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Effect of music intervention on preoperative anxiety, a randomised clinical study

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Preoperative anxiety is common among adults undergoing elective surgery and has been associated with adverse clinical outcomes. This study evaluated the effectiveness of music intervention in reducing preoperative anxiety compared with standard care. In this randomized controlled trial, 104 women scheduled for elective gynecological surgery with elevated anxiety levels (State-Trait Anxiety Inventory-State scale ≥ 39) were enrolled. Participants were randomized in a 1:1 ratio to receive either the two sessions of preoperative music intervention (one on the eve of surgery and another in the anesthesia preparation room) or a control condition consisting of headphones without music. The primary outcome was the change in anxiety between post-intervention on the day of surgery (T3) and baseline (T0; pre-intervention on the eve of surgery). The secondary outcome included changes in anxiety levels between 24 h postoperatively (T4) and T0; changes in blood pressure and heart rate from T0 to T3 and T4; 24-h numeric rating scale (NRS) pain scores and patient's satisfaction at T4. A total of 95 patients were analysed (median age, 43.0 years). From T0 to T3, anxiety scores decreased in the music group but increased in the control group (median change, − 5.0 vs. 3.0). The change in anxiety scores over this period differed significantly between groups (median difference=-8.0; 95% CI, -14.0 to -2.5; *P* = 0.003). After adjustment for multiple comparisons, no significant between-group differences were observed in anxiety change between T4 and T0, changes in blood pressure and heart rate from T0 to T3 and T4, or 24-h NRS pain scores. Patient satisfaction scores were significantly higher in the music group. Two-session music interventions may reduce preoperative anxiety among patients with high baseline anxiety undergoing elective gynecological surgery; however, this effect is not sustained postoperatively.

Clinical trial registration: This study was approved by the Ethics Committee of the Chinese Clinical Trial Register (ChiCTR2400089224) on 04/09/2024.

Keywords Blood pressure, heart rate, music intervention, Patient satisfaction, Preoperative anxiety

Patients awaiting surgical procedures often experience high levels of anxiety, with the global incidence of preoperative anxiety estimated to range between 60% and 92%[1]. Preoperative excessive anxiety may affect the induction of anesthesia and result in adverse events, such as delayed wound healing and an increased risk of infection[2]. Additionally, preoperative anxiety is associated with perioperative hypertension, which in turn increases the risk of bleeding, myocardial ischemia, and cerebrovascular events[3]. Evidence suggests that preoperative anxiety is particularly pronounced in female patients[4–6] highlighting the need for targeted interventions to manage anxiety in this vulnerable population.

Pharmacological strategies, such as sedatives, are commonly employed to alleviate preoperative anxiety. However, these medications may interact with anesthetic agents and are often associated with undesirable side effects, including sedation and respiratory depression[2]. Virtual reality technologies have been investigated in clinical settings for their anxiolytic effects[7]. However, their reliance on visual input may lead to sensory

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mismatches with the vestibular system, potentially inducing motion sickness, particularly in older adults[8]. Music therapy is a safe, low-cost, and non-invasive intervention that has demonstrated promise in reducing perioperative anxiety[9]. A randomized controlled study has shown that relaxing music can effectively alleviate preoperative patient anxiety, even more than orally administrated midazolam[10]. Another recent randomized controlled study indicated that music therapy could reduce stress, anxiety, and the need for sedatives during procedures performed under regional anesthesia[11]. Nevertheless, the efficacy of music therapy specifically in patients with high baseline anxiety remains to be established.

This study aimed to evaluate the effectiveness of a two-session music intervention compared with standard care in reducing preoperative anxiety among patients with high baseline anxiety undergoing elective gynecological surgery. We hypothesized that two-session music intervention would significantly reduce the preoperative anxiety levels compared with standard care.

Methods

This single-center, randomised clinical study was conducted from July 2024 to February 2025. The study was approved by the Ethics Committee of the First Affiliated Hospital of Soochow University (Approval No. 2024 – 336) on 02/08/2024 and registered in Ethics Committee of the Chinese Clinical Trial Register (ChiCTR2400089224 https://www.chictr.org.cn/showproj.html?proj=241380) on 04/09/2024. Written informed consent was obtained from all participants prior to data collection. The study adhered to the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Participants

Eligible participants were women aged ≥ 18 years who were scheduled for elective gynecological surgery under general anesthesia and had a self-reported anxiety score ≥ 39 on the State-Trait Anxiety Inventory-State (STAI-S) scale[12]. Patients were excluded if they had auditory impairment, preoperative sedative use, hyperthyroidism or adrenal disorders, atrial fibrillation or other arrhythmias, or uncontrolled psychiatric disorders (e.g., depression, anxiety disorders, schizophrenia, etc.). Participants were withdrawn if surgery was cancelled/delayed or if consent was withdrawn.

