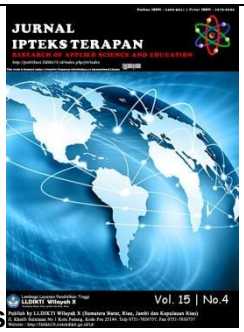

The Effectiveness of Virtual Reality (VR) on Preoperative Anxiety in Elective Surgery Patients Under General Anesthesia: A Systematic Review

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Abstract

Background: The high prevalence of preoperative anxiety is associated with adverse postoperative outcomes such as pain, prolonged recovery, impaired wound healing, prolonged hospitalization, increase in the need for anesthetic drugs, prolonging the duration of anesthesia, one of the possible causes of canceling surgeries and death. One of the current non-pharmacological interventions to reduce preoperative anxiety is Virtual Reality (VR). This systematic review aims to evaluate the effectiveness of virtual reality on preoperative anxiety in elective surgery patients under general anesthesia. Methods: This study was a systematic review of randomized controlled trials (RCTs) and prospective cohort study. A systematic was conducted using ClinicalKey, Clinicalkey for Nursing, EBSCOhost, Proquest, ScienceDirect, Scopus, Pubmed, SpringerLink, and the Cochrane library, and using keywords and Boolean Operators. Search for English and publish from January 2018 to December 2022. Results: Eight studies were found eligible for inclusion, seven studies showed a significant decrease in perioperative anxiety levels in patients with the use of virtual reality in providing education and distraction compared to the standard care group. Conclusion: The findings of the systematic review show that Virtual reality is an effective education and distraction method to reduce preoperative anxiety in elective surgery patients under general anesthesia..

Keywords: anesthesia; elective surgery; preoperative anxiety; virtual reality

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INTRODUCTION

Preoperative anxiety is a common finding in patients scheduled for surgical procedures (Eberhart et al., 2020; Vogt et al., 2021). It is estimated that among patients admitted for surgery 25% to 80% of them experience preoperative anxiety due to fear of pain and complications, or fear of death (Bayrak et al., 2019; Koo et al., 2020). Other reasons that cause fear and anxiety are waiting for surgery, anxiety that surgery may cause physical or mental harm, anxiety about loss of function, fear of waking up during surgery, postoperative pain, postoperative paralysis delayed recovery, death, not being able to awakening after surgery, transferred to the intensive care unit, and separation from family members (Amini et al., 2019; Stamenkovic et al., 2018; Surme & Çimen, 2022).

Several studies in Canada, Saudi Arabia, and Ethiopia showed the prevalence of preoperative anxiety to be 89%, 55%, and 61% (Matthias & Samarasekera, 2012; Mulugeta et al., 2018; Oteri et al., 2021). In addition, other studies reported that as many as 60-75% of a total of 80 respondents experienced moderate levels of anxiety during the preoperative period before general anesthesia procedures (Ahmetovic-Djug et al., 2017). Anxiety is an unpleasant emotional experience such as worry, fear, and tension that can cause patients undergoing surgical procedures intended to avoid the procedure (Bedaso & Ayalew, 2019). Anxiety is a response to external or internal stimuli that has behavioral, emotional, cognitive, and physical symptoms by releasing catecholamines and inducing cardiovascular responses, such as hypertension, tachycardia, and arrhythmias (Koo et al., 2020; Mulugeta et al., 2018). The results of a study found that 75% patients have anxiety from the moment they are told they need surgery, to the time they enter the hospital and operating room (Baytar & Bollucuoğlu, 2021; Erkilic et al., 2017; Masjedi et al., 2017).

The high prevalence of preoperative anxiety has negative effects and it can increase the risk of postoperative complications such as postoperative pain, prolonged anesthesia recovery, delayed wound healing, longer hospitalization, and death (Baytar & Bollucuoğlu, 2021; Kuzminskaite et al., 2019; Mulugeta et al., 2018; Peuchot et al., 2021). In the other hand, a high level of preoperative anxiety is associated with an increase in the need for anesthetic drugs, extends the duration of anesthesia and reduces the quality of postoperative recovery and is one of the possible causes of canceling unnecessary surgeries (Almalki et al., 2017; Baytar & Bollucuoğlu, 2021; Bedaso & Ayalew, 2019). Given the magnitude of the consequences of preoperative anxiety, the latest update regarding the European Society of Anesthesiology (ESA) Guidelines recommends incorporating anxiety evaluation into the preoperative assessment of patients (de Hert et al., 2018).

Several interventions have been evaluated in an attempt to reduce preoperative anxiety and prevent adverse outcomes. Current methods that are often used to reduce patient anxiety in the preoperative period mainly focus on pharmacological interventions such as administering benzodiazepines, antihistamines and barbiturates (Sürme & Çimen, 2022). However, Pharmacological treatments can cause side effects such as difficulty breathing, drowsiness, recovery

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elongated, anaphylaxis, addiction, and even organ damage (Chan et al., 2020; Ganry et al., 2018). In addition, various non-pharmacological interventions were carried out to help reduce preoperative anxiety such as family presence during anesthesia induction, various distraction programs during anesthesia preparation, listening to the music, aromatherapy, pre-procedural education including operating room visits (Park et al., 2019; Ryu et al., 2017; Sürme & Çimen, 2022).

