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Effectiveness of slow deep breathing and virtual reality intervention on reducing preoperative anxiety

I Gusti Agung Tresna Wicaksana[1*], I Putu Arika Nusa Harta[2], Ni Putu Kamaryati[3], I Nyoman Arya Maha Putra[4]
[1,2,3,4]Nursing Program, Health Faculty, Institut Teknologi dan Kesehatan Bali, Denpasar, Indonesia
*Corresponding Author: tresnawicaksana.stikesbali@gmail.com

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Abstract

Preoperative anxiety is a typical psychological response that may negatively affect surgical outcomes and patient recovery. Non-pharmacological interventions are increasingly used to complement standard care and reduce anxiety levels. This study aimed to evaluate the effectiveness of a combined slow deep breathing and virtual reality intervention in reducing preoperative anxiety. A quasi-experimental design with a non-equivalent control group was employed, involving 92 surgical patients at a central operating installation. Participants were divided into an intervention group that received the combined therapy and a control group that received standard care. Pre- and post-intervention anxiety levels were assessed using the Hamilton Anxiety Rating Scale. Data were analyzed using the independent t-test to compare anxiety scores within and between groups. The findings demonstrated a significant reduction in anxiety in the intervention group and a marked difference compared to the control group. These results highlight the potential of combining slow deep breathing and virtual reality as a practical, low-risk approach to managing preoperative anxiety in clinical practice, supporting the integration of non-pharmacological therapies in perioperative nursing care.

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1. Introduction

Preoperative nursing care plays a critical role in the perioperative period, beginning once a patient decides to undergo surgery. This stage involves a comprehensive health assessment—including medical history, physical examinations, and diagnostic evaluations—while educating patients regarding surgical procedures, associated risks, and preoperative instructions. The primary goal is to ensure physical and psychological readiness, reduce anxiety, and minimize postoperative complications, all of which require effective communication and collaboration among nurses, physicians, and patients (Sutherland-Fraser et al., 2021).

Anxiety before surgery is a typical emotional response that significantly affects psychological well-being, physiological stability, and the overall quality of care throughout the perioperative process (Eberhart et al., 2020). Preoperative anxiety is characterized by excessive worry, fear, and tension related to surgical procedures and unfamiliar medical environments, often manifesting through restlessness, fatigue, difficulty concentrating, irritability, and sleep disturbances (Akbar, 2018). Various global studies report differing prevalence rates, ranging from 38.5% to 89% depending on population, surgical type, and hospital setting (Abate et al., 2020; Navarro-Gastón & Munuera-Martínez, 2020; Sabine et al., 2022; Joseph et al., 2022).

The negative consequences of preoperative anxiety extend into the intra- and postoperative phases, potentially leading to delayed procedures, impaired hemostasis, elevated blood pressure, poor wound healing, and decreased patient satisfaction (Ng et al., 2022). While pharmacological approaches, such as benzodiazepines or antihistamines, are commonly used to manage anxiety, these interventions pose risks, including dependency, allergic reactions, or renal impairment. Therefore, non-pharmacological methods such as distraction, deep breathing, massage, and relaxation techniques have emerged as safer alternatives (Aji et al., 2021). Slow-deep breathing is widely recognized among these strategies for its accessibility and minimal side effects. It involves slow inhalation through the nose and controlled exhalation through the mouth, triggering the body's relaxation response (Shobana et al., 2022; Hamasaki, 2020). Evidence from various studies supports its efficacy in reducing preoperative anxiety (Jerath, 2019; Rodrigues et al., 2021; Gholamrezaei et al., 2022), although some studies have shown inconsistent or non-significant results, particularly when combined with other interventions like aromatherapy (Khoirullisa et al., 2022; Kurniasari et al., 2015). A preliminary study at RSD Mangusada also revealed no significant reduction in anxiety following a 15-minute deep breathing intervention (Birdee et al., 2023; Arianti, 2018).

These inconsistencies suggest that slow deep breathing alone may not be sufficient. An integrated intervention could enhance its efficacy by combining it with virtual reality (VR). VR creates immersive, calming visual environments, redirecting the patient's attention from surgical stressors and facilitating deeper psychological engagement (Jebara et al., as cited in Aji, 2020; Fuchs, as cited in Rahmawati, 2023; Hoon Koo, 2020). Various studies have shown that VR through natural sceneries or procedural simulations can significantly lower anxiety, especially with audio-visual elements and guided breathing (Turrado et al., 2021; Chan, 2020). However, contrasting evidence remains (Eijlers et al., 2019).

