditation III: HMD with 360° 3D display, participant-selected content (documentary, meditation, game)	Exploratory RCT	VR 3 times daily for 10 minutes per session on days 1-4 after surgery	VAS STAI-6	Pain Anxiety Stress	Days 1-4 postoperatively	VR showed no effectiveness in reducing pain (p = 0.43) VR was effective in reducing stress (p = 0.01) and anxiety (p = 0.03)	10/ 13
McCune et al. (2023) (33) United States	30 patients laparoscopic hysterectomy	VR content chosen by participant: Meditation with natural visual experiences Merry Snowballs. Sedona scenery with music. Forest of Serenity tour.	RCT	On-demand VR. Mean duration of VR use: 27.4 ± 16.6 minutes	VAS MME	Pain Opioid consumption	Every 30 minutes during the patient's PACU stay	VR did not show a significant effect on reducing postoperative pain (p = 0.39) or opioid consumption (p = 0.88)	10/ 13
Wang et al. (2024) (25) China	115 patients gynecological laparoscopy	Natural visualization (tropical rainforest, birdsong and insect sounds) RCT 15 minutes before surgery	RCT	15 minutes before surgery	VAS HADS NRS	Pain Anxiety Sleep quality	30 minutes, 2, 4, 8, 12, and 24 hours postoperatively	VR was effective in reducing preoperative anxiety (p<0.001) and postoperative pain (p<0.05). VR was effective in improving sleep quality (p<0.001)	10/ 13
Gür & Başar (2023) (28) Turkey	21 patients TKA	Video walking to reduce kinesiophobia and pain catastrophizing	RCT parallel	VR 10 minutes per session, twice a week for 3 weeks, before	NPRS TKS PCS TUG SCT WOMAC SF-36	Pain Kinesiophobia Pain catastrophizing	Postoperative day 1: baseline measurement Week 4: Evaluation after VR	VR was effective in reducing pain (p = 0.005), kinesiophobia (p = 0.006), and pain catastrophizing (p = 0.012).	10/ 13

Researcher, year, country	Sample (n)	Virtual environment	Design	Intervention	Assessment tools	Variables	Measurement time variables	Results	JBI score
				physical exercise		Knee flexibility TUG SCT	intervention and exercise completion	• VR improved knee flexibility (p=0.010) and physical function (p=0.017)	
Yesilot et al. (2022) (30) Turkey	110 patients LSG	VR videos with nature visualizations (mountains, seas, forests) and relaxation music	Parallel RCT	VR for 30 ± 5 minutes, Once	NPRS FAS	Pain Anxiety	10 minutes after intervention	VR was effective in reducing pain (p<0.001) • VR was not significant in reducing anxiety (p=0.087)	10/ 13
Abbasnia et al. (2023) (21) Iran	150 patients laparoscopic cholecystectomy	360-degree nature images and educational animation	RCT	5-minute VR 2 hours before and 4 hours after surgery	Spielberger's State Anxiety Inventory VAS McGill Pain Questionnaire	Anxiety Pain	2 hours before surgery and 4 hours after the first analgesic dose	Distraction and educational VR effectively reduced preoperative anxiety (p<0.001) and postoperative pain (p<0.001)	10/ 13
Fuchs et al. (2022) (26) Israel.	55 patients TKA	Nature films or music films in VR	Prospective RCT	15 minutes per session, 1 session per day for 2 days	STAI VAS WOMAC	Pain Anxiety	Day 1 and 2 post-operatively, and 6 months post-operative	VR reduced pain (p<0.05) and anxiety (p<0.05) in the short term but was not more effective than conventional physiotherapy in improving long-term knee function	9/ 13
Rousseaux et al. (2022) (18) Belgium	100 patients cardiac surgery	Mountain landscape with lake backdrop at sunrise and relaxation above the clouds with ambient nature sounds	Prospective RCT	20 minutes per session, one day before and one day after surgery	VAS	Pain Anxiety Opioid use	One day before and one day after surgery	VR and VRH were effective in reducing anxiety (p=0.023). VR was ineffective in reducing pain (p<0.0001) and opioid use (p=0.63)	9/ 13
Abdelmoniem Ibrahim et al. (2024) (22) Saudi Arabia	40 patients Radical Modified Radical Mastectomy	VR system "Pablo" is an interactive, immersive game-based	RCT	15 minutes per session, three times a week for 8 weeks. Each session consisted of five games, each lasting 3 minutes	VAS SAI	Pain Anxiety	before intervention, after 4 weeks of intervention, and after 1-month follow-up	VR effectively reduced pain (p<0.001) and anxiety (p<0.001)	12/ 13
İnce & Karaman Özlü (2024) (23) Turkey	80 patients Spinal anesthesia (Cesarean section)	Samsung Gear VR (nature, seaside, submarine)	RCT	20-25 minutes	VAS VCS SAI	Pain Anxiety Oxygen saturation	Preoperative, intraoperative, postoperative (at 1, 2, 4, 8, 12, 24, and 48 hours after surgery)	VR effectively reduced pain (p<0.001), anxiety (p<0.05), and headache. • VR was shown to be effective in increasing oxygen saturation (p<0.05)	10/ 13
Droc et al. (2023) (27) Romania	51 patients major abdominal surgery	Natural scenery (hills, forest, sea)	Prospective RCT	Immersive VR for 5–8 minutes 24–48 hours after surgery	VAS MMSE	Pain Cognitive deficits	24 and 48 hours postoperative	VR significantly reduced pain intensity (p=0.04) VR had no impact on short-term postoperative	10/ 13

