VER
Vascular & Endovascular Review

Comparison of the Effectiveness of Virtual reality and Midazolam Premedication on Preoperative Anxiety and Hemodynamic Changes in Patients Undergoing Elective Surgery

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ABSTRACT

Background: Preoperative anxiety is a common condition experienced by up to 80% of patients undergoing elective surgery. This condition not only has psychological impact but also triggers physiological changes that may affect hemodynamic stability and anesthetic outcomes. While midazolam is an effective pharmacological premedication to reduce anxiety, it carries respiratory and cognitive side effects. Virtual reality (VR) has emerged as a non-pharmacological alternative that offers distraction effects through immersive multisensory experiences. This study aims to compare the effectiveness of VR to midazolam in reducing preoperative anxiety and maintaining hemodynamic stability. Methods : This study was designed as a randomized controlled trial involving 30 patients aged 18–45 years, ASA physical status I–II, who underwent elective surgery under spinal anesthesia. Subjects were divided into two groups: the VR group (n=15) and the midazolam group (n=15). Anxiety levels were measured using the Amsterdam Preoperative Anxiety and Information Scale (APAIS) at baseline and after intervention. Hemodynamic parameters—including systolic blood pressure, diastolic blood pressure, mean arterial pressure, and heart rate—were recorded at baseline, 5 minutes, and 30 minutes after intervention. All data were statistically analyzed. Results : Analysis demonstrated a reduction in APAIS score 30 minutes after intervention in the VR group compared to baseline. A similar result was observed in the midazolam group. However, comparison between the VR and midazolam groups revealed no significant difference in the reduction of preoperative anxiety at the 30-minute evaluation ($p>0.05$). Likewise, changes in hemodynamic parameters (systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate) measured at baseline, 5 minutes, and 30 minutes showed no significant differences between the two groups ($p>0.05$). Conclusion : Both interventions effectively reduced preoperative anxiety, but their effectiveness was equivalent as no difference was found. Hemodynamic changes were also not different between the two groups.

KEYWORDS: Virtual Reality, Midazolam, Preoperative Anxiety, Hemodynamics, APAIS.

How to Cite: Wahyu Cahyana Hidayat, Maulydia, Hamzah, Prananda Surya Airlangga, Kohar Hari Santoso, Atika. (2025) Comparison of the Effectiveness of Virtual reality and Midazolam Premedication on Preoperative Anxiety and Hemodynamic Changes in Patients Undergoing Elective Surgery, Vascular and Endovascular Review, Vol.8, No.15s, 385-394

INTRODUCTION

According to the World Health Organisation (WHO) in 2018, there was an increase of 165 million surgical procedures in hospitals worldwide. It was recorded that surgical procedures in Indonesia reached 1.2 million in 2020 (Indonesian Ministry of Health, 2020). Surgical procedures go through three stages, namely pre-operative, intra-operative and post-operative. The preoperative stage is one of the stages that must be carried out during the perioperative phase. In this initial preoperative stage, more than two-thirds of patients awaiting surgery experience anxiety on average [1]. Anaesthesia and surgery are very stressful procedures, with around 80% of patients undergoing surgery experiencing preoperative anxiety [2].

Anxiety is a feeling of insecurity, tension and worry that arises due to a dangerous condition whose cause is not yet known [3]. Anxiety in preoperative patients can take the form of acute or chronic anxiety [4], which will affect perioperative anaesthesia management, delay surgery, cause sleep disturbances, haemodynamic disturbances, post-operative pain, immune response disturbances and slow down the healing process [5].

Preoperative anxiety is characterised by feelings of tension, worry, and nervousness in the period leading up to surgery. This condition has the potential to directly affect not only physical condition but also the condition during surgery and recovery. Several studies have shown that increased preoperative anxiety is associated with various adverse outcomes, including increased pain perception, higher anaesthesia requirements, and prolonged recovery time. In addition, preoperative anxiety can lead to serious complications in the heart and postoperative delirium [6].

The high prevalence and negative effects of preoperative anxiety necessitate treatment [7]. To date, there are two types of interventions for preoperative anxiety, namely pharmacological and non-pharmacological. Pharmacological interventions include sedatives and anti-anxiety medications. Midazolam is one of the most commonly used anxiolytic agents [8]. Midazolam, a benzodiazepine medication, enhances the effects of primary inhibitory neurotransmitters in the central nervous system, thereby

reducing anxiety and promoting relaxation. However, midazolam has the potential to cause side effects such as respiratory depression, paradoxical reactions, and prolonged recovery time. In addition, the timing of midazolam administration is very important as it can affect the drug's performance and the overall perioperative workflow [9].