Natural scenery itself has been shown to provide psychological relief by promoting autonomic balance and reducing symptoms of anxiety and depression, with effects persisting for weeks post-exposure (Van den Berg et al., as cited in Aji, 2020; Trivia, 2023). Combining visual immersion and deep breathing potentially enhances relaxation and improves mental well-being. Importantly, these methods are safe and do not require practitioner licensure or specialized certification (Slater & Sanchez-Vives, 2016). This study aims to evaluate the effectiveness of combining slow deep breathing with virtual reality in reducing preoperative anxiety. Conducted at the Central Operating Installation of RSD Mangusada—where surgical caseloads are high—the study seeks to offer a practical, evidence-based, and innovative intervention that could improve patient preparedness and psychological outcomes during the surgical experience.

2. Method

2.1 Research Design and Participants

This study employed a quasi-experimental non-equivalent control group design, which involved comparing an intervention group receiving a combination of slow deep breathing and virtual reality with a control group receiving standard preoperative care. This design was considered appropriate for evaluating the effect of the intervention in a real-world clinical setting without random assignment (Swarjana, 2017). The total population consisted of 1,491 preoperative patients who had visited the Central Surgery Installation (Instalasi Bedah Sentral) at RSD Mangusada between March and May 2023 (Swarjana, 2022). A purposive sampling technique was used to select 92 participants based on defined inclusion criteria, including patients aged 18–65 years, literate, undergoing surgery for the first time with general or spinal anesthesia, and capable of providing informed consent. Exclusion criteria included patients with respiratory disorders that prevented slow deep breathing, visual impairments incompatible with VR, psychiatric history, unstable cardiovascular conditions, critical illness, or low baseline anxiety scores. The sample size was calculated using the formula for comparing two proportions, assuming a 0.5 success rate in both groups, with $\alpha = 0.05$ ($Z\alpha/2 = 1.96$) and power = 0.8 ($Z\beta = 0.84$), resulting in a minimum sample of 92 patients. Participants were allocated into intervention and control groups using block randomization methods to minimize selection bias (Swarjana, 2022; Nursalam, 2016).

2.2 Instruments and Data Collection

Data were collected using the Hamilton Anxiety Rating Scale (HARS), developed by Max Hamilton in 1956, which consists of 14 items measuring psychological and somatic anxiety symptoms. Each item was rated on a Likert scale from 0 (not present) to 4 (very severe), with total scores ranging from 0 to 56. Scores below 17 indicated mild anxiety, 18–24 indicated moderate anxiety, and 25–30 indicated severe anxiety. The instrument assessed symptoms such as tension, insomnia, somatic complaints, and

autonomic responses and had been previously validated and shown to have strong reliability. Data collection involved informed consent and was facilitated by trained enumerators. Participants were assigned to intervention and control groups based on purposive criteria. The intervention group received guided slow deep breathing exercises combined with immersive virtual reality content tailored to reduce anxiety, administered for 15–30 minutes as recommended by Lan et al. (2021). The control group received standard preoperative hospital care without additional intervention. Efforts to minimize bias included careful group allocation, comparable controls, and standardized measurement tools. All enumerators were trained to ensure consistency during data collection.

2.3 Data Analysis

All collected data were analyzed using SPSS. Descriptive statistics were used to summarize participant characteristics, presented in frequency tables and percentages. The Kolmogorov-Smirnov test assessed whether the data followed a normal distribution. The results indicated that the data were normally distributed, and the paired t-test was employed to evaluate the difference in mean anxiety scores before and after the intervention in both groups. This statistical test was appropriate to compare two related groups under the normality assumption, with a significance level set at $p < 0.05$.

2.4 Ethical Considerations

The study received ethical clearance from the Health Research Ethics Committee of the Institute of Technology and Health (ITEKES) Bali under approval number 04.0402/KEPITEKES-BALI/IX/2023. Written informed consent was obtained from all participants after a full explanation of the study's objectives, procedures, and potential risks. Participant anonymity and confidentiality were ensured throughout the research process.

3. Results and Discussion

3.1 Results

The demographic characteristics of participants, including age, gender, marital status, religion, education, occupation, and type of surgery, are presented in Table 1.