Researcher, year, country	Sample (n)	Virtual environment	Design	Intervention	Assessment tools	Variables	Measurement time variables	Results	JBIScore
Payne et al. (2022) (29) Australia	35 patients gynecological laparoscopy	Oculus Go (Sky Lights 2 active VR and Cosmic You passive VR)	Randomized crossover pilot trial	2 sessions, each session 10 minutes	NRS	Pain Opioid use	0, 10, 20, 30 minutes postoperative	cognitive deficits (p=ns) VR significantly reduced pain (p<0.0005) and opioid use (p=0.04)	11/ 13
Mogahed et al. (2024) (24) Egypt	30 patients Modified radical mastectomy	VR smartphone-based	RCT	30 minutes per session, 3 times a week for 3 weeks	VAS Anxiety Rating Scale	Pain Anxiety	Pre-intervention, post-intervention (3 weeks)	VR significantly reduced pain (p<0.001) and anxiety (p<0.001)	10/ 13

Notes: Joanna Briggs Institute (JBI), Virtual Reality Hypnosis (VRH), Randomized Controlled Trial (RCT), Virtual Reality (VR), The Graphic Rating Scale (GRS), Medical Outcome Study Sleep Problem Index (MOS), Head-mounted display (HMD), Visual Analog Scale (VAS), State-Trait Anxiety Inventory (STAI-6), Morphine Milligram Equivalent (MME), Post Anesthesia Care Unit (PACU), Hospital Anxiety and Depression Scale (HADS), Numerical Rating Scale (NRS), Total knee arthroplasty (TKA), Numerical Pain Rating Scale (NPRS), Tampa Kinesiophobia Scale (TKS), Pain Catastrophizing Scale (PCS), Timed Up and Go Test (TUG), Stair-Climb Test (SCT), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Short Form-36 (SF-36), Laparoscopic sleeve gastrectomy (LSG), Faces Anxiety Scale (FAS), State Anxiety Inventory (SAI), Verbal Category Scale (VCS), Mini-Mental State Examination (MMSE).

## DISCUSSION

The focus of this fourteen-article review was to assess the effectiveness of immersive virtual reality-based distraction in adult patients undergoing surgical procedures. Virtual reality (VR) is a computer technology that presents an immersive three-dimensional world in which users interact as if they were actually interacting (34). VR technology utilizes distraction methods involving multisensory visual and auditory modalities (16). The mechanism of VR in reducing pain is through cognitive distraction, shifting the patient's focus to more engaging virtual stimuli (35). In this process, users interact with stimuli through their senses of sight, hearing, and touch simultaneously to divert attention from cognitive processes (36). This concept aligns with the Interaction Model described by Tedja (2025)(37), which emphasizes that the effectiveness of distraction-based interventions including VR is shaped by the dynamic interaction between nurses, patients, and the clinical environment.

