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Cover Page Footnote

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Effectiveness of virtual reality interventions to reduce pre-operative anxiety in adult surgical patients in the pre-operative period: Systematic review and meta-analysis

Abstract

Aims: To synthesise and evaluate the effectiveness of virtual reality (VR) interventions compared to standard care to reduce pre-operative anxiety in adult surgical patients during the pre-operative period.

Design: Systematic review of effectiveness and meta-analysis.

Data sources: MEDLINE, EMBASE, JBI EBP, PUBMED, CINAHL, SCOPUS, PsycINFO, Cochrane Library, EMCARE, World Health Organisation, WEB OF SCIENCE, Grey Literature, National Institute of Health & Care Excellence were searched with limits between 2010 to 2022.

Review methods: The review followed the Joanna Briggs Institute (JBI) methodology for systematic reviews of effectiveness and the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA 2020) guidelines. Two independent reviewers conducted the selection, critical analysis, data extraction and critical appraisal using the JBI Critical Appraisal Checklist for Randomised Controlled Trials. Data was synthesised through meta-analysis using random effect model in RevMan 5 software (version 5.4.1) and narrative syntheses.

Results: This analysis included data from five studies with a combined total of 466 adults. The meta-analysis of the included studies suggested positive outcomes (SMD = -0.18 [-0.37, 0.00]) of VR interventions compared to standard care in managing anxiety in pre-operative adult patients. The pooled results showed statistically significant difference (p-value <0.001; I^2=69%) with no substantial heterogeneity in effects among the included studies. The null hypothesis was thus rejected and it was concluded that, on average, the VR intervention does decrease anxiety in the universe of populations comparable to those in the analysis. Similarly, all the independent studies also indicated that VR interventions were favorable in the reduction of pre-operative anxiety in adult surgical patients, though the statistical significance was not overwhelming.

Conclusion: The primary evidence on the effectiveness of VR interventions to manage pre-operative anxiety, though limited, is increasing and substantiates the need for more rigorous research to optimise its application in adults.

Keywords: virtual reality, anxiety, standard care, pre-operative anxiety, pre-operative period, adult surgical patients

Background

Anxiety is widespread in adult patients undergoing surgery.[1] It is commonly associated with various psychological and physical symptoms[2] and can be debilitating. It is reported to be of high prevalence among surgical patients,[1,2,3] particularly during the immediate pre-operative waiting period when it is most likely for patients to envision potential risks of surgery. Previously, two studies have reported estimates of between 11 and 80 per cent prevalence of pre-operative anxiety in adult patients and between 60 and 92 per cent prevalence among patients in general.[1,3]. In Australia alone, 2.7 million surgical procedures were performed during 2017–2018[4]; therefore, pre-operative anxiety is a major concern.

Pharmacological interventions, and to a lesser extent non-pharmacological interventions (NPIs), have long been used to manage pre-operative anxiety.[5] The NPIs include music, hypnosis, multimedia and virtual reality (VR).[5] VR interventions have gained momentum in health care settings for not only managing pre-operative anxiety but also various phobias, as well as delivering patient education and assisting in rehabilitation and other health disorders.[6–10]

Despite being applicable to adults, studies into the effect of VR interventions on pre-operative anxiety have been conducted in paediatric and adolescent populations.[11–15] As such, applicability of those results to the adult population may have limitations due to differences in coping behaviours and attitudes, developmental stage and levels of uptake of VR technology.[16] Hence, the objective of this systematic review was to synthesise the results of included studies to evaluate the effectiveness of VR interventions in the adult population and report on its effectiveness to manage pre-operative anxiety during the pre-operative period.

Anxiety is described as a vague, uncomfortable feeling of unknown source and is acknowledged to cause atypical hemodynamics due to the stimulation of the sympathetic and parasympathetic nervous systems and the endocrine systems.[3] It is a typical protective response to an actual or potential threat elicited by various factors.[1] For pre-operative patients, these factors derive from the actual or potential fear of anaesthesia and threat of complications during a surgical procedure with escalated fears including fear of the unknown, loss of control, pain and incapacity to wake up.[3,17]

Misinformation and lack of pre-operative education about the surgical procedure have also been suggested as major factors that exacerbate perioperative anxiety and influence patient compliance with treatment.[18,19] When left unchecked anxiety-related symptoms may result in increased demand for analgesics and antiemetics, and extended recovery periods, as well as progress beyond the perioperative period to impact on overall treatment results and post-operative recuperation.[7,18] Predisposing factors for pre-operative anxiety include pre-existing comorbidities, age and gender, in addition to the type of surgical procedure to be performed.[2,18,20]

