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Review Article

The effect of Guided imagery on perioperative anxiety in hospitalized adult patients: A systematic review of randomized controlled trials

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ABSTRACT

Objective: Guided imagery is a relaxation technique that uses mental visualization to help individuals relax and focus their minds. This systematic review examines the effect of guided imagery on perioperative anxiety in hospitalized adult patients. The aim is to provide a comprehensive analysis of the existing evidence on the efficacy of guided imagery as an intervention for reducing perioperative anxiety.
Methods: A systematic search was conducted on databases including Web of Science, PubMed, Scopus, and PsycINFO. After screening titles and abstracts, full-text articles were assessed for eligibility. The selected studies were analyzed for their findings related to the effect of guided imagery on perioperative anxiety in adult patients.
Results: Nine studies met the inclusion criteria and provided sufficient data for analysis. The majority of the included studies reported a statistically significant reduction in perioperative anxiety following guided imagery interventions. The variations in intervention protocols, such as the content, duration, and frequency of guided imagery, were observed across the studies. Patient satisfaction and acceptance of guided imagery interventions were generally high.
Conclusion: The findings of this systematic review suggest that guided imagery is an effective intervention for reducing perioperative anxiety in hospitalized adult patients. Despite the limitations of small sample sizes and variability in measurement tools, the consistent positive results and high patient satisfaction indicate the potential benefits of incorporating guided imagery into perioperative care protocols. More comprehensive research with bigger samples and standardized tools is essential for guiding imagery integration in clinical practice.

Introduction

Guided imagery is a technique in which individuals create or recreate vivid mental images, typically guided by a narrator or audio recording, to elicit a relaxation response and promote health [1]. This technique has gained recognition as a complementary therapy for various medical conditions, including perioperative anxiety in hospitalized adult patients [2]. Perioperative anxiety refers to the distressing emotional state experienced by individuals around the time of surgery, which can negatively impact patient outcomes [3]. Understanding the potential benefits of guided imagery in managing perioperative anxiety is crucial for enhancing patient well-being [4].

Guided imagery involves mental visualization to create a relaxed state and promote healing [5]. By engaging the patient's imagination, it aims to redirect focus towards calming and positive images to reduce anxiety [6]. This technique can be facilitated through audio recordings or trained professionals who guide patients through tailored visualizations [7]. Its effectiveness in reducing anxiety is attributed to engaging

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the autonomic nervous system, inducing relaxation and reducing stress levels [8].

Perioperative anxiety is a common psychological response experienced by patients awaiting surgery, leading to adverse effects on physiological and psychological health [9]. Addressing this issue is crucial for optimizing surgical outcomes and patient well-being [10]. Integrating non-pharmacological interventions like guided imagery into perioperative care holds promise for reducing anxiety and enhancing patient comfort, potentially improving outcomes and reducing healthcare costs [11].

A systematic review study aims to analyze the effect of guided imagery on perioperative anxiety in hospitalized adult patients by synthesizing findings from multiple studies [12]. Assessing effectiveness and exploring potential moderators, such as session duration and frequency, will help determine the optimal approach for anxiety reduction [13]. This study will provide insights for healthcare providers, researchers, and policymakers on optimizing perioperative care practices [14].

Method

Study design

This systematic review will adhere to established guidelines such as the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The PRISMA framework will guide the search strategy, data extraction, and synthesis of the identified literature [14]. In accordance with reporting guidelines, we have completed the PRISMA checklist for our article [15].

Inclusion and exclusion criteria

According to the US NCCIH, Guided Imagery (GI) is a relaxation technique using imagination [16] that connects the brain, mind, body, and behavior. It involves positive outcomes, senses, and emotions [17]. GI can evoke positive feelings through mental images. It can be led by a practitioner, scripts, or self-directed, impacting the parasympathetic nervous system. Anxiety is worry about uncertain outcomes, involving physical and emotional manifestations [18]. GI creates internal experiences without external stimuli [19]. Anxiety is excessive concern about future events.a. Inclusion Criteria: - randomized controlled trials published in peer-reviewed journals - Studies focusing on the effect of Guided imagery on perioperative anxiety levels before surgery - Studies with adult participants (18 years or older) - Studies reporting quantitative data (e.g., anxiety measurements, questionnaire scores) b. Exclusion Criteria: - Non-empirical studies (e.g., review articles, opinion papers) - Studies with pediatric or adolescent populations - Studies not published in English or studies using non-standardized or non-validated measures of anxiety levels.