Along with advances in technology that are getting better in the health sector, recently there has been an increase in the use of virtual reality (VR) technology as a non-pharmacological intervention method that has been developed and used as an alternative approach to reduce preoperative anxiety (Chan et al., 2020; Koo et al., 2020; Peuchot et al., 2021). VR is a computer technology that provides an immersive experience in a three-dimensional simulated world that allows users to interact with virtual environments (Koo et al., 2020; Yamamoto et al., 2018). VR is a simulation of the environment experienced through head-mounted eye goggles that allows users to interact in realistic three-dimensional situations (Yamamoto, Ozgeldi, & Altun, 2018). Basically, VR is a technology that simulates an interactive 360° digital environment that replaces the real world and is one of the digital media created to present reality in real life or allows users to have the feeling of being present in an environment other than the actual environment and to interact with that environment. Yamamoto et al., 2018).

Several studies have shown the effectiveness of using VR to significantly reduce preoperative anxiety and have a positive effect on hemodynamics and patient satisfaction (Baytar & Bollucuoğlu, 2021; Chan et al., 2020; Hendricks et al., 2020; Turrado et al., 2021; Yang et al., 2019) but other studies state that VR does not significantly reduce the level of preoperative anxiety (Vogt et al., 2021). The benefits of VR are still very controversial, especially since several of these studies did not report adverse event of using VR, such as headaches, discomfort, nausea and vomiting. Therefore, this study aims to evaluate the effectiveness of using VR technology on preoperative anxiety in adults undergoing elective surgery under general anesthesia.

RESEARCH METHODS

This study was conducted according to the Preferred Items for Systematic Review and Meta Analyzes (PRISMA) statement guidelines (Page et al., 2021).

Inclusion and Exclusion Criteria

Participants, interventions, benchmarks, results, and approach to study design were used to shape the research questions of this review and to establish study selection criteria. Researchers independently screened and selected studies according to predetermined inclusion and exclusion criteria. The inclusion criteria were (1) adult patient population aged more than or equal to 18 years, (2) randomized control trial (RCT), Prospective Cohort, (3) including elective surgery patients under general anesthesia, and (4) patients in the intervention group experienced virtual reality before surgery. Exclusion criteria were (1) types of research such as reviews, protocols, systematic reviews, meta-analyses, case reports, opinion articles, or letters and (2) no complete articles (eg, abstracts, protocols). Initially, article titles and

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abstracts were filtered to exclude irrelevant articles. Next, the full text of the articles was reviewed and the relevant articles were included in this systematic review.

Identification

The first identification is to determine research questions using the PICO (Population, Intervention, Comparison, and Outcome) method. The formulation of the problem with the PICO method is as follows: the specified population is adult patients who undergo elective surgery under general anesthesia, the intervention applied is in the form of virtual reality intervention, the comparison or comparison intervention is standard intervention without VR, and the expected result is to reduce preoperative anxiety, so that the research questions in full are: In patients who will undergo elective surgery under general anesthesia (P), is virtual reality (VR) (I) more effective than those who receive standard procedures (C) in reducing preoperative anxiety (O)?

Search Strategy

An article search was performed through online databases such as ClinicalKey, Clinicalkey for Nursing, EBSCOhost, Proquest, ScienceDirect, Scopus, Pubmed, SpringerLink, and the Cochrane library to identify studies assessing the effectiveness of virtual reality on preoperative anxiety in elective surgery patients under general anesthesia. The search was performed using Boolean Operators such as AND, OR, NOT and MeSH terms and keywords such as "virtual reality", "preoperative anxiety", "anesthesia", and "elective surgery", the search was carried out in October 2022 and was limited to language articles English published between January 2018 to December 2022.

Selection of Research Articles

The screening process was completed independently by the researcher based on the inclusion criteria described previously. The title and abstract of each article were initially filtered. Duplicates and irrelevant studies are removed. The full text of the relevant articles was further examined to determine whether the inclusion criteria were met. Based on search results from various databases such as ClinicalKey, Clinicalkey for Nursing, EBSCOhost, Proquest, ScienceDirect, Scopus, Pubmed, SpringerLink, and the Cochrane library, the first search found 73,996 articles, then limiters were used such as open access (All open access), the last 5 years (2018-2022), document type (article), English and then the results obtained were 705 articles. Furthermore, the first selection was carried out regarding the title, abstract and inclusion criteria so that 23 articles were obtained, then followed by the second selection, namely reading the full text of the article, a total of 7 articles were the same (duplicate) and 8 articles were excluded because 1 protocol, 6 local anesthetic articles or regional, and 2 diagnostic procedure articles so that the final number of articles that meet the criteria and can be analyzed is 8 articles (Figure 1).