VR is a novel technology defined as 'an artificial world made up of computer-generated images and sounds and is influenced by the actions of an individual who is experiencing that world'.[21] It is progressively applied in health care settings for education and training purposes, facilitating treatments, managing health disorders and enhancing cognitive coping.[22] It is a non-invasive intervention where individuals are exposed to and interact with representations of specific stimuli in a controlled simulated setting using VR technology.[2,5,9]

For disorders or phobias, VR enables self-paced exposure to the fears or stressors in a simulated environment.[23] The noxious stimuli are experienced with awareness and controlled by the user.[24] Simulated VR can be delivered as either a non-immersive or immersive intervention. Non-immersive VR is projected onto a screen whereas the immersive VR is delivered via devices with head-mounted displays to provide a full immersion and interaction with the environment.[24] The exponential rise in use of VR across various sectors can be attributed to the ubiquity of high-tech mobile devices and software.[25]

The included studies used various instruments to analyse pre-operative anxiety; two of these are the Hospital Anxiety and Depression Scale (HADS), a self-reported questionnaire, and the Galvanic Skin Response (GSR), an effective, non-invasive finger sensor. The sensors are attached continuously to the patient for the required period to monitor autonomic nerve responses to identify arousal from state of relaxation.[2] Both instruments are validated scales for measuring pre-operative anxiety.[2] The studies also measured systolic blood pressure (when the heart is pumping blood out into the aorta) and diastolic blood pressure (when the heart is refilling with blood) using a sphygmomanometer, heart rate (the number of heart beats in a minute) and respiration rate (the number of breaths per minute) using a pulse oximeter.

During the pre-operative period, various pharmacological and non-

pharmacological interventions are used to prevent and manage pre-operative anxiety.[7] Although pharmacological interventions are routinely administered pre-operatively to ease patient anxiety, randomised controlled trials (RCTs) have suggested that the drugs considerably delay the period to extubate and the cognitive recovery periods.[26] Further, most pharmacological interventions can cause side effects unlike NPIs which ameliorate pre-operative anxiety in safer ways using distraction, cognitive coping and relaxation.[26]

Aim

The aim of this review was to synthesise and evaluate the effectiveness of VR interventions compared to standard care in reducing pre-operative anxiety in adult surgical patients during the pre-operative period. The review addresses the following question: What is the effectiveness of virtual reality (VR) interventions for reducing pre-operative anxiety in adult surgical patients in the pre-operative period?

Methods

The systematic review was conducted using the Joanna Briggs Institute (JBI) methodology for systematic reviews of effectiveness[27] and the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA).[28]

Study selection

The selection of studies for inclusion was based on the population of interest, intervention, control and outcomes (PICO) format. Table 1 summaries the PICO details that were applied. Only studies published in English were selected.

Search strategy

A systematic three-step search process was conducted in 2021 and repeated in 2022 to identify published and unpublished studies that met the review inclusion criteria. The first step was a limited search conducted in CINAHL (via EBSCO) and Medline (PubMed) databases. All relevant words included in the titles, abstracts and index terms were analysed then adapted according to each database requirement. The four key concepts from the review topic: 'virtual reality', 'perioperative period', 'pre-operative anxiety', and 'surgical patient' were combined with the relevant search terms identified to develop the search strategy used in second search (see Table 2).

In the second step, an experienced librarian was consulted to assist with developing the second electronic search strategy. The databases and other sources that were searched included Scopus, PsycINFO, Cochrane Library, Emcare, World Health Organization, Web of Science, Grey Literature, National Institute of Health & Care Excellence, CINAHL PubMed, Medline, Embase, JBI EBP and Advanced Google. A total of 237 studies, identified from the search of databases, grey literature and registers, were uploaded into the EndNote 20.4.1 (Clarivate Analytics) citation manager, and all duplicate entries were removed. Finally, the third step involved applying the refined search strategy designed to locate studies relating to the review question as illustrated in the PRISMA diagram (see Figure 1). This resulted in the final five studies that were included in the review and meta-analysis.