With technological advances, non-pharmacological interventions are gaining attention as alternatives or complements to pharmacological therapies. One emerging innovation is the use of virtual reality (VR) in a medical context. VR is a technology that allows users to engage in an immersive three-dimensional virtual environment, which can be used as a distraction tool to divert patients' attention from their anxiety. Several studies have shown that VR interventions are effective in reducing preoperative anxiety [10]. In addition, VR also functions as an educational tool, improves mood, reduces apathy, and is often considered a more interesting and enjoyable experience compared to non-virtual methods [11].

Although both VR and Midazolam have been proven effective in reducing preoperative anxiety, direct comparisons between these two interventions are still limited. A deeper understanding of the relative effectiveness of pharmacological and non-pharmacological interventions is needed to inform clinical practice and therapeutic decision-making. Furthermore, it is important to evaluate how these two interventions affect haemodynamic parameters, given that haemodynamic changes can have a significant impact on patient prognosis during and after surgery.

Therefore, this study aims to compare the effectiveness of virtual reality versus midazolam premedication on preoperative anxiety and haemodynamic changes in patients undergoing elective surgery. The results of this study are expected to contribute to the selection of optimal and safe anxiety management strategies for patients, as well as enrich the literature on non-pharmacological interventions in the perioperative context.

RESEARCH METHOD

Type and Design of Research

This study is a quantitative experimental study with a Randomised Controlled Trial (RCT) design. This study aims to compare the effectiveness of premedication using virtual reality (VR) and midazolam premedication on preoperative anxiety and haemodynamic changes in patients undergoing elective surgery. The experimental approach was conducted by randomly dividing the subjects into two intervention groups, namely the group receiving VR premedication and the group receiving midazolam premedication. A comparative approach was applied to assess the differences in the effectiveness of the two methods in reducing preoperative anxiety and changes in haemodynamic parameters, such as blood pressure, heart rate, and Mean Arterial Pressure (MAP). The Amsterdam Preoperative Anxiety and Information Scale (APAIS) was administered to both groups. The data obtained were analysed using appropriate statistical tests, such as independent t-tests or Mann-Whitney U tests, to objectively compare the results between groups.

Research Location and Time

The study was conducted in the premedication room on the 7th floor of Airlangga University Hospital after the study was approved by the Airlangga University Hospital Research Ethics Committee in Surabaya.

Population and Sample Size

The population in this study consisted of patients who were scheduled to undergo elective surgery and met the inclusion and exclusion criteria at Airlangga University Hospital since July 2025.

The sample consisted of patients who were prepared for elective surgery at RSUA. The required sample size was based on power analysis or the calculation of the minimum sample size required to achieve significant results. The calculation resulted in a total sample size of 24 people. To anticipate sample loss (dropouts), a correction factor of 20% was used, resulting in a total sample size of 1.25 x 24 = 30 people, with each group consisting of 15 people.

This study used inclusion criteria in the form of patients who were willing to follow all research procedures by signing informed consent, aged 18–45 years, scheduled to undergo elective surgery, had ASA I–II physical status, body mass index (BMI) < 30, and preoperative pain scale 0–1.

Exclusion criteria included patients with comorbid hypertension or diabetes mellitus, those with psychiatric disorders and undergoing therapy, those with visual or hearing impairments that hindered the use of virtual reality, those with a history of allergies or contraindications to midazolam, and pregnant patients.

Research Variables

The research variables in this study consisted of independent, dependent, and control variables used to evaluate the comparative effectiveness of virtual reality (VR) premedication and midazolam premedication on preoperative anxiety and haemodynamic changes in patients undergoing elective surgery.

Independent variables: Virtual reality premedication and midazolam premedication administration.

Dependent variables: Anxiety levels and haemodynamic changes (systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate).

Data analysis

The collected data were analysed using appropriate statistical methods to compare the effectiveness of virtual reality and midazolam premedication on preoperative anxiety and haemodynamic changes. Descriptive analysis was performed to describe patient characteristics such as age, gender, and ASA status, which were presented as mean ± standard deviation (SD) or percentage (%) according to the type of data. Prior to inferential analysis, normality testing was performed using Shapiro-Wilk to determine data distribution. If the data were normally distributed, independent t-tests were used to compare changes in anxiety and haemodynamics between the VR and midazolam groups. If the data were not normally distributed, Mann-Whitney U tests were used as an alternative. Statistical test results will be considered significant if the p-value is < 0.05. This analysis aims to determine whether virtual reality is more effective, equivalent, or less effective than midazolam premedication in reducing preoperative anxiety and maintaining haemodynamic stability in patients undergoing elective surgery.