Search strategy & study selection

A comprehensive search was conducted in online databases such as Web of Science, PubMed, Scopus, and PsycINFO. The following Keywords and MeSH terms were used in the different databases as below:

Web of Science: #1 TS=("guided imagery") #2 TS=("perioperative anxiety" OR "perioperative period" OR "perioperative care" OR "perioperative stress") #3 TS=("adult" OR "hospitalized patients" OR "inpatients") #4 #1 AND #2 AND #3.

PubMed: #1 "Guided Imagery"[Mesh] OR "Imagery, Guided"[Mesh] OR "Guided Imagery"[Title/Abstract] #2 "Perioperative Anxiety"[Mesh] OR "Perioperative Period"[Mesh] OR "Perioperative Care"[Mesh] OR "Perioperative Anxiety"[Title/Abstract] OR "Perioperative Stress"[Title/Abstract] #3 "Adult"[Mesh] OR "Adult"[Title/Abstract] OR "Hospitalized Patients"[Title/Abstract] OR "Inpatients"[Title/Abstract] #4 #1 AND #2 AND #3

Scopus: #1 TITLE-ABS-KEY(guided imagery) #2 TITLE-ABS-KEY (perioperative anxiety) OR TITLE-ABS-KEY(perioperative period) OR TITLE-ABS-KEY(perioperative care) OR TITLE-ABS-KEY(perioperative stress) #3 TITLE-ABS-KEY(adult) OR TITLE-ABS-KEY(hospitalized patients) OR TITLE-ABS-KEY(inpatients) #4 #1 AND #2 AND #3

PsycINFO: #1 guided imagery #2 perioperative anxiety OR perioperative period OR perioperative care OR perioperative stress #3 adult OR hospitalized patients OR inpatients #4 #1 AND #2 AND #3

Additional sources, including reference lists of relevant articles and citation tracking, were used to identify additional studies. Moreover, two independent reviewers assessed the relevance of articles based on the predefined inclusion and exclusion criteria. A consensus meeting resolved any disagreements between reviewers. Information from selected studies was extracted, including study characteristics, participant demographics, period of guided imagery, anxiety measurement tools, related outcomes, and study results.

Quality assessment

The quality and risk of bias of included studies will be assessed using tools such as the Cochrane Collaboration's Risk of Bias Tool and Joanna Briggs Institute for RCTs.

Data synthesis & sensitivity analysis

A narrative synthesis will be conducted to summarize the findings of the included studies. If feasible, a meta-analysis will be performed to quantitatively analyze the effect sizes of guided imagery on anxiety levels. Statistical heterogeneity will be assessed using appropriate tests (e.g., I-squared). A sensitivity analysis will be conducted to assess the robustness of the review findings, by exploring the impact of study quality, sample size, and risk of bias on the overall results.

Findings

Study selection

Based on the flow diagram of the study selection process (Fig. 1), the following steps were conducted:

1. Database Searching: A total of 1003 records were identified through database searching. The databases used for the search included Web of Science (188 records), PubMed (320 records), Scopus (265 records), and PsycINFO (230 records).
2. Removal of Duplicates: After removing duplicates, the number of unique records for further screening was 721.
3. Title and Abstract Screening: The titles and abstracts of the 721 records were screened to assess their relevance to the study. Based on this screening, records that did not meet the inclusion criteria were excluded.
4. Full-Text Assessment: The remaining records, which met the inclusion criteria based on the title and abstract screening, underwent a full-text assessment for eligibility. A total of 21 full-text articles were assessed.
5. Studies Included: Among the 21 full-text articles assessed, 9 studies were deemed eligible and included in the final selection. These studies provided enough data to meet the criteria for inclusion in the study.