Randomization and blinding

An independent researcher, who was not involved in patient recruitment, coordination, data collection, or outcome assessment, used an online randomization tool (https://www.sealedenvelope.com/simple-randomiser/v1/lists) to generate a random sequence with a 1:1 allocation ratio and permuted block sizes of 2 and 4. Participants were randomized to either the music group or the control group. Allocation results were sealed in opaque envelopes and stored in a locked cabinet. A researcher opened the envelopes sequentially to assign the patients to receive music intervention or standard of care. Outcome assessments were conducted by an investigator blinded to group allocation, and data analysis was performed by statisticians who were also blinded to treatment assignment.

Perioperative intervention

On the eve of surgery (18:00–19:00), participants in the music group received 30 min of music intervention, comprising a curated selection of traditional Chinese instrumental pieces ("Pinghu Qiuyue," "Chun Jiang Hua Yue Ye," "Zhegu Fei," and "Meihua San Nong") and Western classical works ("Canon," "Schubert's Serenade," "Air," and "Largo from the Serenade for Strings"). Patients were allowed to choose their preferred music, which was delivered via headphones connected to MP3 players at a standardized volume of 55–65 dB. Anxiety levels, blood pressure, and heart rate were measured immediately before and after the intervention. Participants in the control group also wore headphones during the same time period but did not receive any auditory stimulation. The same assessments were also performed. On the day of surgery, the intervention protocol was repeated in the anesthesia preparation room and continued until the patient entered the operating room. Upon entry to the operating room and prior to induction of anesthesia, anxiety score, blood pressure and heart rate were reassessed following removal of headphones. The control group underwent the same procedures without exposure to music.

In this study, STAI-S scores, blood pressure and heart rate were assessed at five predefined time points: baseline (T0, pre-intervention on the eve of surgery), post-intervention on the eve of surgery (T1), pre-intervention on the day of surgery (T2), post-intervention on the day of surgery (T3), and 24 h after surgery (T4).

Anesthesia

No preoperative sedative or analgesic medications were administered. General anesthesia was induced with propofol (2–2.5 mg/kg), sufentanil (0.3–0.5 μg/kg), and cisatracurium (0.2 mg/kg). Anesthesia was maintained with sevoflurane inhalation, titrated to maintain a bispectral index (BIS) value between 40 and 60. Prior to surgical incision, sufentanil (0.1–0.2 μg/kg) was administered, and remifentanil was continuously infused at a rate of 0.05–0.2 μg/kg/min until the completion of skin closure. Postoperative analgesia was provided with intravenous oxycodone (5–10 mg), followed by flurbiprofen axetil (50–100 mg) for multimodal analgesia at the conclusion of surgery.

Intraoperative hypotension, defined as a mean blood pressure (MBP) reduction > 30% from baseline or MBP < 65 mmHg, was managed with intravenous ephedrine (6–10 mg) or phenylephrine (50–100 μg). Bradycardia, defined as heart rate (HR) < 50 beats per minute, was treated with intravenous atropine (0.3–0.5 mg) or ephedrine in cases of concurrent hypotension. Hypertension, defined as an increase in MBP > 30% above baseline, was managed with intravenous urapidil (5–10 mg), and tachycardia (HR > 100 beats/min) was treated with intravenous esmolol (10–20 mg). All patients received intravenous ondansetron (8 mg) for prophylaxis against postoperative nausea and vomiting following skin closure. (Table 1; raw data in Supplementary Table S2)

	Music group ($n=47$)	Control Group ($n=48$)	*P*-value
Mean arterial pressure (mmHg)			
Induction	89.0 (83.0 to 108.0)	95.5 (90.0 to 108.8)	0.102
Intubation	91.0 (77.0 to 98.0)	89.0 (78.0 to 99.5)	0.832
Skin incision	80.0 (71.0 to 93.0)	82.5 (77.3 to 89.5)	0.515
0.5 h in surgery	90.0 (80.0 to 102.0)	85.0 (74.0 to 97.0)	0.120
End of surgery	87.0 (76.0 to 99.0)	84.5 (77.0 to 95.0)	0.979
Heart rate (beats min^{-1})			
Induction	76.0 (68.0 to 90.0)	76.5 (68.3 to 86.5)	0.952
Intubation	74.0 (64.0 to 82.0)	74.0 (63.0 to 87.0)	0.579
Skin incision	64.0 (58.0 to 69.0)	65.50 (58.0 to 79.8)	0.269
0.5 h in surgery	58.0 (53.0 to 65.0)	62.0 (55.0 to 68.0)	0.087
End of surgery	62.0 (56.0 to 73.0)	65.5 (57.3 to 65.5)	0.280
Anaesthetics and analgesics			
Propofol (mg)	18.0 (17.0 to 19.0)	18.0 (16.3 to 21.0)	0.298
Sufentanil (μg)	40.0 (30.0 to 50.0)	40.0 (30.0 to 50.0)	0.376
Remifentanil (μg)	343.3 (196.7 to 470.0)	380 (217.5 to 575.0)	0.493
Sevoflurane (%)			
Skin incision	2.8 (2.3 to 3.0)	2.6 (2.5 to 3.0)	0.970
0.5 h in surgery	2.0 (2.0 to 2.0)	2.0 (1.8 to 2.0)	0.104
End of surgery	0.8 (0.6 to 0.8)	0.8 (0.6 to 0.8)	0.476
Intraoperative hypotension	2 (4.2)	1 (2.0)	0.617
Intraoperative bradycardia	4 (8.5)	5 (12.2)	0.820
Intraoperative hypertension	7 (14.8)	9 (18.7)	0.486
Intraoperative tachycardia	11 (23.4)	8 (17.8)	0.573
Pathological diagnosis			0.355
Benign	42(89.3)	41(85.4)	
Malignant	5(10.6)	7(14.6)	
Length of surgery (min)	103 (59 to 140)	108 (61 to 167)	0.623