Research Ethics

Before participating, each patient will be given clear and detailed information about the purpose, procedures, benefits, and potential risks of the research. Patients will be given time to consider their participation before signing an informed consent form, which is given voluntarily without coercion. They also have the right to withdraw from the research at any time without consequences for the medical care they receive. In this study, patient confidentiality and anonymity are strictly maintained. The identity and personal information of participants will be kept confidential, and the results of the study will be analysed in groups without mentioning individual names. To ensure the safety and comfort of the research subjects, the interventions used, namely virtual reality and midazolam premedication, are widely used in anaesthesiology and have minimal risks. All procedures will be performed by competent medical personnel to ensure patient safety, and if any side effects or discomfort occur during the intervention, patients will immediately receive appropriate medical treatment.

This study also refers to the principles of beneficence and non-maleficence. The principle of beneficence is applied with the aim of providing benefits in reducing preoperative anxiety and maintaining the patient's haemodynamic stability. Meanwhile, the principle of non-maleficence is applied by ensuring that the intervention provided does not harm the patient and has greater clinical benefits than risks. This study has been approved by the Airlangga Hospital Research Ethics Committee with Number: 139/KEP/2025 on 18 July 2025.

RESULT

Characteristics of Research Subjects

The study was conducted in the premedication room on the 7th floor of Airlangga University Hospital in Surabaya from July 2025 to August 2025 with the research subjects being patients who were undergoing surgery and met the inclusion and exclusion criteria. Sampling was conducted using randomised sampling. A total of 30 patients participated in the study.

The demographic characteristics in this study were based on age, BMI, gender, ASA PS, gender, and anaesthesia plan. Based on gender, the sample consisted of 17 female samples (56.67%) and 13 male samples (43.33%). Eighteen samples (60%) were planned for general anaesthesia and 12 samples (40%) for regional anaesthesia with subarachnoid block (SAB). Fifteen of the total samples (50%) were given VR and the rest were given midazolam premedication.

A normality test was performed on the age and BMI variables in both groups. A normal distribution was found for the age and BMI variables. An independent samples T-test was performed to assess the difference in age and BMI variables, yielding a p-value of 0.621 ($p > 0.05$) for age and 0.977 ($p > 0.05$) for BMI, indicating no difference in age and BMI characteristics between the two groups.

Table 1: Demographic characteristics of the research sample

Subject Characteristics	Group		Total	p value
	Intervention with VR (n = 15)	Midazolam (n = 15)		
Age (years) (Mean ± SD)	31.40 ± 9,95	29,80 ± 7,38	30.60 ± 8.64	0.621
BMI (kg/m²) (Mean ± SD)	21,61 ± 0,57	21.60 ± 0.65	21.61 ± 0.60	0.977
PS ASA n (%)				
I (one)	4 (26,67)	6 (40,00)	10 (33,33)	
II (two)	11 (73,33)	9 (60,00)	20 (66,67)	
Total	15 (100,00)	15 (100,00)	30 (100,00)	
Gender				

Male	7 (46,67)	6(40,00)	13 (43,33)	
Female	8 (53,33)	9 (60,00)	17 (56,67)	
Total	15 (100,00)	15 (100,00)	30 (100,00)	
Anaesthesia Plan				
General Anaesthesia	8 (26,70)	10 (33,33)	18 (60,00)	
SAB	7 (23,33)	5 (16,70)	12 (40,00)	

Preoperative Anxiety in Patients Undergoing Surgery at RSUA

Initial preoperative anxiety was assessed when subjects arrived at the premedication room, while preoperative anxiety was evaluated after 30 minutes of VR use or receiving midazolam premedication. The level of preoperative anxiety was measured using the Amsterdam Preoperative Anxiety and Information Scale (APAIS) questionnaire. The Shapiro Wilk normality test was performed to determine whether preoperative anxiety was normally distributed or abnormally distributed.

The Shapiro Wilk normality test concluded that initial preoperative anxiety was not normally distributed, while evaluated preoperative anxiety was normally distributed. In this study, the initial APAIS score in the VR group was 13 (11-14) and in the midazolam premedication group was 13 (12-14). The evaluation APAIS score in the VR group had a mean of 8.80 and SD of 1.74, while the evaluation APAIS score in the midazolam premedication group had a mean of 7.53 and SD of 1.75.