Most of the studies reviewed demonstrated that the use of VR technology is effective in reducing post-surgical pain and anxiety. In this systematic review, ten articles supported these findings. The study by Wang et al., (2024)(25) even revealed that VR intervention not only reduced pain and anxiety but also significantly improved sleep quality in post-surgery patients ( $p < 0.001$ ). Furthermore, research by Payne et al. (2022)(29) demonstrated that VR was effective in reducing pain while decreasing opioid consumption ( $p = 0.04$ ). In patients undergoing spinal anesthesia during cesarean sections, VR was shown to significantly increase oxygen saturation ( $p < 0.05$ ) (23). Consistent with these findings, a qualitative study by Lier et al. (2023)(38) also confirmed that VR helps reduce pain and anxiety by providing distraction, relaxation, and increasing privacy for post-surgery patients.

These findings are in line with other non-pharmacological interventions such as Quranic recitation therapy in hemodialysis patients, which has also been shown to reduce anxiety and enhance patient comfort (39). This suggests that sensory-stimulation-based approaches whether through spiritual audio or immersive VR have significant potential in improving patient well-being. Similarly, research on lavender aromatherapy by Kumalasari et al. (2025)(40) demonstrated that non-pharmacological interventions can significantly reduce postoperative pain. Together, this evidence reinforces the idea that complementary approaches, including immersive VR, have substantial potential to improve patient comfort and recovery.

VR appears to modulate neural pathways involved in both anxiety and pain, although these pathways are not identical. Anxiety regulation is closely linked to prefrontal cortex activity and limbic structures, whereas pain perception involves regions such as the thalamus, insula, anterior cingulate cortex, and somatosensory cortices, which VR has been shown to modulate (41). These mechanisms support the findings of the included studies, which consistently reported reductions in both anxiety and pain following VR intervention. This approach aligns with the mechanisms of other sensory therapies such

as listening to Quranic recitation, which also works through activation of the parasympathetic nervous system and increased emotional relaxation (39). Similarly, complementary therapies such as lavender aromatherapy also modulate the central nervous system and influence patients' emotional responses (40). Taken together, these parallels suggest that sensory-based interventions whether through aroma, spiritual audio, or VR visual-auditory stimulation can provide meaningful analgesic and anxiolytic effects.

However, several other studies have shown conflicting results regarding the effectiveness of VR in reducing pain and anxiety in post-surgical patients. Rhodes et al. (2024)(32) in their study of 180 orthopedic patients found that VR had no significant effect on reducing post-surgical pain ( $p = 0.71$ ) and anxiety ( $p = 0.81$ ). Several factors suspected to contribute to this ineffectiveness include differences in the severity of trauma experienced by patients, inconsistent frequency of interventions, VR content perceived as too similar to the real world and therefore insufficiently distracting, and the length of the study (2014-2018), which may have led to changes in standard hospital care policies during that period.

In line with this, McCune et al. (2023)(33) also showed that VR was ineffective in reducing pain ( $p = 0.39$ ) due to the lack of standardization of VR sessions, the relatively short and non-repeated duration and frequency of interventions, differences in underlying diseases, and limited sample size. Meanwhile, Lier et al. (2024)(31) in their study of 100 patients undergoing major surgery also showed that VR was ineffective in reducing post-surgical pain due to the short duration of VR and the frequency of VR use not meeting the researchers' recommendations. However, in this study, although the results were ineffective in reducing pain, VR intervention was proven to reduce anxiety ( $p = 0.03$ ).