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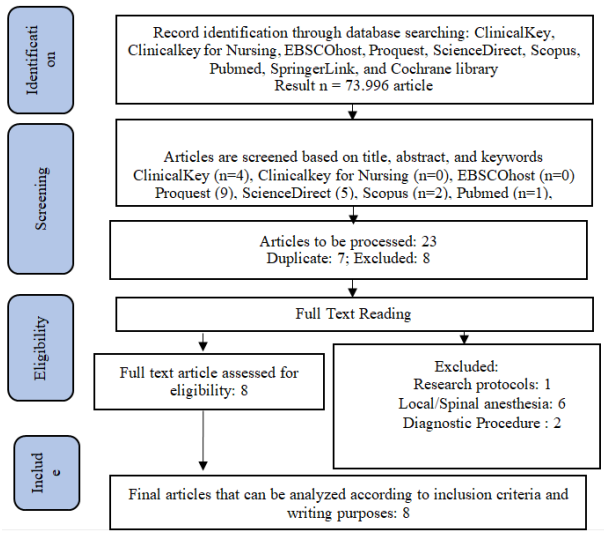

Figure 1. PRISMA Flowchart Study Selection (Page et al., 2021)

Extraction

Each research article included in the final qualitative analysis, some information was extracted such as: (1) Researcher (country, year), (2) type of operation, (3) Study design, sample size, (4) Age (Mean, SD), (5) duration and place of VR intervention, (6) VR group intervention, (7) Control group intervention, (8) Primary and secondary outcome (measurements), (9) Result, (10) Quality. The heterogeneity of the literature is extensive as it relates to sample characteristics, type and content of interventions, and methods of assessment or outcome measures (observed, self-reported, and physiological). We expect heterogeneity to affect our ability to directly assess effect size and clinical significance of study findings. Therefore, the researcher provides a summary and conclusion of the research findings (table 1).

Article Quality Assessment

The risk of bias was assessed for each research article independently. The article was reviewed using The Joanna Briggs Institute (JBI) critical appraisal tool to help assess the trustworthiness, relevance and results of published articles. This article review uses the JBI Critical Appraisal Checklist for randomized Controlled trials (JBI, 2017) and the JBI Critical Appraisal Checklist for Cohort Studies (JBI, 2017) according to the type of research design found in this systematic review. JBI for RCT contains 13 items that must be assessed such as randomization, blinded, similarity of characteristics and treatment between groups, follow-up period, measurement and analysis of similar results between groups, and whether the statistical test used is appropriate. While the JBI for the cohort contains 11 items that must be assessed including the similarity of sample selection, exposure is measured in the same way to determine the group, whether exposure measurement is appropriate, identification of confounding factors and strategy, group of participants free from exposure, results are measured in an appropriate way, the follow-up period and follow-up of participants who dropped out, and whether the statistical test was appropriate. Assessment criteria are scored as 'yes', 'no', 'unclear' or 'not applicable', and each criterion with a 'yes' score is assigned one point and any other score is zero, each study's score is then tallied and added. Critical Assessment to assess the eligibility of studies conducted by researchers. If the research score is at least 50%, it meets the Critical Appraisal criteria with a cut-off point value (JBI, 2017). Based on the results of the review that was carried out using the JBI instrument, it can be concluded that the entire article (RCT=6, prospective cohort=2) can be included in this systematic review because based on the

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results of the quality assessment the articles are good methodologically.

Data analysis

The data analysis used in this systematic review is by grouping the data based on the findings from the various articles obtained. Data analysis is presented in narrative or qualitative form based on the groups obtained so that they can answer research questions.

RESULTS AND DISCUSSION

No.	Authors (Country, Year)	Type of Surgery	Desain Study, Sampel (n)	Age (Mean, SD)	Duration (D) and Place (P) of VR Intervention	Intervention Group VR	Intervention Control Group	Primary Outcome (Measuring Instrument)	Result	Quality of Article (JBI)
1.	Yang, et. al (Korea, 2019)	Arthroscopic knee surgery	RCT (*Randomized Controlled Trial*) Sample:48 Patients (Experiments: 24; Controls: 24)	15-65 years E: 32.5 (15.0-62.0) K: 38.0 (20.0-65.0)	D: 20-30 minutes and 1 day/12 hours before surgery P: In outpatient clinics and in the treatment room during preoperative counseling	Watched their 3D MRI model through a VR headset, depicting the anatomy of the knee as well as the lesion requiring an arthroscopic procedure	Standard preoperative information about their MRI via an image archiving and communication system.	Anxiety level Measuring tool: the Amsterdam Preoperative Anxiety and Information Scale score (APAIS)	Application of preoperative VR experience of 3D reconstructed knee MRIs in patients undergoing arthroscopic knee surgery effective reduces preoperative anxiety	10/13
2.	Chan, et.al (Singapore, 2020)	Gynecological Surgery	Prospective Cohort 108 patients	21-70 Years 43.56 ± 6.68	D: 10 minutes, 1-2 hours before surgery. P: Patient lying on a bed in Fowler's position with knees straight, in a quiet preoperative waiting area	'Relax VR' program which contains eleven immersive scenes to choose from against a backdrop of meditation music and breathing exercises.	-	Preoperative anxiety as measured by the Hospital Anxiety and Depression Scale (HADS).	HADS anxiety scores were significantly reduced from 7.2 ± 3.3 pre-intervention to 4.6 ± 3.0 post-intervention (p< 0.0001)	7/11
3.	Vogt, et.al (Jerman, 2021)	Undergo elective surgery under general anesthesia	*Clinical Trials randomized parallel-group design with 2 study arms* Sample: 68 patients, 34	≥18 years mean age 54.19, SD 15.94, with a range of 20 to 81 years	D: 6 minutes 28 seconds before surgery/anesthesia. P: In the surgery ward	Watch a virtual tour of the operating room (containing preoperative preparations, premedication and medicatio	Standard Operational Preparation Procedure. Following standard hospital procedures, patients in this study group	Preoperative anxiety measured by the state and trait anxiety scales from the state-trait operation anxiety	There were no significant differences in perioperative state anxiety between VORT and standard operation	13/13