Table 2: Preoperative anxiety among patients undergoing surgery at RSUA

APAIS	**Group**	
	VR	Midazolam
Start **Median (min-max)**	13 (11-14)	13 (12-14)
Evaluation **Mean ± Std**	8,80 ± 1,74	7,53 ± 1,75

Analysis of Preoperative Anxiety Levels and Evaluation in the Midazolam Premedication Group

Before analysing the initial APAIS and evaluation in the midazolam premedication group, a normality test was first conducted to assess the data distribution. The Shapiro-Wilk test was used for the normality test, as the sample size was 15 subjects.

The results of the Shapiro-Wilk test showed that the initial APAIS was not normally distributed, while the evaluation APAIS was normally distributed. The analysis was continued with the Wilxocon test to determine the difference between the initial APAIS score and the evaluation in the midazolam premedication group.

Table 3: APAIS in the midazolam premedication group

Sample group	**APAIS Score**			**P Value**
	Beginning mean ± Std	Evaluation mean ± Std	Delta	
Midazolam	12.87 ± 0.74	7,53 ± 1,76	5,33	0,001

Statistical tests showed a difference between initial APAIS and evaluation in the midazolam premedication group ($p<0.05$). This indicates that midazolam premedication can reduce preoperative anxiety levels in patients.

Analysis of Preoperative Anxiety Levels and Evaluation in Virtual Reality Groups

Before conducting the analysis of the initial APAIS and evaluation in the virtual reality group, a normality test was first conducted to assess the distribution of data. The Shapiro-Wilk test was used for the normality test, as the sample size was 15 subjects.

The results of the Shapiro-Wilk test showed that the initial APAIS was not normally distributed, while the evaluation APAIS was normally distributed. The analysis continued with the Wilxocon test to determine the difference between the initial APAIS scores and the evaluation in the virtual reality group.

Table 4: APAIS in the virtual reality premedication group

Sample group	**APAIS Score**			**P Value**
	Beginning mean ± Std	Evaluation mean ± Std	Delta	
Virtual reality	12.73 ± 0.96	8,80 ± 1,74	3,93	0,001

Statistical test results showed a difference between initial APAIS and evaluation in the virtual reality group ($p<0.05$). This indicates that virtual reality premedication can reduce preoperative anxiety levels in patients.

Comparison of Initial Preoperative Anxiety Levels and Evaluation between the Virtual Reality Group and the Midazolam Premedication Group

Before conducting a test of differences between groups, a normality test was first conducted to assess the distribution of APAIS anxiety scores in both groups. The Shapiro-Wilk test was used for the normality test, as each group consisted of 15 subjects.

The results of the Shapiro-Wilk test showed that the data were normally distributed in the initial APAIS of the VR group, the evaluation APAIS of the VR and midazolam groups, while the initial APAIS scores of the midazolam group were not normally distributed. The analysis continued with the Mann-Whitney U test to determine the difference in initial APAIS between the VR and midazolam groups, while the Independent Samples T-Test was used to determine the difference in evaluation APAIS between the VR and midazolam groups.

Table 5: Comparison of initial APAIS scores and evaluation between the virtual reality group and the midazolam premedication group

APAIS	Group		Total	P Value
	VR	Midazolam		
Initial Median (min-max)	13 (11-14)	13 (12-14)	13 (11-14)	0,824a
Evaluation Mean ± Std	8,80 ± 1,74	7,53 ± 1,75	8,17 ± 1,84	0,058b

a Whitney U test
b Independent-Samples T Test

Statistical test results show that there is no difference in initial APAIS scores between the two groups. This means that the initial anxiety levels in both groups are homogeneous. Statistical test results show that the mean APAIS evaluation score in the Midazolam group is 7.53 ± 1.75, while in the VR group it is 8.80 ± 1.74. Although the mean APAIS score for the VR group was higher, the t-test showed a p-value of 0.058 (>0.05). This means that there was no statistically significant difference in the APAIS evaluation scores between the two groups. Thus, both midazolam premedication and virtual reality are equally effective in reducing preoperative anxiety levels in patients undergoing surgery.

Comparison of Haemodynamic Parameters between Patients Given Virtual Reality and Midazolam Premedication

Before conducting statistical tests, normality tests were first performed on systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and heart rate (HR) data at baseline, 5 minutes, 30 minutes, delta 5 minutes from baseline, and delta 30 minutes from baseline. The normality test was performed using Shapiro-Wilk because the number of samples in each group was 15 samples.