Studies demonstrating the effectiveness of VR in reducing pain intensity and anxiety generally implemented VR interventions with repeated frequency ( $> 1$  time) with varying durations of 5-30 minutes. However, these effects were not uniform across all studies. For example, Yesilot et al. (2022)(30) found that immersive VR effectively reduced postoperative pain but did not significantly reduce anxiety levels, indicating that VR may influence pain and anxiety through different mechanisms or may be more effective for certain outcomes depending on patient characteristics and clinical context. Mogahed et al. (2024)(24) used an initial VR duration of 10 minutes to monitor for discomfort such as dizziness or headaches, then gradually increased this duration to 30 minutes according to patient tolerance. The frequency of VR use is also closely related to the hospital's care routine. For some participants, afternoons and evenings are considered the best times to use VR because they can help improve sleep quality afterward (38).

The timing of post-intervention measurements plays a crucial role in assessing the effectiveness of VR use. Many patients are not fully awake after surgery, so pain intensity assessments at hour 0 are often inaccurate. Therefore, Wang et al. (2024)(25) chose to begin initial recordings 30 minutes postoperatively to ensure more valid results. Pain assessments were then continued at hours 2, 4, 8, 12, and then again at 24 hours postoperatively. This approach aligns with the findings of Ali et al. (2014) (42), which showed that pain intensity in postoperative patients tends to increase during these times.

The VR content used plays a crucial role in determining the effectiveness of the intervention. Several studies have shown that VR interventions with nature visualization content produce significant results (18,21,25-27,29,30). This type of content helps reduce anxiety and promote relaxation through sensory distraction mechanisms by limiting the activity of brain areas responsible for pain processing. This is in line with the Gate Control theory, which states that sensory stimulation from VR can inhibit the transmission of pain signals to the brain (43). Furthermore, interactive game content is also effective as a distraction in diverting patients' focus from pain and anxiety (22). However, Payne et al. (2022)(29), who in their study compared active and passive content, found no significant difference in pain reduction between the two types of content. Many participants actually preferred content that aligned with their interests, hobbies, and occupations (38). This is consistent with Tedja (2025)(37) who emphasizes that environmental factors and sensory experiences play an important role in shaping patients' emotional responses to technology-based interventions.

Kosonogov et al. (2023)(44) stated that the effectiveness of VR in reducing anxiety is based on two main approaches. The first approach involves exposing patients to anxiety-provoking situations through VR to gradually reduce fear. The second approach involves combining VR with relaxation therapy to enhance the therapeutic effect. Virtual reality stimulates brain areas involved in fear processing and

emotion regulation, thereby helping to reduce anxiety. Exposure to virtual environments decreases sensitivity to fear through activation of the ventromedial prefrontal cortex and the anterior cingulate cortex, which are central to fear regulation (45). In line with this, Tedja (2025)(37) emphasized that anxiety regulation is not solely influenced by VR's visual stimuli, but also by the emotional interactions between nurses, patients, and environmental support, which together create a more adaptive and supportive clinical experience. Thus, VR is a promising non-pharmacological method for reducing pain and anxiety, thereby enhancing the effectiveness of patient care.

Another factor that may contribute to the variability in VR effectiveness is the 'novelty effect.' VR is often a new and stimulating experience for patients, which may enhance engagement and produce stronger distraction effects during the first exposure. However, repeated sessions over several days may reduce this sense of novelty, potentially diminishing the therapeutic impact. Some studies included in this review reported greater reductions in pain and anxiety during the initial sessions compared with later sessions, suggesting that habituation may occur. This possibility highlights the importance of designing VR interventions that maintain engagement such as by varying content, increasing interactivity, or tailoring experiences to patient preferences to sustain effectiveness over time. Future research should further explore whether the observed benefits reflect true therapeutic mechanisms or are partially driven by novelty-related responses.

In line with findings from other complementary therapies such as listening to Al-Quran recitation which has been shown to be safe, easy to implement, and effective in reducing psychological symptoms (39) as well as lavender aromatherapy which has demonstrated effectiveness in reducing postoperative pain (40), immersive VR similarly presents as a feasible, safe, and non-pharmacological intervention with strong potential to enhance the quality of postoperative care.