Methodological quality appraisal

Two reviewers (AM & ZS) independently appraised the eligible studies for methodological quality using the standardised JBI Critical Appraisal Checklist for RCTs.[27] All five RCTs were rated 'yes' for ten out of the 13 questions. Three RCTs

Table 1: PICO summary

Review question	Inclusion criteria details
Population	• pre-operative patients aged 18 years and older (female and male) • pre-operative patients awaiting elective surgical procedures
Intervention	• VR interventions during the pre-operative period • immersive or non-immersive VR delivery • no limitations were considered regarding the device types or duration and frequency of the intervention
Control	• standard care provided pre-operatively
Outcome	• objective measures: detected arousal from state of relaxation, heart rate, respiration rate and blood pressure. • subjective outcomes included severity of state and trait anxiety, and detection and severity of anxiety.

Table 2: Review concepts with search terms

Concept	Search terms
Virtual reality	virtual reality, immersive virtual reality, head-mounted virtual reality, computer simulated virtual reality, augmented virtual reality, virtual reality immersive therapy, computer assisted therapy
Perioperative period	pre-operative period, pre-anaesthetic period, pre-anesthesia period, pre-surgery period
Pre-operative anxiety	anxiety, anxiety disorder
Surgical patient	pre-operative patient, patient, before surgery patient, before anaesthesia, prior to anaesthesia, prior to surgery

did not clearly mention if outcome assessors were blinded to treatment groups.[2,29,30] For question five, two RCTs were either unclear or did not provide sufficient information if those delivering treatment were blinded to treatment assignment.[2,30] Similarly, two RCTs were either unclear or did not state if follow up was complete.[2,31] No differences arose requiring a third reviewer. The two reviewers (AM & ZS) agreed to include all the five appraised studies and report on observed methodological weaknesses. Overall, the number of 'yes' ratings for the appraisal questions indicated superior methodological quality of each study.

Data extraction

Systematic data extraction was performed, checked and verified by two reviewers (AM & ZS) using the JBI Data Extraction Form for Experimental/Observational Studies.[27] The extracted data included the study methods, setting, population (participant details), intervention, clinical outcome measures, the measurement scales of the study results (outcomes and interventions), author's conclusions and comments.

Synthesis

Studies were pooled with statistical meta-analysis using RevMan 5 software (version 5.4.1). To synthesise the post-intervention effect measures and compute estimates of effect for continuous outcomes, the standardised mean differences (SMD) and 95 per cent confidence intervals (CI) were used in the meta-analysis. Some studies had missing summary data and uncertainties, three studies[29–31] did not disclose values for the sample mean and standard deviations while two studies[31,32] had inconsistent values for sample sizes. The original study authors were contacted for the missing means and standard deviations (SDs) for continuous outcomes; however, they were not responsive, and the missing data had to be imputed using statistical methods[33–35] from the available information.

Results

Characteristics of included studies

Sample size

The five included studies had varying sample sizes with the smallest comprising 20 participants and the largest comprising a total sample of 126 participants. The included studies had a combined total of 438 participants at pre-intervention and post-intervention. However, two studies reported inconsistent sample sizes for both study arms which when added had a combined total of 466 participants.[31,32]

Characteristics of the study, settings, participants, interventions and outcomes

Only one of the five studies reported frequency of VR exposure[29] and one study had three arms of interventions[2]; however, only the VR arm was incorporated in the review. All studies were single-site studies in hospital settings from five countries. All interventions were done during the pre-operative period and involved different methods and measurement scales. The characteristics of the included studies are summarised in the supplemental material.

Outcome measures

Primary outcomes contained both objective and subjective measures. Two studies included objective measures – heart rate,[2,32] systolic and diastolic blood pressure,[2,32] respiratory rate[32] and galvanic skin response (GSR).[2] All five studies included the subjective measure of severity of anxiety using self-administered or assisted questionnaires – the hospital anxiety depression scale (HADS),[2,29] state-trait operation anxiety (STOA) inventory,[31] state–trait anxiety inventory (STAI)[29] and anxiety specific to surgery questionnaire (ASSQ).[30]