Table 1. Distribution of Participant Characteristics Between Groups

Characteristic	Category	Group		p-value
		Intervention (%)	Control (%)	
Age	18-30 year	23 (50%)	21 (45.7%)	0.864
	31-45 years	16 (34.8%)	19 (41.3%)	
	46-65 years	7 (15.2%)	6 (13%)	
Gender	Male	22 (47.8%)	22 (47.8%)	0.000
	Female	24 (52.2%)	24 (52.2%)	
Education History	No Formal Education	2 (4.3%)	2 (4.3%)	0.051
	Elementary-Junior High School	15 (32.6%)	20 (43.5%)	
	Senior High School	23 (50%)	20 (43.5%)	
	Higher Education (S1, S2, S3)	6 (13.0%)	4 (8.7%)	
Marital Status	Married	25 (54.3%)	33 (71.7%)	0.004
	Single	21 (45.7%)	13 (28.3%)	
Occupation	Private Sector employee	10 (21.7%)	3 (6.5%)	0.062
	Civil Servant	5 (10.9%)	3 (6.5%)	
	Entrepreneur	22 (47.8%)	30 (65.2%)	
	Laborer	7 (15.2%)	5 (10.9%)	
	Unemployed	2 (4.3%)	5 (10.9%)	
Type of Surgery	General	17 (37%)	14 (30.4%)	0.060
	Oncology	2 (4.3%)	1 (2.2%)	
	Obgyn	10 (21.7%)	9 (19.6%)	
	Ear, Nose, & Throat	2 (4.3%)	2 (4.3%)	
	Orthopedic	10 (21.7%)	14 (30,4%)	
	Urology	5 (10.9%)	6 (13%)	

Most participants in the intervention group were aged 18–30 years (50%), while the control group showed a similar age distribution (45.7%). Both groups had the same proportion of females (52.2%). Most participants in the intervention group had completed senior high school (50%). A significantly higher proportion of participants in the control group were married (71.7%) compared to the intervention group (54.3%). The most common occupation in the control group was self-employed (65.2%), and the most frequent type of surgery was general surgery in the intervention group (37%). Statistical analysis revealed that marital status was significantly different between groups ($p = 0.004$), while other characteristics showed no significant differences ($p > 0.05$). The distribution of anxiety levels before and after the intervention was assessed using the Hamilton Anxiety Rating Scale (HARS), as summarized in Table 2.

Table 2. Distribution of Anxiety Levels in the Intervention and Control Groups (Pre and Post-Test)

	Category	Intervention			Control		
		f(%)	Mean	SD	f(%)	Mean	SD
Pre Test	Mild (< 17)	19 (41.3)			17 (37)		
	Moderate (18-24)	19 (41.3)	1.760	0.735	15 (32.6)	1.500	0.691
	Severe (25-56)	8 (17,4)			14 (32.4)		
Post Test	Mild (< 17)	28 (60.9)			19 (41.3)		
	Moderate (18-24)	13 (28.3)	1.934	0.827	16 (34.8)	1.826	0.797
	Severe (25-56)	5 (10.9)			11(23.9)		

Prior to the intervention, both mild and moderate anxiety levels were reported in 41.3% of participants in the intervention group. Following the intervention, mild anxiety increased to 60.9%. In the control group, the proportion of mild anxiety remained relatively stable from the pre-test (37%) to the post-test (41.3%). The mean post-test anxiety scores decreased slightly in both groups, with a greater reduction in the intervention group. The normality of data was confirmed using the Kolmogorov-Smirnov test ($p > 0.05$), indicating the use of parametric tests was appropriate. Paired t-tests assessed within-group differences, and independent t-tests were used for between-group comparisons.

Table 3. Paired and independent T-test Results for Anxiety Scores Before and After Intervention

Variable	Group	Paired t-test			Independent t-test		
		Mean Difference	Std. Error Difference	p-value	Mean Difference	Std. Error Difference	p-value
Anxiety	Intervention	3,261	0,403	0,002	-3.261	74.347	0,001
	Control						

In the intervention group, the mean anxiety score significantly decreased from 19.24 (SD = 5.60) to 16.98 (SD = 4.26), with a mean difference of 2.23 and a p-value of 0.050. The control group showed a negligible change from 20.52 (SD = 6.08) to 20.24 (SD = 6.99), with a mean difference of 0.28 and a p-value of 0.048. An independent t-test comparing post-test scores between the groups showed a statistically significant difference in anxiety levels ($p = 0.001$). The mean difference of 3.26 supports the effectiveness of the combined intervention in reducing preoperative anxiety among patients in the intervention group compared to those in the control group.