The normality test results showed that the data were normally distributed ($p > 0.05$) in all data except for the delta SBP at 5 minutes from baseline, heart rate delta at 5 minutes from baseline, TDD at 30 minutes from baseline, delta TDS at 30 minutes from baseline, delta TDS at 30 minutes from baseline, and heart rate delta at 5 minutes from baseline in both the VR group and the midazolam premedication group.

Statistical tests on normally distributed data will use the Independent T-test, while non-normally distributed data will use the Mann-Whitney U test to compare haemodynamic parameters between the VR group and the midazolam premedication group, both at baseline, minute 5, minute 30, delta minute 5 with baseline, and delta minute 30 with baseline.

Table 6: Comparison of haemodynamic parameters between the virtual reality group and the midazolam premedication group

Variable	VR (Mean ± SD)	Midazolam (Mean ± SD)	p-value
TDS			
Start	122.73 ± 8.23	124.67 ± 7.90	0.517b
Minute 5	112.07 ± 7.54	114.20 ± 7.50	0.443b
Minute 30	111.13 ± 7.18	113.67 ± 6.64	0.324b
Delta min to 5-start	-11 [(-12) - (-9)]	-11 [(-12) - (-9)]	0.676a
Delta min to 30-start	-12 [(-13) - (-8)]	-12 [(-14) - (-8)]	0.309a
TDD			
Start	82.13 ± 5.97	83.07 ± 5.50	0.660b
Minute 5	75.40 ± 5.76	76.13 ± 5.01	0.713b
Minute 30	74.27 ± 5.97	75.47 ± 4.76	0.548b
Delta min to 5-start	-7 [(-8) - (-6)]	-7 [(-8) - (-6)]	0.427a

Delta min to 30-start	-8 [(-9) - (-6)]	-8 [(-9) - (-5)]	0.682a
MAP			
Start	98.29 ± 4.30	96.88 ± 3.77	0.553b
5th minute	87.53 ± 6.27	88.80 ± 5.77	0.569b
30th minute	86.67 ± 6.32	88.13 ± 5.26	0.495b
Delta min to 5-start	-8.63 ± 0.65	-8.81 ± 0.54	0.421b
Delta min to 30-start	-9.50 ± 0.88	-9.47 ± 1.29	0.948b
HR			
Start	80.67 ± 6.04	80.53 ± 4.24	0.945b
5th minute	76.00 ± 5.00	75.27 ± 3.96	0.659b
30th minute	76.67 ± 5.08	75.47 ± 4.14	0.484b
Delta min to 5-start	-5 [(-6) - (5)]	-5 [(-6) - (-5)]	0.848a
Delta min to 30-start	-5 [(-6) - (6)]	-5 [(-7) - (-4)]	0.339a

a Whitney U test
b Independent-Samples T Test

The results of the analysis showed that there were no statistically significant differences ($p > 0.05$) in all haemodynamic parameters compared, both in the initial minute, the 5th minute, the 30th minute, the delta between the 5th minute and the initial minute, and the delta between the 30th minute and the initial minute. This indicates that the changes in haemodynamic parameters between the VR and midazolam groups were not significantly different. Therefore, it can be concluded that both interventions have equivalent effects on haemodynamic parameters.

Characteristics of Research Subjects

This study involved 30 patients who were preparing for elective surgery using either general anaesthesia or regional subarachnoid block at Airlangga University Hospital in Surabaya, with ages ranging from 19 to 43 years and classified as adults. The average age of the patients was 30.60 ± 8.64 years. A study by Wahyudi et al. on the relationship between preoperative anxiety and plasma adrenaline levels in pregnant women undergoing caesarean section surgery had an average age of 28.40 years [12]. One of the internal characteristics that influence anxiety is age. Young people experience greater anxiety than older people, and the older they are, the more experience they have [13]. Age is related to experience, learning, understanding, and how a person handles situations that shape attitudes and perspectives. The ability of adults to think clearly allows them to use strategies to overcome problems compared to younger age groups [14]. Other studies have found that preoperative anxiety decreases with age, with younger patients experiencing higher levels of anxiety than older patients. This is due to the younger population having less experience. However, some studies show higher levels of anxiety in older age groups, which may be due to several comorbidities [15].