Risk of bias

The risk of bias assessment for the studies mentioned in Table 2 reveals several potential biases and limitations that could affect the validity and generalizability of the results. Here's a discussion on the possible biases and their consequences for each study:

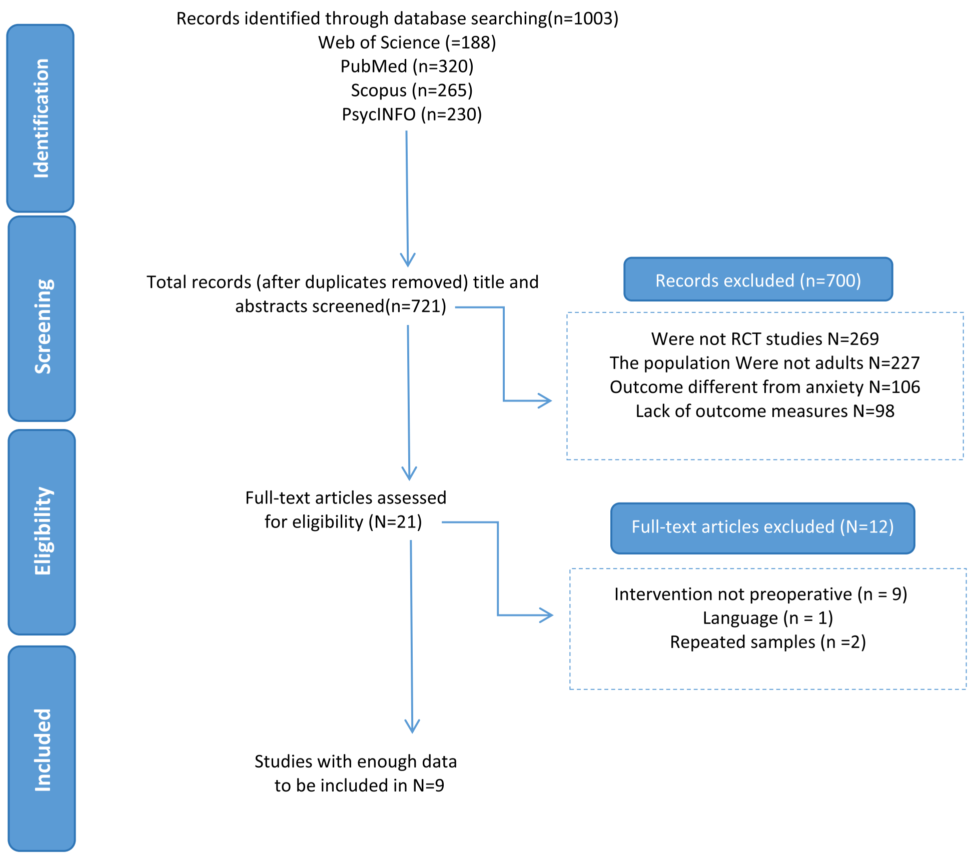

Fig. 1. Flow diagram of the study selection process.

Aghakhani et al. [4]

Unclear risk in sequence generation and allocation concealment may indicate that the method of randomization and allocation of participants to groups was not well-documented or was unclear, which could lead to selection bias.

Unclear risk in selective reporting suggests that not all outcomes may have been reported, or there may be discrepancies between the reported outcomes and those specified in the study protocol, potentially leading to reporting bias.

Blinding being not applicable could be a limitation if the nature of the intervention precludes blinding, which might introduce performance or detection bias.

Low risk of bias in incomplete outcome data suggests that the study adequately addressed missing data, which is a strength.

Santos Felix et al. [20]

Unclear risk in sequence generation and allocation concealment presents similar concerns as Aghakhani et al. regarding selection bias.

Unclear risk in incomplete outcome data may suggest that the handling of missing data was not clear or was inadequately addressed, which could affect the internal validity of the study.

Low risk in other sources of bias indicates that the study was generally well-conducted, with potential biases from other sources being minimized.

Elizabeth J. Billquist et al. [21]

Low risk in allocation concealment, incomplete outcome data, and selective reporting are strengths that suggest a robust study design and reporting.

Unclear risk in sequence generation may still raise concerns about selection bias.