This systematic review has several limitations. One potential bias that could arise from the data selection process is that research articles not in English were excluded. The number of included studies was also relatively small, despite a literature search conducted based on clear inclusion criteria. Furthermore, variations in study quality made the analysis more complex and risked misinterpretation of the results. Two of the 14 RCTs used scored below 10 (out of a total score of 13) but were included due to the small number of suitable articles. Furthermore, variations in the duration, frequency, and content of interventions used across studies may also have led to inconsistent results. Therefore, the results of this review need to be generalized with caution, taking these contexts into account.

## **CONCLUSION**

This review concludes that distraction using immersive virtual reality is a feasible and acceptable method for adult post-surgical patients. The effectiveness of VR-based distraction in reducing pain and anxiety has shown variable results, with some studies reporting significant reductions in pain and anxiety, while others showed no significant changes. VR distraction can be used alone or in combination with other techniques such as relaxation, meditation, hypnosis, or education. This approach offers flexibility in its application based on patient needs and preferences. Therefore, the use of VR in adult post-surgical patients is worth considering as part of a pain and anxiety management strategy during post-operative care. This method offers an innovative non-pharmacological intervention alternative to improve patient comfort and quality of care.

Further research is expected to focus on evaluating specific aspects related to the VR technology used, such as the visual and auditory content displayed, the frequency and duration of use, and the type of VR device used. With a deeper understanding of these factors, it is hoped that VR technology can develop into an effective non-pharmacological intervention to reduce pain intensity and anxiety in post-surgical patients.

## **FUNDING**

This research has not received any external funding.

## **ACKNOWLEDGMENTS**

The authors would like to thank the University of Indonesia for providing institutional and administrative support, including access to academic resources and research facilities during the conduct of this study.

## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

## REFERENCES

1. Şimşek T, Şimşek HU, Cantürk NZ. Response to trauma and metabolic changes: posttraumatic metabolism. *Ulus cerrahi Derg.* 2014;30(3):153–9.
2. Nerbass FB, Feltrim MIZ, de Souza SA, Ykeda DS, Lorenzi-Filho G. Effects of massage therapy on sleep quality after coronary artery bypass graft surgery. *Clinics [Internet].* 2010;65(11):1105–10. Available from: <https://www.sciencedirect.com/science/article/pii/S1807593222028927>