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No.	Authors (Country, Year)	Type of Surgery	Desain Study, Sampel (n)	Age (Mean, SD)	Duration (D) and Place (P) of VR Intervention	Intervention Group VR	Intervention Control Group	Primary Outcome (Measuring Instrument)	Result	Quality of Article (JBI)
			patients each for the experimental group and control group			n administration, travel from the treatment room to the operating room, procedures performed in the preparation room and operating room).	underwent no additional preparation.	inventory (STOA).	preparation procedures before and after the surgery. Nonetheless, patients' ratings of VORT overall were positive.	
4.	Turrado, et., al. (Spanyol, 2021)	Colorectal cancer surgery	*Randomized prospective controlled trial.* Sampel: *(126 pasien (58 exposed, 68 unexposed). Patients were randomized using en bloc randomization with random block*	≥18 years E: 64 (41–85) K: 68 (50–86)	D: 16 minutes 34 seconds P: In the Surgery Ward	The VR videos describe a realistic environment in which patients can experience the various steps of their admission to surgery, from interviews with surgeons, to admission to the surgical ward, operating theater, and postoperative recovery room.	Standard operating preparations	The main outcome is anxiety and its intensity was measured using two validated scales, the State-Trait Anxiety Inventory Scale (STAI-S) and the Hospital Anxiety and Depression Scale (HADS).	The use of simulation using virtual reality can reduce preoperative anxiety in patients undergoing surgery for colorectal cancer	9/13
5.	Oudkerk Pool, et., al. (Belanda, 2022)	Heart surgery: *percutaneous closure of a patent foramen ovale* (PFO) atau *atrial septal*	*This study was designed as a prospective, single-center, randomized*	≥18 years E: 44.5 ± 9.9 K: 43.1 ± 12.0	D: 5 minute VR educational video. P: When conducting consultations for approval of operating procedures	The intervention group received similar oral information, and an informative leaflet,	Received information about routine procedures orally from their cardiologist during outpatient	Pre-procedure anxiety was measured using The *State-Trait Anxiety Inventory*	Patient education using Virtual Reality is effective in reducing pre-procedura	9/13

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No.	Authors (Country, Year)	Type of Surgery	Desain Study, Sampel (n)	Age (Mean, SD)	Duration (D) and Place (P) of VR Intervention	Intervention Group VR	Intervention Control Group	Primary Outcome (Measuring Instrument)	Result	Quality of Article (JBI)
		defect (ASD)	*controlled trial.* Sampel: 50 patients (VR grup:25, control grup: 25). patients were randomization blocks of 4			followed by an additional display of a 5-minute VR educational video.	clinic visits, and received an informative leaflet about the procedure to be performed.	(STAI) and *the Amsterdam Preoperative Anxiety and Information Scale* (APAIS).	l anxiety in patients undergoing percutaneous PFO or ASD closure	
6.	Baytar & Bollucuoglu (Turkey, 2021)	Septorhinoplasty surgery	*Single-center prospective observational cohort trial*. Sample: 40 patients	18-65 years 32.68 ± 8.74	D: 15 Minute On the day of surgery P: While waiting for the surgery in the preoperative area	The patient viewed a 360◦ three-dimensional VR video depicting the beauty of nature and accompanied by meditation music via a mobile phone using a VR device via Oculus.	-	State Anxiety Inventory test (STAI-S) for measuring anxiety.	VR reduces preoperative anxiety (Median anxiety scores decreased significantly from 40.5 to 34 ($p<0.001$) and has positive effects on hemodynamic parameters	7/11
7.	Ugras, et., al. (Turkey, 2022)	First-time elective colorectal and abdominal wall surgery.	*Design: A prospective, parallel two-armed, randomized controlled trial.* Sample: 86 patients. Control group (n = 43), experimental group (n = 43).	18-65 years E: 44.7 ± 12.9 K: 43.0 ± 15.8	D: 10-minute P: In the preoperative waiting room	The researchers created a playlist of five three-dimensional videos (for example, underwater world, museum trip, forest and park walk, beach trip, and spacewalk) to a relaxing music	-	Preoperative anxiety was measured using the Anxiety Specific to Surgery Questionnaire (ASSQ) instrument.	VR applications can reduce Preoperative Anxiety levels in the experimental group (P<.001).	11/13