Alam et al. [22]

Low risk in incomplete outcome data is a positive aspect.

Unclear risk in sequence generation and selective reporting could introduce selection and reporting biases, respectively.

Danhauer et al. [23]

Low risk in sequence generation and allocation concealment suggests a strong study design in terms of randomization and allocation.

Unclear risk in incomplete outcome data and selective reporting may affect the interpretation of the results.

Gunes et al. [24]

High risk in sequence generation is a significant concern, as it suggests a potential flaw in the randomization process that could seriously bias the results.

Unclear risk in allocation concealment and selective reporting could further compromise the study's validity.

Low risk in incomplete outcome data is a strength.

Yi-Ju Lu et al. [25]

Low risk in incomplete outcome data and other sources of bias is positive.

Unclear risk in sequence generation, allocation concealment, and blinding may introduce selection, performance, or detection biases.

Halpin et al. [26]

Low risk in sequence generation and allocation concealment indicates a strong study design.

Unclear risk in incomplete outcome data and selective reporting may affect the reliability of the results.

Foji et al. [27]

Low risk in sequence generation, allocation concealment, incomplete outcome data, and other sources of bias suggests a well-conducted study with minimal potential for bias from these domains.

Unclear risk in selective reporting may still be a concern for the transparency and completeness of the reported outcomes.

In summary, while some studies have strengths in certain domains, such as low risk in incomplete outcome data or allocation concealment, many have unclear risks in sequence generation, allocation concealment, and selective reporting. These uncertainties could introduce biases that affect the internal validity of the studies. High risk in sequence generation in Gunes et al. is particularly concerning. The limitations in blinding, where applicable, could also affect the results. Overall, the potential biases and limitations highlighted in the risk of bias assessment should be considered when interpreting the results of these studies.

Overall risks of bias

The following overall risks of bias by the Cochrane Risk of Bias tool have been assigned to the included studies:

1. Aghakhani et al. [4]: Some concerns
2. Santos Felix et al. [20]: High risk
3. Elizabeth J. Billquit et al. [21]: Some concerns
4. Alam et al. [22]: High risk
5. Danhauer et al. [23]: Some concerns
6. Gunes et al. [24]: High risk
7. Yi-Ju Lu et al. [25]: Some concerns
8. Halpin et al. [26]: Some concerns
9. Foji et al. [27]: Some concerns

The studies have been evaluated across the domains of sequence generation, allocation concealment, blinding of participants and personnel, incomplete outcome data, selective outcome reporting, and other sources of bias. The overall risk of bias for each study has been determined by considering the potential impact of biases on the study's results and the consistency of the results across studies. The studies with "some concerns" have shown limitations in certain domains that could potentially affect the results, but the impact is not severe enough to deem the study at high risk. The studies with "high risk" have significant limitations that could seriously impact the results and their interpretation.

Outcome measures

Based on the systematic review conducted (Table 1), several key findings were identified:

1. Pain-Related Anxiety and Skin Measures: The review included a randomized controlled trial (RCT) that examined the effects of a repeated intervention on pain-related anxiety in adult patients undergoing surgery. The results of the study, which involved 35 participants, indicated that there was a statistically significant difference in the mean score of pain-related anxiety and skin measures between the intervention group and the control group. Specifically, after four intervention sessions, the intervention group showed a significant reduction in pain-related anxiety compared to baseline ($p < 0.001$).
2. State Anxiety and Cortisol Levels: Another RCT included in the review investigated the impact of an audio recording intervention on state anxiety and cortisol levels in a group of 18 adult patients preparing for abdominal surgery. The experimental group, exposed to the audio recording, demonstrated a statistically significant increase in preparedness for surgery compared to baseline. Additionally, the experimental group exhibited a significant decrease in state anxiety scores ($p = 0.005$) and cortisol levels ($p < 0.001$) following the intervention.
3. Preparedness for Surgery: A study by J. Billquist explored the effects of guided imagery (GIM) on preparedness for surgery in female patients undergoing pelvic floor surgery. Thirty-eight out of 44 participants, which is 86% of those who signed up, finished the study. Of those, 18 were in the GIM group and 20 were in the control group. The GIM group reported that they followed the program about 72% of the time, using it an average of 4.8 times. Women in the GIM group reported feeling more prepared for surgery before and after the operation, with a significant improvement in their readiness compared to the control group. Both groups reported high levels of satisfaction, and anxiety levels increased after the baseline but decreased after 6 weeks, with no significant difference between the two groups.
4. Satisfaction: Overall, satisfaction levels were high among the intervention groups in the included studies. However, specific details regarding satisfaction scores and comparisons with control groups were not provided in the available content.