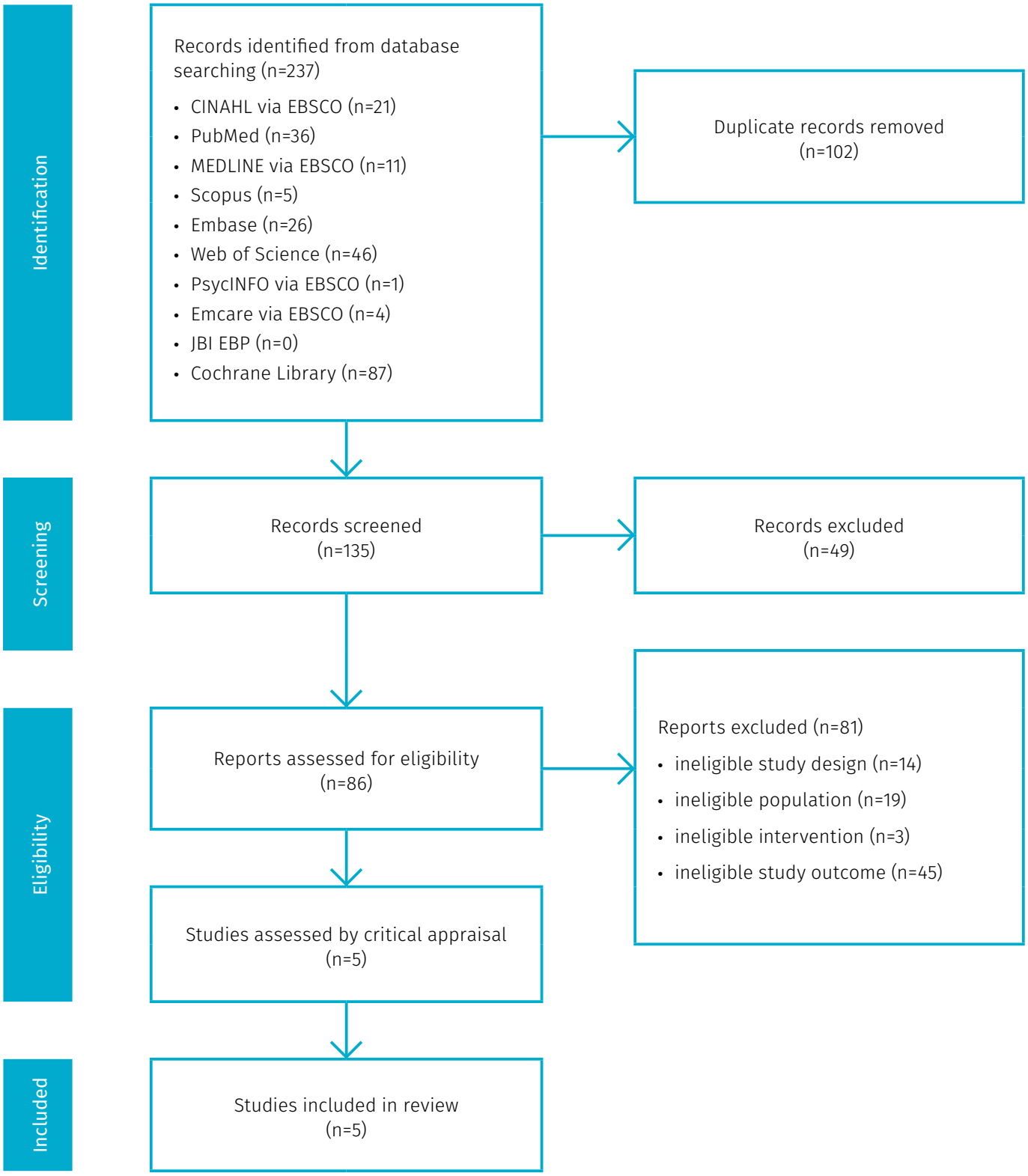

Figure 1: PRISMA 2020 flow diagram of the search and study selection process

Effectiveness of VR interventions

Comparison and analysis of outcome measures were conducted on studies employing similar measurement scales. As studies used different scales, all effect sizes were calculated using standardised mean difference (SMD) and reported with 95 per cent confidence intervals (95% CI) for continuous outcome data.

Severity of state and trait anxiety

Two studies[29,31] reported the effect of VR intervention on both state and trait anxiety. There was substantial variability (X^2 = 3.88, I^2 = 74%, P = 0.05) between the two studies with only one study[29] showing significant statistical difference between VR and standard care groups (SMD = 0.45[0.20, 0.70]). This could be attributed to the large sample size and methodological quality of this study compared to the other study.

Heart rate

Two studies[2,32] measured heart rate and showed minimal heterogeneity (SMD = -0.37[-0.74, -0.01], I^2 = 0%, P = 0.40). Outcomes were statistically significant in favour of VR compared to standard care.

Respiratory rate

Only one study[32] measured and reported respiratory rate results [SMD = -0.35[-0.79, 0.09] and found outcomes were statistically significant in favour of VR compared to standard care.