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No.	Authors (Country, Year)	Type of Surgery	Desain Study, Sampel (n)	Age (Mean, SD)	Duration (D) and Place (P) of VR Intervention	Intervention Group VR	Intervention Control Group	Primary Outcome (Measuring Instrument)	Result	Quality of Article (JBI)
						background.				
8.	Hendricks, et., al. (Amerika, 2020)	The first Sternotomy surgery	RCT (*Randomized Controlled Trial*) *prospective, single-blind, randomized, controlled pilot study.* Sample: 20 patients	The mean age of all study participants was 70 years (range, 53 to 77 years)	D: 20 minute P: In the surgery ward before being transferred to the preoperative waiting room	Patient played a VR Game entitled "Bear Blast" wearing a Samsung Gear Oculus and audio headset equipped with a Samsung Galaxy S7 Device to deliver VR content	Game application with non-VR tablet-based audiovisual tactile stimulation (Candy Crush)	The main outcome is preoperative anxiety was measured using the State-Trait Anxiety Inventory (STAI) instrument.	VR users experienced significant reductions in strained, upset, and tense when compared with their own self-reported anxiety measure pre- and post-intervention (P<0.05)	10/13

Table 1. Summary of Article Search Results

The research articles used in this paper are eight articles with a range of publication years from 2018 to 2022. The total sample in this study was 546 people divided into an experimental group and a control group with standard or other different interventions. The author classifies the use of VR based on the VR content group itself which consists of preoperative education and distraction techniques such as relaxation and playing games.

Characteristics of Research Articles

Characteristics of research articles included in the systematic review of 8 studies from various countries in the world such as Korea, Singapore, Germany, Spain, the Netherlands, Turkey and America with various research designs including 6 studies with RCT designs (Hendricks et al., 2020; Oudkerk Pool et al., 2022; Turrado et al., 2021; Ugras et al., 2022; Vogt et al., 2021; Yang et al., 2019) and 2 studies with a prospective cohort design (Baytar & Bollucuoğlu, 2021; Chan et al., 2020). The study was conducted in Germany (n=1) with 72 patients aged ≥18 years, (mean age 54.19, SD 15.94, age interval 20-81 years), 35 female and 37 male subjects, (VORT: n= 35 vs STOPP: n=37) (Vogt et al., 2021). In Korea (n = 1) with a sample size of 48 patients with 24 in each group, ages 15-65 years (mean and SD in the experimental group 32.5 (15.0-62.0) and control 38.0 (20.0-65.0) (Yang et al., 2019). In Singapore (n=1) with a sample of 108 women aged 21-70 years with an average age of 43.56 ± 6.68 (Chan et al., 2020) America (n=1) a sample of 20 adults (Hendricks et al., 2020), Spain (n=1) sample size 126 patients (58 exposed, 68

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unexposed), 46 women and 80 men with Median age was 65 (26; 94) (Turrado et al., 2021) Turkey (n=2) with a total of 40 patients with a mean age of 32.68 ± 8.74 years (Baytar & Bollucuoğlu, 2021a), a total sample of 86 with each group of 43 samples and an average age of the experimental group 44.7 ± 12.9 years and control group 43.0 ± 15.8 years (Ugras et al., 2022) Netherlands (n=1) 50 adult samples each group of 25 samples, the average age of the experimental group 44.5 ± 9.9 years and the control group 43.1 ± 12.0 years (Oudkerk Pool, et. al., 2022).

Types of Virtual Reality (VR) Intervention

VR Education

Four studies with RCT designs compared VR education (a realistic environment in which patients can experience various surgical steps with the provision of standard preoperative information about exposure (Oudkerk Pool et al., 2022; Turrado et al., 2021b; Vogt et al., 2021)) .(Oudkerk Pool et al., 2022; Turrado et al., 2021b; Vogt et al., 2021) Yang, et., al. (2019) study in Korea in patients who were going to undergo arthroscopic knee surgery were given a VR intervention that displaying MRI images, knee anatomy and surgical procedures performed with standard preoperative information given 20-30 minutes before scheduling surgery and 1 day/12 hours before surgery in outpatient clinics and in the treatment room preoperative counseling time using a VR headset (Vive; HTC, New Taipei City, Taiwan) compared with a control group who received standard preoperative information about their MRI via an image archiving and communication system (p-viewer v. 5.0.8.1; Infinite, Seoul, Korea).

Turrado, et., al. (2021) in Spain research patients undergoing colorectal cancer surgery were given a 16 minute 34 second VR video intervention depicting a realistic environment in which patients can experience the various steps of their admission for surgery, from interviewing the surgeon, to admission to the surgical ward, operating room. , and a postoperative recovery room. The VR application can be downloaded on all smartphones, so patients can view the images as often as they want. The patient is then given VR glasses (Bluebee™ Genuine VR 3D Glasses which can be adapted to any smartphone model given in the treatment room compared to the control group which is only given standard preparations.