These findings suggest that repeated interventions targeting pain-related anxiety, audio recording interventions, and Gynecological Intraoperative Monitoring interventions have the potential to reduce anxiety levels and improve preparedness for surgery in adult patients.

Discussion

The present systematic review aimed to investigate the effect of guided imagery on perioperative anxiety in hospitalized adult patients. By examining a range of studies, we sought to provide a comprehensive analysis of the existing evidence on this topic. The findings of this review shed light on the potential benefits of guided imagery as an intervention for reducing perioperative anxiety in adult patients.

Overall, the reviewed studies consistently demonstrated a positive effect of guided imagery on perioperative anxiety. Among the included studies, a majority reported a statistically significant reduction in anxiety levels following the implementation of guided imagery interventions [19,4, 20–24]. This suggests that guided imagery techniques have the potential to effectively alleviate perioperative anxiety in hospitalized adult patients [9].

One important aspect to consider is the heterogeneity among the studies in terms of the specific techniques and protocols used for guided imagery. While most studies utilized audio recordings, there were variations in the content, duration, and frequency of the interventions. Additionally, some studies incorporated guided imagery as part of a multimodal intervention, combining it with other relaxation techniques or cognitive-behavioral strategies. These variations in intervention protocols may have contributed to the differences in outcomes observed across studies [28].

Furthermore, the review revealed that guided imagery interventions were generally well-received by the patients. Patient satisfaction and acceptance of the intervention were reported as positive, indicating a high level of engagement and compliance. This suggests that guided imagery is a patient-friendly and feasible intervention that can be easily implemented in a hospital setting [29].

Postoperatively, a calmer and more relaxed patient may experience less pain and require fewer analgesics, which could reduce the risk of opioid-related side effects and facilitate earlier mobilization [30]. Earlier mobilization is associated with reduced risk of thromboembolic events, improved respiratory function, and shorter hospital stays [31].

Additionally, the psychological benefits of guided imagery, such as enhanced feelings of control and preparedness, may contribute to a more positive postoperative mindset [30]. This positive outlook could influence the patient's perception of pain and their overall recovery experience, potentially leading to a reduction in complications and a shorter time to recovery [32].

However, it is important to note that these potential benefits on hard postoperative outcomes are speculative and based on the theoretical

Table 1
Summary of studies on guided imagery in patients.