The average Body Mass Index (BMI) of patients was 21.61 ± 0.60 kg/m², which is classified as normal according to WHO standards (18.5–24.9 kg/m²). This data is important because research by Ebshena and Alsayeh explains that obesity can interfere with haemodynamic stability in surgical patients undergoing general anaesthesia [16]. Obese patients also had lower mean arterial pressure (82.4 vs. 91.5 mmHg, $p = 0.026$), higher heart rate (95.2 vs. 88.3 beats per minute, $p = 0.041$), and lower oxygen saturation (94.1% vs. 96.7%, $p = 0.018$). Comorbidities such as hypertension and diabetes were significantly more common in obese patients. Obese patients required a higher dose of midazolam premedication than patients with ideal body weight. Research at the University of Lampung shows that obese people have a 4.6 times higher risk of OSA than non-obese people ($p = 0.000$, OR = 4.618) [17]. There is research at the Indonesian Christian University which explains that there is no relationship between stress levels and Body Mass Index [18]. Another study at Diponegoro University in 2013 also found the same result, namely that there was no significant relationship between BMI and anxiety ($p = 0.165$) [19]. In this study, the average BMI was normal in all samples, which avoided confounding factors in assessing haemodynamic changes in patients premedicated with midazolam.

Patients in this study were in ASA status I (33.33%) and ASA status II (66.67%). ASA I status indicates that patients are in normal health, while ASA II status indicates patients with very mild systemic disease. The higher the ASA physical status, the more complications or pathological conditions the patient undergoing anaesthesia will experience, resulting in more pathological changes during the anaesthesia procedure [20]. Another study stated that the use of beta-blockers before surgery, ASA class III status, procedures lasting more than 4 hours, haemodynamic instability during surgery, and the use of regional anaesthesia were significantly associated with haemodynamic instability in the post-anaesthesia recovery room [21]. Additionally, research indicates a relationship between ASA physical status and preoperative haemodynamic conditions, where a higher ASA status is often correlated with an increased risk of haemodynamic instability and complications before surgery [22]. The average patient in this study had an ASA PS I and ASA PS II, which helped to avoid confounding factors in the assessment of haemodynamic changes. A study by Forsberg in 2020 explored the relationship between ASA classification, self-rated physical health, psychological well-being, and anxiety in orthopaedic patients. The results revealed that a higher ASA classification (ASA III/IV) was associated with higher levels of self-reported anxiety before surgery. Therefore, in this study, samples with ASA III and IV were excluded to prevent confounding.

In this study, the majority of samples were women, with 17 samples (56.67%), while male samples numbered 13 (43.33%). In the initial APAIS scores, the female samples showed 6 female samples with an APAIS score of 14 and 11 female samples with an APAIS score of 13. Meanwhile, the initial APAIS scores of the male samples showed 2 samples with an APAIS score of 11, 8 samples with an APAIS score of 12, and 3 samples with an APAIS score of 13. This is similar to the research conducted by Nursoffa at Dr Soetomo General Hospital in 2015. The number of female samples (61.8%) was greater than that of male samples (38.2%). Based on the statistical results, females tended to experience more anxiety than males ($p = 0.001$) [23]. A study in Pakistan in 2007 on 193 patients statistically showed that anxiety was more prevalent in women than in men. The most common factors affecting anxiety included concerns about family 173 (89.6%), fear of complications 168 (87%), fear of surgical outcomes 159 (82.4%), and post-operative pain 152 (78.8%) [24].

In terms of anaesthesia plans, 18 samples received general anaesthesia and 12 samples received regional subarachnoid block anaesthesia. A study found that the anxiety level in patients undergoing spinal anaesthesia was higher, with an average of 10.3, compared to general anaesthesia, which had an average of 8.27 [25]. The higher anxiety in spinal anaesthesia patients may be due to the fact that they remain conscious during surgery [26]. Spinal anaesthesia patients also feel anxious about the injection into the spine and fear feeling something during the procedure, even though it is painless. Conversely, general anaesthesia patients feel more comfortable because they are asleep during the operation and only wake up afterwards [27].