3. Süner ZC, Kalayci D, Sen Ö, Kaya M, Ünver S, Oğuz G. Postoperative Analgesia after Total Abdominal Hysterectomy: Is the Transversus Abdominis Plane Block Effective? *Niger J Clin Pract [Internet].* 2019;22(4). Available from: [https://journals.lww.com/njcp/fulltext/2019/22040/postoperative\\_analgesia\\_after\\_total\\_abdominal.5.aspx](https://journals.lww.com/njcp/fulltext/2019/22040/postoperative_analgesia_after_total_abdominal.5.aspx)
4. Lovich-Sapola J, Smith CE, Brandt CP. Postoperative Pain Control. *Surg Clin North Am [Internet].* 2015;95(2):301–18. Available from: <https://www.sciencedirect.com/science/article/pii/S0039610914002011>
5. Gan TJ. Poorly controlled postoperative pain: Prevalence, consequences, and prevention. *J Pain Res.* 2017;10:2287–98.
6. Ryu JH, Park SJ, Park JW, Kim JW, Yoo HJ, Kim TW, et al. Randomized clinical trial of immersive virtual reality tour of the operating theatre in children before anaesthesia. *Br J Surg [Internet].* 2017 Nov 1;104(12):1628–33. Available from: <https://doi.org/10.1002/bjs.10684>
7. Llerena GE, Krzykwa E, Huzior M, Vilar N, Donahue D, Zisling H, et al. Exploring Novel Non-pharmacologic Approaches to Address Preoperative Anxiety and Postoperative Pain in Pediatric Patients Undergoing In-Patient Surgical Procedures: A Scoping Review. *Cureus.* 2024;16(1):1–11.
8. Sukantarat KT, Williamson RCN, Brett SJ. Psychological assessment of ICU survivors: A comparison between the Hospital Anxiety and Depression scale and the Depression, Anxiety and Stress scale. *Anaesthesia.* 2007;62(3):239–43.
9. Bartels K, Mayes LM, Dingmann C, Bullard KJ, Hopfer CJ, Binswanger IA. Opioid use and storage patterns by patients after hospital discharge following surgery. *PLoS One.* 2016;11(1):1–10.
10. Kemenkes. Keputusan Menteri Kesehatan Republik Indonesia Nomor HK.01.07/MENKES/481/2019 Tentang Pedoman Nasional Pelayanan Kedokteran Tata Laksana Nyeri. 2019; Available from: <https://kemkes.go.id/id/pnkp-2019---tata-laksana-nyeri>
11. Niyonkuru E, Iqbal MA, Zhang X, Ma P. Complementary Approaches to Postoperative Pain Management: A Review of Non-pharmacological Interventions. *Pain Ther [Internet].* 2025;14(1):121–44. Available from: <https://doi.org/10.1007/s40122-024-00688-1>
12. Veneva E, Belcheva A, Raycheva R. Chapter 48 - Virtual reality induced analgesia and dental pain. In: Rajendram R, Patel VB, Preedy VR, Martin Mechanisms, and Adverse Reactions of Anesthetics and Analgesics CRBTT, editors. Academic Press; 2022. p. 575–81. Available from: <https://www.sciencedirect.com/science/article/pii/B978012820237100048X>
13. Muthia, E.; Masfuri, M.; Yulia Y. Effectiveness Of Virtual Reality On Post-Amputation Pain Lower Extremities : Literature Review. 2024;12(1):53–9.
14. Faraj MM, Lipanski NM, Morales A, Goldberg E, Bluth MH, Marusak HA, et al. A Virtual Reality Meditative Intervention Modulates Pain and the Pain Neuromatrix in Patients with Opioid Use Disorder. *Pain Med [Internet].* 2021 Nov 1;22(11):2739–53. Available from: <https://doi.org/10.1093/pm/pnab162>
15. Garrett B, Taverner T, Masinde W, Gromala D, Shaw C, Negraeff M. A Rapid Evidence Assessment of