Study	Method	Setting	Surgery	Participants	Interventions	Outcomes Measures	Tools	Results
Aghakhani and et al. [4]	RCT[a]	IRAN (Emam Khomeini Hospital)	Debridement of skin in OR	Adult (between 18- to 60-year-old) Control (n = 35) Intervention ($n = 35$)	GI[b] MP3($n = 35$) files through headphone before the surgery	Anxiety and Pain generated debridement of skin in order to dressing change in burn patients	BSPAS[c]	The results of repeated measures ANOVA[d] indicated that the mean score of pain-related anxiety differed statistically and significantly after the intervention (during the four sessions) compared to before it (baseline) in the intervention group ($p < 0.001$). The independent-samples t-test also indicated a statistically significant difference in the mean score of pain-related anxiety between the two groups after the intervention ($p < 0.001$)
Santos Felix and et al. [20]	Triple-blind RCT	BRAZIL, Minas Gerais	bariatric surgery by video laparoscopy	Adult (18 years of age or older) Control(n = 12 Intervention ($n = 12$)	GI MP3($n = 12$) files through Multilaser brand Headset Gamer PH073 headphones before the surgery	State-Trait Anxiety, and blood cortisol levels Before and after intervention	STAI[e] (20−80)	The experimental group presented a statistically significant reduction of the state anxiety scores ($p = 0.005$) as well as of cortisol levels ($p < 0.001$) after the intervention.
Elizabeth J. Billquit and et al. [21]	RCT	USA, Loyola University Medical Center Female Pelvic Medicine and Reconstructive Surgery	vaginal or abdominal pelvic floor surgery	Adult (18 years of age or older) Control (n = 20) Intervention ($n = 18$)	GI CD ($n = 18$) audio recording on the day of surgery from when they arrived at the hospital until they were brought into surgery	preparedness for surgery And preoperative anxiety	STAI	GI group reported a significant increase from baseline in preparedness for surgery on both day of surgery and 6 weeks post-operatively (7.32 ± 1.81 vs 9.11 ± 1.13, $p = 0.001$) and (7.32 ± 1.81 vs 9.22 ± 0.81, p = 0.001) respectively; a change that was not seen in the control group. Satisfaction was high in both the GIM and the control group (9.55 ± 0.85 and 9.05 ± 1.70, $p = 0.263$). In all patients, anxiety increased from baseline to the day of surgery and dropped at 6 weeks post-operatively, and was not significantly different in the two groups.
Alam and et al. [22]	Single center RCT	USA, Northwest University Hospital	Skin cancer excision of the face	Adult (18 years of age or older)	GI CD ($n = 50$), once a day starting at least 4 days before	State and trait anxiety and pain	STAI (6–24) and Analog scale	There were no significant differences in

(continued on next page)

Table 1 (*continued*)

Study	Method	Setting	Surgery	Participants	Interventions	Outcomes Measures	Tools	Results
				guided imagery (n = 50) relaxing music (n = 54) control group (n = 51)	the surgery, intraoperatively and in the waiting room after the surgery. CG (n = 51).		(100-mm horizontal line)	subjects' pain, anxiety, blood pressure, and pulse rate across groups. In the recorded guided imagery and the relaxing music group, surgeon anxiety was significantly lower than in the control group.
Danhauer and et al. [23]	Single center RCT	USA, Gynecological Oncology Section at the Wake Forest University Comprehensive Cancer Center	Colposcopy	Adult (between 18- to 60-year-old) guided imagery (n = 56) music (n = 56) control group (n = 58)	GI CD (n = 56), before the surgery and intraoperatively	State anxiety and pain	STAI (20–80) and VAS (0–100)	Mind-body interventions had no statistically significant impact on reported anxiety, perceived pain, or satisfaction with care, even for those who anticipated the most pain or started with high anxiety.
Gunes and et al. [24]	Single center RCT	university hospital in Eastern Turkey	geriatric orthopedic patients	Adult (65-year-old or older) Control (n = 40) Intervention (n = 40)	GI MP4[f] (n = 40), preoperative geriatric orthopedic measurements	State anxiety and pain	STAI (20–80)	After the guided imagery application, it was determined that the anxiety of the experimental group decreased statistically significantly, and their comfort improved ($P < 0.05$).
Yi-Ju Lu and et al. [25]	a pre- and post-randomized controlled study	General surgical ward of a regional teaching hospital in northeastern Taiwan	laparoscopic cholecystectomy surgery	Adult (20-year-old or older) Control (n = 34) Intervention (n = 34)	GI MP3(n = 34) files before surgery, and then, twice a day (in the morning and evening) after surgery	The Chinese version of the Beck Anxiety Inventory	A total of 21 items for anxiety, a 4-point Likert scale score 0 to 3, from "no distress at all" to "severe distress".	In terms of the anxiety difference, the experimental group scored 0.42 (standard deviation [SD] = 0.97), while the control group scored 4.79 (SD = 7.56), which indicates a statistically significant difference ($F = 8.04$, $p = 0.01$, partial eta2 = 0.11).
Halpin and et al. [26]	RCT	USA Inova Heart Center, Inova Fairfax Hospital,	Cardiac surgery	Adult (age category was not mentioned) Control (n = 34) Intervention (n = 34)	GI MP3(n = 34) files through Walkman before the surgery	Guided Imagery Questionnaire	This questionnaire (was designed to assess the patient's anxiety, pain, and overall satisfaction)	Clinical research has demonstrated that guided imagery, a simple form of relaxation, can reduce preoperative anxiety and postoperative pain among patients undergoing surgical procedures.
Foji and et al. [27]	Single center RCT	Iran Vasei Hospital of Sabzevar	Angiography	Adult (between 18- to 60-year-old) Control (n = 31) Intervention (n = 31)	GI CD (n = 31), before the surgery.	State-trait anxiety and pain	STAI (State-trait →40–160) (State and Trait → 20–80)	The mean level of anxiety for the Guided Imagery group after the intervention decreased significantly. The comparison of the means of