Vogt, et., al. (2021) in Germany, research patients who were going to undergo general anesthesia were given a Virtual Operating Room Tour (VORT) video intervention for 6 minutes 28 seconds before surgery/anesthesia in the treatment room, a virtual tour of the operating room (containing preoperative preparations, premedication and drug administration, travel from the treatment room to the operating room, procedures performed in the preparation room and operating room) using the Oculus Go Standalone VR. VR videos were recorded with an Insta360Pro 3D camera (Arashi Vision Inc), with 4k resolution and built-in microphone, the control group was given standard operating procedures in accordance with hospital regulations.

Oudkerk Pool, et., al. (2022) in the Netherlands, research patients who were going to undergo heart surgery: percutaneous closure of a patent foramen ovale (PFO) or atrial septal defect (ASD) were given interventions, giving information about routine procedures orally

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and an additional 5-minute VR video containing an introduction to the team. the doctor involved in the procedure, during the virtual video visit, using a 360-degree view, all the locations the patient will visit on the day of their procedure (i.e., cardiology ward, catheterization laboratory, and recovery room) as well as explain the procedure in more detail from the cardiologist involved cared for them during their outpatient clinic visit using the Oculus GO Headset (Oculus, Facebook Technologies, LLC, Menlo Park, CA, USA), whereas the control group was given routine procedure information orally from their treating cardiologist during the outpatient clinic visit , and receive an informative leaflet about the procedure to be performed.

VR Distraction

There are four studies that provide VR distraction interventions. 3 studies in the form of VR relaxation with 1 RCT study (Ugras et al., 2022), 2 prospective cohort studies (Baytar & Bollucuoğlu, 2021a; Chan et al., 2020), and 1 RCT study with distraction interventions in the form of VR games (Hendricks et al. al., 2020). Research by Ugras, et., al. (2022) in Turkey, colorectal and abdominal wall elective surgery patients were first given a 10-minute VR distraction intervention in the preoperative waiting room using a VR headset (VR BOX 2) and headphones minimizing loss of sound (EarPods with Apple Lightning Connector) with a cell phone. The VR headset and headphones were controlled by the researcher's cell phone (iPhone 7 Plus). The researchers created a playlist of five three-dimensional videos (eg, underwater world, museum trip, forest and park walk, beach trip, and spacewalk) with relaxing music as a background, whereas the control group was given no intervention. whatever.

Baytar and Bollucuoglu (2021) in Turkey, research patients who planned septorhinoplasty surgery were given a 15-minute 360◦ three-dimensional VR video intervention depicting the beauty of nature and accompanied by meditation music via a cellphone using a VR device equipped with a Samsung Gear VR headset (Samsung Electronics, Suwon, South Korea) equipped with the Samsung Note 7 Edge smartphone. VR device showing video with mobile app (guided meditation VR, virtual reality relaxation app) via Oculus on surgery day, VR procedure explained to patient while waiting for surgery in preoperative area.
Research Chan, et., al. (2020) in Singapore, patients with planned gynecological surgery were given a VR intervention with a 10-minute 'Relax VR' program which contained eleven immersive scenes to choose from with a background of meditation music and breathing exercises using a Samsung Gear VR3 (Samsung Co. Ltd) headset and earpieces. audio, equipped with the Samsung 8 smartphone. VR interventions are performed with the patient lying on a bed in a Fowler's position with knees straight, in a quiet preoperative waiting room and performed 1-2 hours before surgery (Chan et al., 2020).

Hendricks, et., al. (2020) research patients planning for sternotomy surgery were first given the VR game “Bear Blast” in which the patient moves his head and visual sights to a target object in an energetic cartoon world. Patient was allowed to use the VR device freely for 20 minutes during which time would normally be spent waiting to be transferred to the preoperative waiting room (AppliedVR, Los Angeles, CA) wearing a Samsung Gear

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Oculus and audio headset (Ridgefield Park, NJ) equipped with a Samsung Galaxy Device S7 to present VR content and the control group was given a tablet with a game application based on audiovisual tactile stimulation "Candy Crush".

Anxiety Measurement Scale

Preoperative anxiety scores were measured and reported in 6 RCTs and 2 prospective cohorts with a total sample of 546 patients using several instruments such as the Amsterdam Preoperative Anxiety and Information Scale score (APAIS), the Hospital Anxiety and Depression Scale (HADS), State-Trait Operation Anxiety - State (STAI-S) and State-Trait Operation Anxiety-Trait (STAI-T), and the Anxiety Specific to Surgery Questionnaire (ASSQ). Yang, et., al. (2019) used a measuring tool: the Amsterdam Preoperative Anxiety and Information Scale score (APAIS). The APAIS scale is a validated self-report instrument for assessing preoperative patient anxiety. The questionnaire consists of 2 scales, which relate to the scale of anxiety and the scale of information needs related to the situation waiting for surgery. The tool has 6 items that are rated by the patient on a 5-point Likert scale. The APAIS anxiety scale is the sum of items 1, 2, 4, and 5, with a range of scores from 4 (lowest) to 20 (highest), and the APAIS information needs scale with a sum of 3 items and 6, with a score range of 2 to 10.