Analysis of Preoperative Anxiety Levels and Evaluation in the Midazolam Premedication Group

This study found a difference between the initial APAIS score and the APAIS score evaluated 30 minutes after the intervention. This is in line with the 2020 study by Derakhshan et al, which showed that the STAI anxiety scores of patients who received midazolam before surgery decreased from 63.80 ± 12.85 in the pre-test to 32.61 ± 12.6 in the post-test, and there was a statistically significant difference between the pre-test and post-test results ($p<0.001$). Meanwhile, the group that received zolpidem also experienced a decrease in STAI anxiety scores, although lower than midazolam ($p<0.001$) [28]. Midazolam acts on specific benzodiazepine receptors concentrated in the cerebral cortex, hippocampus, and cerebellum. The mechanism of action of midazolam as a benzodiazepine agonist inhibits central nervous system neurotransmitters at GABA (Gamma Aminobutyric Acid) receptors. GABA (Gamma Aminobutyric Acid) is the primary inhibitory neurotransmitter in the central nervous system, thereby inhibiting the release of Corticotropin Releasing Factor (CFR). This increase in GABA (Gamma Aminobutyric Acid) activity further inhibits the release of Corticotropin Releasing Factor (CFR), thereby preventing the release of stress hormones, including glucocorticoids and epinephrine [29,30].

Analysis of Preoperative Anxiety Levels and Evaluation in Virtual Reality Groups

This study found a decrease in APAIS scores at baseline and 30 minutes after the intervention, indicating a difference in anxiety levels after VR use. This is consistent with studies comparing the effectiveness of VR with standard care in patients undergoing elective surgery. The VR-based intervention group showed a reduction in preoperative anxiety, lower stress levels, and higher readiness compared to the control group, which followed the hospital protocol. Satisfaction levels increased significantly in the intervention group compared to the control group (mean score [SD], 81.35±9.24 vs 65.28 ± 8.16; $P < 0.001$). VR exposure allowed participants to experience computer-generated surgical environments and procedures, helping to reduce their sensitivity to anxiety triggers from real experiences. The immersive nature of VR helps patients feel as if they are in a realistic environment, thereby increasing its potential impact [10]. Significant results were also obtained in a study by Arifin et al, which assessed surgical anxiety levels using the Spielberger State-Trait Anxiety Inventory 6 (STAI-6). The mean change in anxiety was higher in the IVR group than in the control group, with the VR group (15.73 ± 4.72) compared to the control group (9.27 ± 5.23). IVR significantly reduced anxiety scores compared to the control group ($P < 0.05$) [31].

Virtual reality (VR) is a new technology developed since the 20th century. This computer technology simulates synthetic environments and stimulates various senses through immersive experiences, allowing users to feel realistic and immersive sensations in three-dimensional simulations and helping people manage their emotions better by diverting their attention from pain and anxiety. Immersion, interactivity, and imagination are fundamental features of virtual reality technology. Research has shown that the use of head-mounted immersive displays can successfully divert patients' focus by placing them in realistic scenery settings and has a positive intervention effect on anxiety control during elective surgery [32]. A systematic review by Verhoeven et al. showed some evidence that unimodal psychological prehabilitation interventions reduce preoperative anxiety. Studies investigating virtual reality experiences and computer-based cognitive behavioural therapy have been shown to reduce preoperative anxiety with a moderate risk of bias. The reduction in preoperative stress suggests that virtual reality experiences can reduce subjective stress. The effectiveness of non-pharmacological psychological interventions in reducing perioperative anxiety varies between interventions. This is supported by the results of this review, in which three studies showed significant positive effects and two studies showed no effect or insignificant effects [33].

Comparison of Initial Preoperative Anxiety Levels and Evaluations between the Virtual Reality Group and the Midazolam Premedication Group

Initial preoperative anxiety measurements and evaluations were assessed using the Amsterdam Preoperative Anxiety and

Information Scale (APAIS). The median initial APAIS score in the VR group was 13 (11–14), while the median initial APAIS score in the midazolam group was 13 (12–14). Statistical results showed no difference between the two groups ($p>0.05$). This indicates that there was no difference in initial anxiety levels between the VR group and the midazolam premedication group. Initial anxiety in 66% of the study sample was dominated by moderate anxiety. Similar results were obtained in a study assessing the relationship between patient anxiety levels and haemodynamic stability in pregnant women undergoing caesarean section with SAB anaesthesia in 2024, where the APAIS in the study ranged from 10 to 18, with an average (13.32 ± 4.45), indicating that most patients experienced moderate anxiety [34]. The prevalence of preoperative anxiety in this study was 60%, where out of 25 pregnant women who underwent SC surgery, 15 had anxiety scores above 10. The prevalence of preoperative anxiety varies around the world, such as in a previous study in India which reported a prevalence of preoperative anxiety in 399 patients undergoing one-day care surgery of 58.1% (Jiwanmall et al., 2020). Studies from Mexico showed a higher prevalence of 82%, while in Sri Lanka the prevalence was only 23.4% [35,36]. Preoperative anxiety is a multifactorial issue and requires strategic management. Factors that can influence this include age, gender, marital status, previous surgical experience, and differences in the type of surgery [37].