Blood pressure

Two studies[2,32] measured systolic and diastolic blood pressure to detect presence of anxiety. Results were statistically of moderate heterogeneity with a pooled effect size (SMD = -0.08[-0.53, 0.37], P = 0.09, I^2 = 65%) in favour of VR compared to standard care.

Detected arousal from state of relaxation

One study[2] reported on the objective measure of galvanic skin response (GSR) to identify arousal from a state of relaxation. Results, including a pooled effect size of SMD = -0.65[-1.29,0.01], were in favour of VR compared to standard care.

Detection and severity of anxiety

The meta-analysis showed slight heterogeneity among the studies (Z= 2.98, P= 0.003; I^2= 24%), together with a statistically significant pooled effect size of SMD= -0.27[-0.29, 0.36]. One study[2] was statistically significant considering the small sample size as shown in Figure 2.

Meta-analysis

In summary, all analysed studies favoured VR intervention compared to standard care as illustrated in Figure 2. From observed statistics (heterogeneity: Tau^2 = 0.08; Chi^2 = 38.40, df = 12, P = 0.0001, I^2 = 69% and test for overall effect: Z = 1.93, P = 0.05), on average, VR decreases anxiety by 0.18 standard deviations as compared to standard care with a 95% confidence interval of -0.37 to 0.00. This range doesn't include effect size of zero. The Z-value is 1.93 (*df* = 12), yielding a p-value of 0.05; thus, the null hypothesis is rejected and it was concluded that VR decreases anxiety in populations comparable to those in the analysis. The variance in observed effects (I^2= 69%) reflects variance in true effects rather than sampling error (the difference in statistical characteristics of the sample observed and true values of the population) attributable to possible measurement errors, differences in study characteristics and the fact that a sample is not exactly the same as the population.

Subgroup analysis

The analysis of the objective and subjective measures of anxiety together revealed moderate heterogeneity (Tau^2 = 0.04, Chi^2 = 17.00, df = 6, P = 0.009, I^2 = 65%). The effect size of objective measures was statistically significant with a higher degree of precision unlike the effect size of subjective measures that showed much variability and lower precision, mainly attributed to the subjective nature of the measurement scales. Nevertheless, the overall effect size favoured VR intervention to standard care (see Figure 3).

Discussion

This study presents one of the few reviews that evaluated the efficacy of VR interventions on pre-operative anxiety with an absolute focus on adult surgical patients. The principal findings suggest that VR interventions are effective for managing pre-operative anxiety in adult surgical patients. Data from four of the five included studies[2,29,30,32] show effective reduction of pre-operative anxiety after exposure to VR interventions compared to standard care.

The findings from this review are largely consistent with those of previous reviews conducted in paediatric and adolescent populations.[11–15] In the study by Pestana-Santos et al.,[7] VR intervention was found to be more effective than usual care and other NPIs such as cognitive-behavioral techniques and coping strategies. Hendricks et al.,[26] also reached similar conclusions when comparing both non-immersive and immersive NPIs to standard care. Immersive VR was found to be superior to non-immersive VR, NPIs and standard care. Likewise, Lahti et al.,[36] found VR interventions both feasible and