Chan, et., al. (2020) used the Hospital Anxiety and Depression Scale (HADS) to measure changes in pre-operative anxiety. The HADS is used to assess patients' levels of anxiety and depression during their hospitalization and is preferentially used as an indicator of general psychological distress. Each item on the questionnaire is scored from 0 to 3, so a patient may have a total score of 0 to 21 for the anxiety and depression subscales, respectively. Scores 0–7 indicate a normal level of anxiety/depression while 8–10 indicates an abnormal limit and 11–21 indicates abnormal. Vogt, et. al., (2021) used the state and trait anxiety scales from the state-trait operation anxiety inventory (STOA) as outcome variables. The STOA is a validated inventory with good psychometric properties that assesses surgery-related and anxiety-related traits on separate scales. Trait anxiety (STOA-T, 20 items) is a relatively stable disposition of a person to be anxious about surgery, while state anxiety (STOA-S, 10 items) assesses acute fear reactions in situations just before or after surgery in 2 dimensions (anxiety cognitive and affective anxiety, 5 items each). Measuring relatively stable properties, STOA-T was assessed only before surgery, while STOA-S was assessed before (T1) and after surgery (T2).

Turrado, et., al. (2021) measured anxiety and its intensity using two validated scales, the State-Trait Anxiety Inventory Scale (STAI-S) and the Hospital Anxiety and Depression Scale (HADS). Measurements were taken before the intervention was given and after the intervention or on the day before the surgical procedure. Oudkerk Pool, et., al. (2022) measured pre-procedure anxiety using the State-Trait Anxiety Inventory (STAI) and the Amsterdam Preoperative Anxiety and Information Scale (APAIS) instruments. Measurements were taken before the intervention was given and after the intervention or on the day before the surgical procedure. Baytar and Bollucuoglu (2021), The patient's oxygen saturation values, heart rate, and blood pressure are monitored and recorded. State Anxiety Inventory test (STAI-S), for measuring

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anxiety. During follow-up, the patient's blood pressure, oxygen saturation values, and heart rate were recorded at 5, 10, and 15 minutes. The patient completed the STAI-S scale a second time. In addition, they were asked about their satisfaction with the procedure (very satisfied, satisfied, undecided, dissatisfied).

Ugras, et., al. (2022) measured preoperative anxiety using the Anxiety Specific to Surgery Questionnaire (ASSQ) instrument. This scale was developed by Karanci and Dirik to measure specific anxiety due to surgery. The scale is a 5-point Likert scale (1: completely disagree, 5: strongly agree) with 10 items. The ASSQ score is obtained by adding up the answers to all items (minimum score = 10; maximum score = 50). Higher scores indicate greater levels of anxiety. ASSQ and physiological response to anxiety for all patients were measured before being transferred from the operating room to the operating room. While patient data in the experimental group was measured and recorded before and after the VR application. The control group was measured and recorded after 10 minutes of the first measurement equivalent to the VR application time. Hendricks, et. al., (2020) used The State-Trait Anxiety Inventory (STAI) to measure anxiety before and after intervention. Turrado, et. al., (2021) uses two scales to measure anxiety, namely The State-Trait Anxiety Inventory Scale (STAI-S) and the Hospital Anxiety and Depression Scale (HADS). The STAI-S scale is between 20 to 80 points and a higher score indicates a higher level of anxiety as well.

Risk of Bias Among Research Articles

Based on the results of a study conducted on 6 RCT study designs, there were 3 RCTs with very good results from a methodological point of view because the researchers and participants were double blinded on group division and outcome measurement, and the other 3 RCTs were quite good methodologically, but it was not explained whether the grouping of participants and outcome measures were blinded between the researcher and the participants. Two studies with a prospective cohort design were not grouped into the exposed and non-exposed groups so that the results could not be compared because all participants were given the intervention.

DISCUSSION

The aim of this systematic review was to assess the effectiveness of using Virtual Reality in reducing preoperative anxiety in patients undergoing elective surgery under general anesthesia. Several of these studies have similarities in the use of anxiety score assessment instruments used to evaluate primary outcomes and usefulness outcomes, with only 1 study combining anxiety, hemodynamic parameters, and patient satisfaction in patients undergoing septorhinoplasty surgery (Baytar & Bollucuoğlu, 2021). The main result was an anxiety assessment based on the seven included studies showing that non-pharmacological interventions with the use of virtual reality in providing education and distraction proved to be effective in reducing the anxiety of preoperative patients who would undergo planned surgery under general anesthesia procedures compared to the group receiving standard care (Baytar & Bollucuoğlu, 2021; Chan et al., 2020; Hendricks et al., 2020; Oudkerk Pool et al., 2022; Turrado et al., 2021; Ugras et al., 2022; Yang et al., 2019). This is in line with the research of Koo, et. al., (2020) which stated that virtual reality has proven effective in reducing anxiety scores in

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pediatric and adult patients who will undergo planned surgery. Only one study was included which had no effect of the VR intervention on reducing anxiety (Vogt et al., 2021). The researchers explained these results by the fact that the provision of VR interventions was carried out after the patient received preoperative education, although this intervention was not effective in reducing anxiety, the patient's assessment of the VR intervention was very positive and considered very useful so that patients showed acceptance for the use of VR (Vogt et al., 2021).