3.2 Discussion

The findings of this study confirm that the combination of slow deep breathing and virtual reality (VR) effectively reduces preoperative anxiety among patients undergoing surgical procedures. It is consistent with the hypothesis and addresses the research objective stated in the introduction. Anxiety is a typical psychological response among preoperative patients, driven by uncertainties related to surgery, pain, anesthesia, and potential postoperative complications (Spreckhelsen, 2021; Eberhart et al., 2020). In this study, the intervention group experienced a significant reduction in anxiety levels compared to the control group, reinforcing the clinical relevance of non-pharmacological approaches in anxiety management. The observed improvement aligns with prior research that has demonstrated the effectiveness of slow deep breathing in promoting parasympathetic nervous activity, enhancing relaxation, and decreasing cortisol levels and sympathetic responses (Hasbi, 2022; Hamasaki, 2020). Techniques such as diaphragmatic breathing have been shown to stabilize physiological responses and create a calming psychological effect,

especially in preoperative contexts (Jerath, 2019; Rodrigues et al., 2021). At the same time, VR offers immersive distraction, allowing patients to disengage from anxiety-inducing stimuli by simulating peaceful environments, such as forests or beaches (Turrado et al., 2021; Hoon Koo, 2020).

Integrating VR with slow deep breathing builds upon cognitive-behavioral theories of distraction and relaxation, offering a synergistic benefit. Studies by Chan (2020) and Slater & Sanchez-Vives (2016) support the notion that immersive VR environments, when paired with guided breathing exercises, can enhance the depth of relaxation and reduce anxiety more effectively than either intervention alone. The present study also supports demographic correlations reported in the literature. For instance, variables such as age, gender, education level, marital status, and occupation were associated with varying anxiety responses, consistent with the findings of Putri (2022) and Ashari (2019). Women, younger adults, and individuals with lower education levels often report higher anxiety, possibly due to differences in coping mechanisms and health literacy (Sugiartha, 2021). It highlights the need for personalized nursing approaches during the preoperative phase, accounting for patient background and psychological resilience.

While the results were promising, several limitations must be acknowledged. First, the study employed a quasi-experimental design without randomization, which may have introduced selection bias. Second, potential confounding variables, such as previous surgical experience, type of anesthesia, and patient personality traits, were not controlled. Third, anxiety was measured only through self-reported scales at two time points, without physiological biomarkers or longitudinal follow-up to assess sustained effects. Despite these limitations, this study offers valuable contributions to nursing practice and research. It demonstrates that combining slow deep breathing with VR is a feasible, cost-effective, and scalable intervention for managing preoperative anxiety. For clinical nursing, this intervention can be easily integrated into preoperative care protocols with minimal training and equipment. For nursing education, the findings underscore the importance of equipping students with evidence-based, non-pharmacological strategies for anxiety management. For future research, randomized controlled trials with larger samples and multi-center settings are recommended to validate and generalize the findings. Further studies should examine long-term outcomes, such as postoperative pain, recovery time, and patient satisfaction. The combined use of slow deep breathing and virtual reality represents an innovative and effective strategy to alleviate preoperative anxiety. It enhances patient-centered care and reflects a shift toward holistic, non-invasive approaches in modern perioperative nursing.

4. Conclusion

This study provides empirical evidence that the combination of slow deep breathing and virtual reality (VR) effectively reduces preoperative anxiety among surgical patients. The intervention significantly lowered anxiety scores in the intervention group compared to the control group, indicating that this integrated non-pharmacological approach can serve as a viable alternative or complement to standard preoperative care. The findings highlight the theoretical contribution of mind-body relaxation techniques supported by immersive technology, bridging cognitive behavioral and neurophysiological models of anxiety management. Practically, the results emphasize the importance of incorporating low-cost, accessible interventions into nursing practice to enhance patient outcomes in high-stress clinical settings such as the operating room. Although the study offers promising results, its limitations include the quasi-experimental design, the lack of randomization, and potential confounding variables such as age, gender, and surgical type. These constraints may affect the generalizability of the findings. Future research should employ randomized controlled trials with larger sample sizes, explore different clinical populations, and examine long-term psychological and physiological outcomes. These directions will strengthen the evidence base and support the integration of combined slow deep breathing and VR interventions into preoperative nursing protocols at national and global levels.

Conflict of Interest

The authors declare no conflict of interest.

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