In this study, the mean APAIS score in the VR group was 8.80 ± 1.74, while the mean APAIS score in the midazolam group was 7.53 ± 1.75. Although the mean APAIS score for the VR group was higher, there was no difference between the two groups. Thus, the use of virtual reality has an effect that is almost the same as midazolam premedication. Both are equally effective in reducing preoperative anxiety levels in patients undergoing elective surgery. This is similar to a study conducted by Koo in 2024, which found that VR provides an alternative equivalent to midazolam in reducing preoperative anxiety. Distraction and immersion in VR can help minimise preoperative anxiety during peak stress moments, namely separation from parents, arrival in the operating room, and anaesthesia induction. VR and midazolam are equally effective and safe in reducing preoperative anxiety and provide similar postoperative clinical outcomes in terms of delirium, pain control, and analgesic use [38].

A study by Giordano et al, conducted on dental surgery patients comparing the effects of preoperative music therapy versus intravenous midazolam on anxiety, sedation, and stress, yielded more significant results. Giardano's research showed a significant difference in anxiety visual analogue scale (A-VAS) scores between the music therapy group and the control group ($p < 0.01$). The music therapy group had significantly lower bispectral index (BIS) scores, used to measure sedation depth, before induction compared to the control group ($p = 0.02$). The patient global impression of satisfaction (PGIS) score was higher in the music therapy group at 86.7% compared to 80% in the control group ($p < 0.05$), indicating that patients who received music therapy were highly satisfied [39].

Differences in Haemodynamic Changes between Patients Given Virtual Reality Compared to Midazolam

The haemodynamic variables assessed in this study were systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and heart rate (HR). The results of the analysis showed that there were no statistically significant differences ($p > 0.05$) in all parameters compared, both at the initial minute, the 5th minute, the 30th minute, the delta at the 5th minute with the initial minute, and the delta at the 30th minute with the initial minute. This indicates that the changes in haemodynamic parameters between the midazolam group and the VR group were not significantly different. A study by Almedhesh et al, 2022 also provided similar results. The results of this study did not show a significant difference in systolic blood pressure, where the VR group had a higher SBP than the control group. Furthermore, the heart rate decreased significantly in the VR group compared to the control group after surgery. The relaxation induced by using VR caused a decrease in SBP and DBP, which had increased due to the physiological mechanisms of preoperative stress and anxiety [40]

One alternative treatment to reduce stress reactions is midazolam. This drug reduces anxiety and improves sleep quality. After being injected intravenously, the effects of this drug last for one to six hours. Heart rate, blood pressure, and systemic vascular resistance all decrease slightly due to the haemodynamic effects of midazolam. [41]. The use of IVR causes a progressive decrease in HR during the session. This indicates a calming autonomic response related to exposure to the environment during VR. The decrease in heart rate observed during VR exposure may reflect the activation of parasympathetic processes indicating autonomic relaxation. Overall, IVR can function not only as a source of sensory engagement but also as a viable therapeutic strategy to enhance physiological calmness and improve emotional health [42].

CONCLUSION

The results of the study indicate that the use of virtual reality (VR) and midazolam premedication are equally effective in reducing preoperative anxiety in patients undergoing elective surgery. The effectiveness of VR is comparable to that of midazolam in reducing anxiety levels, with no significant difference in haemodynamic changes between the two interventions, suggesting that VR is safe and suitable for use as a non-pharmacological alternative. Virtual reality can be used as an option or adjunct therapy in the management of preoperative anxiety, especially in patients with contraindications to sedative drugs. Further research is recommended using a more diverse anxiety scale and involving anxiety biomarkers, while assessing the long-term impact of VR on postoperative outcomes, such as intraoperative haemodynamic stability, postoperative pain, length of hospital stay, and patient satisfaction. The development of VR content tailored to local demographic characteristics and the evaluation of the potential for cyber sickness should also be considered to enhance the effectiveness and safety of use.

This study has limitations, including a relatively small number of subjects, which may affect the generalisability of the results; the

use of a single anxiety assessment instrument without supporting biomarkers; the absence of post-operative pain and patient satisfaction assessments; and the lack of a specific evaluation of cyber sickness. These limitations should be considered in the interpretation of the results and the development of further research.

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