- Immersive Virtual Reality as an Adjunct Therapy in Acute Pain Management in Clinical Practice. *Clin J Pain* [Internet]. 2014;30(12). Available from: [https://journals.lww.com/clinicalpain/fulltext/2014/12000/a\\_rapid\\_evidence\\_assessment\\_of\\_immersive\\_virtual.11.aspx](https://journals.lww.com/clinicalpain/fulltext/2014/12000/a_rapid_evidence_assessment_of_immersive_virtual.11.aspx)
16. Indovina P, Barone D, Gallo L, Chirico A, De Pietro G, Giordano A. Virtual Reality as a Distraction Intervention to Relieve Pain and Distress During Medical Procedures: A Comprehensive Literature Review. *Clin J Pain* [Internet]. 2018;34(9). Available from: [https://journals.lww.com/clinicalpain/fulltext/2018/09000/virtual\\_reality\\_as\\_a\\_distraction\\_intervention\\_to.9.aspx](https://journals.lww.com/clinicalpain/fulltext/2018/09000/virtual_reality_as_a_distraction_intervention_to.9.aspx)
  17. Martinez-Bernal D, Vidovich C, Keenan C, Correll L, Laserna A, Hasselberg M, et al. The Use of Virtual Reality to Reduce Pain and Anxiety in Surgical Procedures of the Oral Cavity: A Scoping Review. *J Oral Maxillofac Surg* [Internet]. 2023 Apr 1;81(4):467–82. Available from: <https://doi.org/10.1016/j.joms.2022.11.011>
  18. Rousseaux F, Dardenne N, Massion PB, Ledoux D, Bicego A, Donneau AF, et al. Virtual reality and hypnosis for anxiety and pain management in intensive care units: A prospective randomised trial among cardiac surgery patients. *Eur J Anaesthesiol*. 2022;39(1):58–66.
  19. Haddaway NR, Page MJ, Pritchard CC, McGuinness LA. PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis. *Campbell Syst Rev*. 2022;18(2):1–12.
  20. Barker TH, Stone JC, Sears K, Klugar M, Tufanaru C, Leonardi-Bee J, et al. The revised JBI critical appraisal tool for the assessment of risk of bias for randomized controlled trials. *JBI Evid Synth*. 2023 Mar;21(3):494–506.
  21. Abbasnia F, Aghebati N, Miri HH, Etezadpour M. Effects of Patient Education and Distraction Approaches Using Virtual Reality on Pre-operative Anxiety and Post-operative Pain in Patients Undergoing Laparoscopic Cholecystectomy. *Pain Manag Nurs* [Internet]. 2023;24(3):280–8. Available from: <https://doi.org/10.1016/j.pmn.2022.12.006>
  22. Abdelmoniem Ibrahim A, Aly SM, Youssef ASA, Ragab MM, Hussein HM. Using Virtual Reality Pablo Gaming in the Post-Operative Rehabilitation of Breast Cancer Patients: Randomized Controlled Trial. Vol. 13, *Journal of Clinical Medicine*. 2024.
  23. İnce M, Karaman Özlü Z. The Effect of Virtual Reality on Pain, Anxiety, Physiological Parameters, and Postspinal Headache in Patients Undergoing Spinal Anesthesia: A Randomized Controlled Trial. *J Perianesthesia Nurs*. 2024;(xxxx).
  24. Mogahed HG, Hamoda RE, Elkalla RA. Virtual reality on pain and anxiety after modified radical mastectomy in menopause. *Res J Pharm Technol*. 2024;17(4):1657–61.
  25. Wang Y, Sun J, Yu K, Liu X, Liu L, Miao H, et al. Virtual reality exposure reduce acute postoperative pain in female patients undergoing laparoscopic gynecology surgery: A Randomized Control Trial (RCT) study. *J Clin Anesth* [Internet]. 2024;97:111525. Available from: <https://www.sciencedirect.com/science/article/pii/S0952818024001545>
  26. Fuchs L, Kluska A, Novak D, Kosashvili Y. The influence of early virtual reality intervention on pain, anxiety, and function following primary total knee arthroplasty. *Complement Ther Clin Pract* [Internet]. 2022;49:101687. Available from: <https://www.sciencedirect.com/science/article/pii/S1744388122001554>
  27. Droc G, Isac S, Nita E, Martac C, Jipa M, Mihai DI, et al. Postoperative Cognitive Impairment and Pain Perception after Abdominal Surgery—Could Immersive Virtual Reality Bring More? A Clinical Approach. *Med*. 2023;59(11):1–10.
  28. Gür O, Başar S. The effect of virtual reality on pain, kinesiophobia and function in total knee arthroplasty patients: A randomized controlled trial. *Knee*. 2023;45(39):187–97.
  29. Payne O, Smith V, Rolnik DL, Davies-Tuck M, Warty R, Seo D, et al. Virtual reality and its use in post-operative pain following laparoscopy: a feasibility study. *Sci Rep* [Internet]. 2022;12(1):1–11. Available from: <https://doi.org/10.1038/s41598-022-17183-2>
  30. Yesilot SB, Yeşilkuş R, Beyaz F. Use of Virtual Reality for Reducing Pain and Anxiety After