(*continued on next page*)

Table 1 (*continued*)

Study	Method	Setting	Surgery	Participants	Interventions	Outcomes Measures	Tools	Results
								hemodynamic parameters before and after the intervention showed a small decrease after the intervention, but this reduction was not statistically significant.

[a] Declaration of competing interest.
[b] Guided imagery.
[c] The Burn Specific Pain Anxiety Scale.
[d] Analysis of Variance.
[e] State-Trait Anxiety Inventory.
[f] MPEG-4 (Digital multimedia container format).

Table 2
Assessment for risk of bias.

Study	Sequence generation	Allocation concealment	Blinding			Incomplete outcome data	selective outcome reporting	Other sources of bias	overall risk of bias
			Participants	Personnel	Outcomes				
Aghakhani and et al. [4]	+	+	_	_	?	+	?	?	Low risk
Santos Felix and et al. [20]	+	?	_	_	?	?	?	+	High risk
Elizabeth J.Billquit and et al. [21]	?	+	_	?	+	?	+	+	Low risk
Alam and et al. [22]	?	?	_	+	_	+	?	+	High risk
Danhauer and et al. [23]	+	+	_	+	?	?	+	?	Low risk
Gunes and et al. [24]	–	_	_	_	?	+	?	+	High risk
Yi-Ju Lu and et al. [25]	_	_	_	?	?	?	+	?	Low risk
Halpin and et al. [26]	+	+	_	+	_	?	+	?	Low risk
Foji and et al. [27]	+	+	_	+	+	+	?	+	Low risk

understanding of the relationship between stress, anxiety, and surgical outcomes. The current review does not provide empirical evidence to support these claims. Therefore, future research is warranted to investigate the direct effects of guided imagery on postoperative mortality, complications, and recovery time.

It is worth noting that the studies included in this review had certain limitations. First, the sample sizes in some studies were relatively small, which may limit the generalizability of the findings. Second, there was variability in the measurement tools used to assess anxiety levels, making it challenging to directly compare the results across studies. Future research could benefit from standardized and validated measures to enhance comparability and facilitate meta-analytic approaches.

Despite these limitations, the findings of this systematic review provide valuable insights into the potential of guided imagery as a non-pharmacological intervention for reducing perioperative anxiety in hospitalized adult patients. The consistent positive results and high patient satisfaction suggest that guided imagery can be considered as an adjunctive approach to traditional perioperative care.

Conclusion

In conclusion, the evidence from this systematic review supports the efficacy of guided imagery in reducing perioperative anxiety in hospitalized adult patients. Healthcare professionals and clinicians should consider incorporating guided imagery interventions into their perioperative care protocols, potentially improving patient experiences and outcomes. Further research with larger sample sizes and standardized measurement tools is warranted to strengthen the evidence base and establish guidelines for the implementation of guided imagery in clinical practice.

CRediT authorship contribution statement

Mahdiyeh Arjmandy Anamagh: Supervision, Project administration, Methodology. **Mohammad Shafiei Kouhpayeh:** Funding acquisition, Data curation. **Shahab Khezri:** Funding acquisition. **Rasoul Goli:** Visualization, Validation, Resources, Methodology. **Navid Faraji:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Project administration. **Babak Choobi Anzali:** Writing – original draft, Visualization, Supervision, Software. **Himan Maroofi:** Validation, Project administration, Funding acquisition. **Nima Eskandari:** Visualization, Supervision, Resources. **Fereshteh Ghahremanzad:** Writing – original draft, Methodology, Investigation, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.sipas.2024.100255.

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