Study or subgroup	Virtual reality			Standard care			Weight	Std. mean difference IV, random, 95% CI	Std. mean difference IV, random, 95% CI
	Mean	SO	Total	Mean	SO	Total			
2.1.1 Severity of state and trait anxiety									
Turrado et al. (2021)[29]	30.9	145.5336	116	-25.3	104.4678	136	9.7%	0.45 [0.20, 0.70]	
Vogt et al. (2021)[31]	-1.9	7.8216	70	-2.2	9.6037	74	8.6%	0.03 [-0.29, 0.36]	
Subtotal (95% CI)			186			210	18.4%	0.25 [-0.15, 0.66]	
Heterogeneity: Tau² = 0.06; Chi² = 3.88, df = 1 (P = 0.05): I² = 74%									
Test for overall effect: Z = 1.23 (P = 0.22)									
2.1.2 Detected arousal from state or relaxation									
Robertson et al. (2017)[2]	-4.79	55.47	20	54.35	113.38	20	5.0%	-0.65 [-1.29, -0.01]	
Subtotal (95% CI)			20			20	5.0%	-0.65 [-1.29, -0.01]	
Heterogeneity: Not applicable									
Test for overall effect: Z = 2.00 (P = 0.05)									
2.1.3 Heart rate									
Keshvari et al. (2021)[32]	-2.17	6.785	40	0.19	0.594	40	7.0%	-0.49 [-0.93, -0.04]	
Robertson et al. (2017)[2]	0.16	5.2	20	1.05	5.84	20	5.1%	-0.16 [-0.78, 0.46]	
Subtotal (95% CI)			60			60	12.2%	-0.37 [-0.74, -0.01]	
Heterogeneity: Tau² = 0.00; Chi²= 0. 71, df = 1 (P = 0.40); I²= 0%									
Testfor overall effect: Z = 2.03 (P = 0.04)									
2.1.4 Respiratory rate									
Keshvari et al. (2021)[32]	-0.25	0.782	40	-0.05	0.156	40	7.1%	-0.35 [-0.79, 0.09]	
Subtota(l 95%C l)			**40**			**40**	**7.1%**	**-0.35 [-0.79, 0.09]**	
Heterogeneity: Not applicable									
Testfor overall effect: Z = 1.56 (P = 0.12)									
2.1.5 Blood pressure									
Keshvari et al. (2021)[32]	-6.375	23.7358	80	-1.45	4.8502	80	8.9%	-0.29 [-0.60, 0.03]	
Robertson et al. (2017)[2]	2.37	12.9085	40	0.155	11.8192	40	7.1%	0.18 [-0.26, 0.62]	
Subtotal (95% CI)			**120**			**120**	**16.0%**	**-0.08 [-0.53, 0.37]**	
Heterogeneity: Tau² = 0.07; Chi²= 2.85, df = 1 (P = 0.09); I² = 65%									
Test for overall effect: Z = 0.35 (P = 0.72)									
2.1.6 Detection and severity of anxiety									
Kapirikan et al. (2021)[30]	-8.7	33.4781	60	-0.9	3.6388	60	8.2%	-0.33 [-0.69, 0 03]	
Keshvari et al. (2021)[32]	-1.01	3.167	40	0.3	0.926	40	70%	-0.56 [-1.00, -0.11]	
Robertson 2017[2]	-0.298	25.8792	100	11.078	54.7928	100	9.3%	-0.26 [-0.54, 0.01]	
Turrado et al. (2021)[29]	-45.3	172.09	58	-2	8.2627	68	8.3%	-0.37 [-0.72, ·0.02]	
Vogt et al. (2021)[31]	-1.9	7.8216	70	-2.2	9.6037	74	8.6%	0.03 [-0.29, 0.36]	
Subtotal (95% CI)			**328**			**342**	**41.5%**	**-0.27 [-0.45, -0.09]**	
Heterogeneity: Tau² = 0.01: Chi²= 5.28, df = 4 (P = 0.26); I² = 24%									
Test for overall effect: Z = 2.98 (P = 0.003)									
Total (95% CI)			**754**			**792**	**100.0%**	**-0.18 [-0.37, 0.00)**	
Heterogeneity: Tau²= 0.08; Chi²= 38.40 df = 12 (P = 0.0001);I² = 69%									
Test for overall effect: Z = 1.93 (P = 0.05)									
Test for subgroup differences: Chi²= 8.67. df = 5 (P = 0.12);I²= 42.3%									