- Laparoscopic Sleeve Gastrectomy: A Randomized Controlled Trial. *Pain Manag Nurs*. 2022;23(6):826–31.
31. Lier EJ, Smits MLM, van Boekel RLM, Vissers KCP, Maandag NJG, de Vries M, et al. Virtual reality for postsurgical pain management: An explorative randomized controlled study. *Surg (United States)* [Internet]. 2024;176(3):818–25. Available from: <https://doi.org/10.1016/j.surg.2024.06.011>
  32. Rhodes JR, Corlett CE, Jensen MP, Patterson DR. Immersive Virtual Reality to Reduce Pain and Anxiety in Individuals Undergoing Orthopedic Surgery for Acute Trauma: A Randomized Clinical Trial. *Int J Clin Exp Hypn* [Internet]. 2024;73(1):106–22. Available from: <https://doi.org/10.1080/00207144.2024.2433270>
  33. McCune M, Tufano S, Gill M, Oelkers K, Segaline N, Foote J, et al. Virtual reality for the treatment of postoperative pain after laparoscopic hysterectomy for benign Indications: A randomized controlled trial. *Eur J Obstet Gynecol Reprod Biol* [Internet]. 2023;289(July):19–22. Available from: <https://doi.org/10.1016/j.ejogrb.2023.08.012>
  34. Hamad A, Jia B. How Virtual Reality Technology Has Changed Our Lives: An Overview of the Current and Potential Applications and Limitations. Vol. 19, *International Journal of Environmental Research and Public Health*. 2022.
  35. Alqudimat M, Mesaroli G, Lalloo C, Stinson J, Matava C. State of the Art: Immersive Technologies for Perioperative Anxiety, Acute, and Chronic Pain Management in Pediatric Patients. *Curr Anesthesiol Rep* [Internet]. 2021;11(3):265–74. Available from: <https://doi.org/10.1007/s40140-021-00472-3>
  36. Wiederhold MD, Wiederhold BK. Virtual Reality and Interactive Simulation for Pain Distraction. *Pain Med* [Internet]. 2007 Oct 1;8(suppl\_3):S182–8. Available from: <https://doi.org/10.1111/j.1526-4637.2007.00381.x>
  37. Tedja JF. Interaction Model for Child to Cope Stress Using Virtual Reality and Watching Video during Venipuncture in the Emergency Department : A Literature Review *Key Messages : 2025;4(3):1154–65*.
  38. Lier EJ, Smits MLM, de Vries M, van Goor H. Self-Administered Virtual Reality for Postsurgical Pain Management: A Qualitative Study of Hospital Patients' Reported Experiences. *J Clin Med*. 2023;12(21).
  39. Rahmah, Tira Nur; Ibrahim, Kusman; Pratiwi SH. The Effects of Listening to Quran Recitation on Patients Undergoing Hemodialysis : A *Key Messages : 2025;4(2)*.
  40. Kumalasari R, Otis P, Oktaviani P, Shintami RA, Rachmawati L. Aromatherapy with Lavender Oil to Reduce Pain Intensity in Post – Cesarean Section Patients : A Study at Cirebon Hospital *Key Messages : 2025;4(3):1144–53*.
  41. Hoffman HG, Richards TL, Coda B, Bills AR, Blough D, Richards AL, et al. Modulation of thermal pain-related brain activity with virtual reality: evidence from fMRI. *Neuroreport* [Internet]. 2004;15(8). Available from: [https://journals.lww.com/neuroreport/fulltext/2004/06070/modulation\\_of\\_thermal\\_pain\\_related\\_brain\\_activity.5.aspx](https://journals.lww.com/neuroreport/fulltext/2004/06070/modulation_of_thermal_pain_related_brain_activity.5.aspx)
  42. Ali A, Altun D, Oguz BH, Ilhan M, Demircan F, Koltka K. The effect of preoperative anxiety on postoperative analgesia and anesthesia recovery in patients undergoing laparoscopic cholecystectomy. *J Anesth* [Internet]. 2014;28(2):222–7. Available from: <https://doi.org/10.1007/s00540-013-1712-7>
  43. Mahrer NE, Gold JI. The use of virtual reality for pain control: A review. *Curr Pain Headache Rep* [Internet]. 2009;13(2):100–9. Available from: <https://doi.org/10.1007/s11916-009-0019-8>
  44. Kosonogov V V, Efimov K V, Rakhmankulova ZK, Zyabreva IA. Review of Psychophysiological and Psychotherapeutic Studies of Stress Using Virtual Reality Technologies. *Neurosci Behav Physiol* [Internet]. 2023;53(1):81–91. Available from: <https://doi.org/10.1007/s11055-023-01393-w>
  45. Drigas A, Sideraki A. Brain Neuroplasticity Leveraging Virtual Reality and Brain–Computer Interface Technologies. Vol. 24, *Sensors*. 2024.