The results of several studies that have been conducted, management of patient anxiety during the preoperative period is proven to be a major factor in improving the patient's recovery process, reducing the length of stay in the hospital, costs related to health care, and postoperative complications as well as increasing patient satisfaction (Baytar & Bollucuoğlu, 2021; Kuzminskaite et al., 2019; Mulugeta et al., 2018; Peuchot et al., 2021; Turksal et al., 2020). On the other hand, several studies have identified that poor anxiety management has been shown to lead to worsening surgical outcomes (including postoperative pain, chronic pain, mood disturbances over time, and death), increased need for anesthetic drugs, prolonging the duration of anesthesia and reducing the quality of postoperative recovery. one of the possible causes of unnecessary surgery cancellation and reduced patient satisfaction (Almalki et al., 2017; Bedaso & Ayalew, 2019; Ganry et al., 2018; Glennon et al., 2018; Hendricks et al., 2020).

Management of preoperative anxiety is carried out both pharmacological and non-pharmacologically. Research on the provision of pharmacological interventions by administering sedative premedication as a common and first-line method in reducing anxiety during the preoperative period has recently been shown to have no significant increase in overall patient satisfaction. Furthermore, administration of these drugs is associated with an increased incidence of delirium which is strongly associated with increased mortality (Kassie et al., 2017). The use of non-pharmacological interventions to reduce anxiety is very much needed as evidenced by several previous studies, VR has emerged as a non-pharmacological intervention method especially in relieving pain and anxiety (Koo et al., 2020; Ridout et al., 2021; Smith et al., 2020; Turrado et al., 2021). The use of VR has proven applicability, ease of use and an easy sterilization strategy that allows devices to be safely reused, and several studies have shown that the cost and appropriate use of VR is beneficial for healthcare institutions where its use effectively shortens patient length of stay (Delshad et al., 2018; Hendricks et al., 2020).

The use of VR in providing preoperative education is useful in increasing the knowledge of patients who will undergo elective surgery with general anesthesia, where patients feel worry and anxiety because they do not know what things will happen while the patient is unconscious. Patient education is the process of influencing patient behavior and producing changes in knowledge, attitudes and skills needed to maintain or improve health (Simonetti et al., 2022). VR helps patients to see and feel the real environment so that patients will feel as if they are in that environment, VR can improve retention and memory. VR experiences become part of long-term memory due to patient engagement and personal relevance (Koo et

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al., 2020; van der Linde-van den Bor et al., 2022; Vogt et al., 2021). While not everyone will agree that VR can be fun, learning is easier when there is a pleasurable experience, which translates to higher levels of engagement and understanding (Koo et al., 2020; Simonetti et al., 2022).

The use of VR in providing preoperative distraction is useful in diverting the patient's anxiety into something else that is fun and calming. Distraction is one of the most commonly used non-pharmacological therapies, its effectiveness reflects the fact that if the distraction is interesting enough and attracts one's attention it will switch from anxiety stimulation to anxiety reduction (Simonetti et al., 2022). For example, playing video games that require high cognitive engagement and attention to the challenges and difficulties of the game can further increase anxiety tolerance through greater activation of the parasympathetic nervous system (Chan et al., 2020; Simonetti et al., 2022). VR acts as a distraction by providing multiple mechanisms by involving different senses simultaneously and encouraging a sense of presence in the virtual environment, thereby diverting one's attention from painful and frightening stimuli and other negative emotions such as stress and anxiety (Baytar & Bollucuoğlu, 2021; Chan et al., 2020; Simonetti et al., 2022).

LIMITATION

This review has some limitations. First, we could not perform a quantitative synthesis because each study is reported anxiety scores and surgical populations were different. Second, the included studies in the systematic review are limited number of studies and only studies published in English were included. Finally, the included studies applied various kinds of VR software, which could have influenced the amount of immersion and VR effectivity.

CONCLUSION

The results of this systematic review validated the effectiveness of VR in reducing preoperative anxiety in adult patients undergoing elective surgery under general anesthesia compared to the standard care group. However, the effect of VR on postoperative satisfaction or behavioral disturbances remains to be clarified. Thus, VR interventions may be an attractive solution to optimize perioperative care.

RECOMMENDATION

This study is a comprehensive review assessing the effectiveness of using VR in reducing preoperative anxiety in adult patients undergoing elective surgery under general anesthesia. These findings have provided a number of directions for future research and clinical applications of this program. This VR application is simple, interactive, multisensory, given a sufficient amount of time before the operation and VR supports the philosophy of the constructivist situation "learning by doing" with "experiential learning" which can be defined as a learning model that begins with direct experience involving learning, followed by reflection, discussion, analysis and evaluation of experiences. So that the use of VR is expected to be used as a technology-based non-pharmacological intervention, especially in reducing anxiety levels in various health care settings.

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