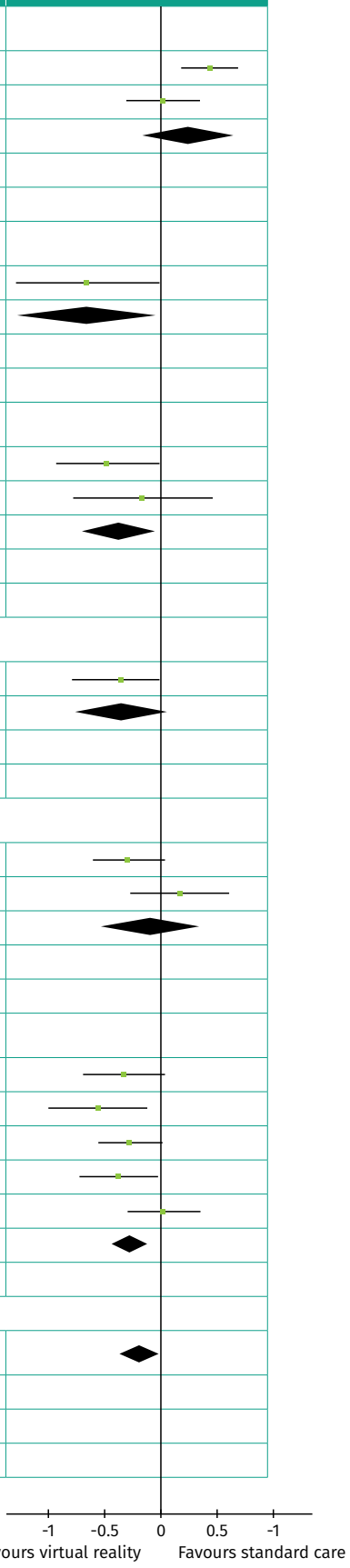

Figure 2: Combined group analysis

Study or subgroup	Virtual reality			Standard care			Weight	Std. mean difference IV, random, 95% CI	Std. mean difference IV, random, 95% CI
	Mean	SD	Total	Mean	SD	Total			
2.2.1 Objectives measures									
Keshvari et al. (2021)[32]	-3.7925	17.2783	160	-0.69	3.517	160	18.7%	-0.25 [-0.47, -0.03]	
Robertson 2017[2]	0.0275	28.9386	80	13.9275	60.9965	80	15.2%	-0.29 [-0.60, 0.02]	
Subtotal (95% CI)			**240**			**240**	**33.8%**	**-0.26 [-0.44, -0.08]**	
Heterogeneity Tau² = 0.00; Chi² = 0.05, df = 1 (P = 0.83); I² = 0%									
Test for overall effect: Z = 2.86 (P = 0.004)									
2.2.2 Subjective measures									
Kapirikan et al. (2021)[30]	-8,7	33.485	60	-0.9	3.639	60	13.5%	-0.33 [-0.69, 0.03]	
Keshvari et al. (2021)[32]	-1.01	3.167	40	0.3	0.926	40	10.8%	-0.56 [-1.00, -0.11]	
Robertson 2017[2]	-1.6	2.33	20	-0.32	1.63	20	6.9%	-0.62 [-1.26, 0.01]	
Turrado et al. (2021)[29]	7,5625	139.6797	232	-5.25	100.9102	272	20.4%	0.11 [-0.070, .28]	
Vogt et al. (2021)[31]	-1.9	7,822	70	-2.2	9.604	74	14.6%	0.03 [-0.29, 0.36]	
Subtotal (95% CI)			**422**			**466**	**66.2%**	**-0.21 [-0.49, 0.08]**	
Heterogeneity: Tau² = 0.07; Chi² = 13.60, df = 4 (P = 0.009); I² = 71%									
Test for overall effect: Z = 1.40 (P = 0.16)									
Total (95% CI)			**662**			**706**	**100.0%**	**-0.21 [.0.41, .0.01]**	
Helerogeneity: Tau² = 0.04; Chi² = 17.00, df = 6 (P = 0.009); I² = 65%									
Test for overall effect: Z = 2.09 (P = 0.04)									
Test for subgroup differences Chi² = 0.11, df = 1 (P = 0.74); I² = 0%									

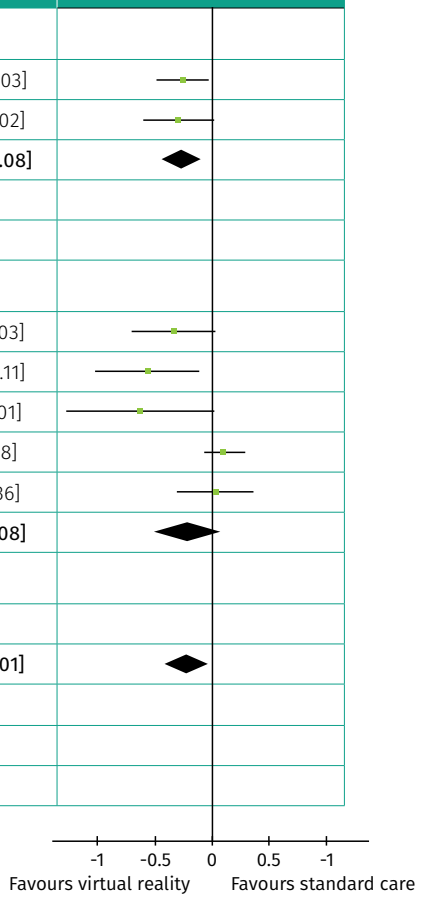

Figure 3: Subgroup analysis

effective in pre-operatively reducing dental anxiety.

In contrast, findings from the study by Vogt et al.,[31] revealed no significant difference in anxiety levels between patients who received VR intervention and those who received standard care. According to Vogt et al.,[31] providing education and information about health care interventions pre-operatively to surgical patients can have positive effects, both mentally and physically, including reducing physiological distress and enhancing recovery. Hence, it may be difficult to discern if the reduction in pre-operative anxiety is from exposure to VR interventions or the standard education and information received before surgery. This assertion correlates with a systematic review by Fardin et al.,[37] which also found no evidence for clinical efficacy of VR and attributed the observed variability in the results to clinical heterogeneity and risks of bias in the studies that were reviewed. Nonetheless, all studies evaluated in this review concur on the efficacy of VR interventions compared to standard care, despite results being not statistically overwhelming. The studies all stated the need for more research into the effectiveness of VR interventions given their promising and widely reported beneficial outcomes compared to standard care.

The flexibility and portability of VR also has positive implications for health care professionals managing patients for surgery during the pre-operative period. Patients experiencing VR immersion tend to overcome feelings and fears associated with state anxiety with the assurance that the environment and emotions are not 'real'.[24] Equally, Son et al.[38] stated that VR applications in education and training in health care provide portability and flexibility; VR is frequently used for teaching and demonstrating surgical and physical examination and gaining anatomical knowledge.[39,40] Further, VR applications can also be extended to enable caregivers, especially those caring for patients with chronic or terminal illnesses, access to VR therapy as a distraction to alleviate and cope with pre-operative stress or anxiety within the vicinity of other patients waiting for surgery.[38] Thus, the use of VR interventions to

reduce symptoms of depression and anxiety through relaxation training are equally beneficial to both pre-operative patients and caregivers.

Though the uptake of VR interventions appears positive in general, its application to the health setting requires it to be safe to use with minimal adverse effects. in this review, only one included study[29] reported that one participant suffered transient dizziness during the initial stage of VR exposure. Overall, the study reported a low (<6%) total rate of complications.[29] Similarly, a systematic review by Smith et al.[41] reported low rates of side effects, nausea, vomiting and vertigo, ranging between zero and eight per cent. Therefore, more studies on how to mitigate potential negative side effects would also be beneficial to avail VR technologies to a wider audience.

Another aspect worth further consideration relates to acceptability of VR. Although some pre-operative patients are generally interested in and eager to use VR, this may not be the case for others who may be skeptical about VR interventions.[42] According to Mosadeghi et al.,[43] some patients may perceive that the VR technology would remove the direct therapeutic interactions with health care providers. Therefore, acceptance and use of VR may depend on individual characteristics and perceptions.[43] Further evidence is required to validate the factors related to VR uptake and acceptance.[38]

Recommendations

This review contributes to the existing gap in research into the effectiveness of VR interventions for pre-operative anxiety in adult surgical patients. As there is a dearth of studies and reviews on this topic in adult pre-operative patients, it is vital that more primary studies are conducted in this population to strengthen or repudiate the findings. In addition, applying both subjective and objective data would provide balanced results, increase accuracy, reduce risk of reporting bias and enhance consistency for grading the outcomes. Based on the reported evidence about the adverse impacts of pre-operative anxiety on quality of life, health outcomes and costs to both patients and the health care system, additional research must be a high priority on this subject.

Strengths and limitations

A strength of this study is that all the studies reviewed used validated measurement tools for pre-operative anxiety. Conversely, the limitations were that all the studies were carried out at a single site and had small sample sizes (20 to 74 participants) for each study arm. Follow-up of participants in the studies was not rigorously performed and only one study reported a minor adverse effect from exposure to the VR intervention in one participant.[29] Further still, all the studies employed different assessment tools and were conducted in different countries. This contributed to the variability observed among the included studies and may not be reproducible in other countries. Lastly, only two studies[2,32] also included objective data in measuring treatment effects rather than solely using subjective data that could be prone to bias or errors and may provide false positive results.

Conclusions

The outcome of this systematic review shows positive correlation between VR interventions and managing anxiety in pre-operative adult patients compared to standard hospital care. Meta-analysis of both objective and subjective measures revealed no significant variability among all the five included studies. However, inconsistencies in some study data, missing values and variation in methodological quality has cast some doubt on a definitive conclusion about the efficacy of VR interventions compared to standard care. Future research should also address the extent to which early VR interventions could impact levels of anxiety in general admissions and pre-operative care settings.

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