Table 1. Perioperative data. Data are shown as median (IQR) or n (%). IQR, interquartile range.

Study outcome

The primary outcome was the change in anxiety between post-intervention on the day of surgery (T3) and baseline (T0), measured using the State-Trait Anxiety Inventory-State scale[12,13].

Second outcomes included changes in anxiety levels between 24 h after surgery (T4) and T0; changes in blood pressure (systolic blood pressure [SBP], diastolic blood pressure [DBP], mean blood pressure [MBP]) from T0 to T3 and T4, measured with cuff-based sphygmomanometer; changes in heart rate from T0 to T3 and T4; numeric rating scale (NRS) pain scores and patient satisfaction at T4.

Safety outcomes included postoperative nausea and vomiting (PONV), fever, dizziness, headache, and insomnia.

Sample size and statistical analysis

We prospectively observed 20 patients who underwent elective gynecological surgery with or without preoperative music therapy between April 2024 and May 2024. The results showed that the change in anxiety levels from baseline to post-intervention was -0.9 ± 4.2 in the music group and 2.0 ± 5.5 in the control group. Based on the preliminary findings, the sample size was determined to detect a mean difference of 2.9 in STAI-S scores, with a significance level of 0.05, 80% power, and anticipated dropout rate of 10%. The required sample size was determined to be 104 patients, with 52 allocated to each group.

Descriptive statistics will be applied to summarize baseline characteristics and demographic data without performing between-group comparisons. Continuous data will be presented as either median with interquartile ranges (IQR) or mean with standard deviations (SD), depending on the data distribution. Categorical data will be presented as counts and percentages. To assess between-group differences, the independent t-test or the Mann-Whitney U test will be applied for continuous data, while Chi-squared test or Fisher's exact test will be used for categorical data analysis, as appropriate.

For study outcomes, the treatment effect of the interventions will be evaluated using odds ratios for binary data and mean differences for continuous data, each accompanied by 95% confidence intervals (CIs). The analysis will be conducted on the modified intention-to-treat (mITT) population, which includes all randomized patients who undergo gynecological surgery and have available primary outcome data. All data will be securely stored and analyzed using SPSS software (version 27.0, IBM) and R statistical software (version 4.3.0, R Development Core Team, Vienna, Austria) by independent statisticians. For the primary outcome and safety outcomes, the

significance level was a 2-sided $P<0.05$. For the secondary outcomes, multiple testing was adjusted using the Benjamini-Hochberg method, and the significance level of a false discovery rate $q<0.05$ was applied.

Subgroup analyses were prespecified to explore whether the effect of music intervention on preoperative anxiety differed across patient characteristics. Subgroups were defined by age (<60 vs. ≥60 years), body mass index (BMI<25 vs. ≥25), history of hypertension (no vs. yes), history of prior surgery (no vs. yes), and type of surgery (hysteroscopy, laparoscopy, or laparotomy). Sensitivity analyses were performed to compare the between-group differences in anxiety, blood pressure and heart rate during both the T0–T1 and T2–T3 intervals.

To assess effect modification, interaction terms between treatment allocation and each subgroup variable were included in a general linear model with anxiety score as the dependent variable. A non-significant interaction term ($p>0.05$) indicated that the treatment effect did not differ significantly across subgroups. No imputation for missing data was planned, and all analyses were conducted using complete-case data.

Results

From July 2024 to February 2025, a total of 706 patients were screened for eligibility, of whom 104 met the inclusion criteria and were randomly assigned to either the music group or the control group (Fig. 1). Prior to surgery, five patients in the music group and four patients in the control group were excluded due to patient withdrawal or surgical delay. Ultimately, 95 participants completed the study and were included in the final analysis, with 47 in the music group and 48 in the control group. The intervention and control conditions were

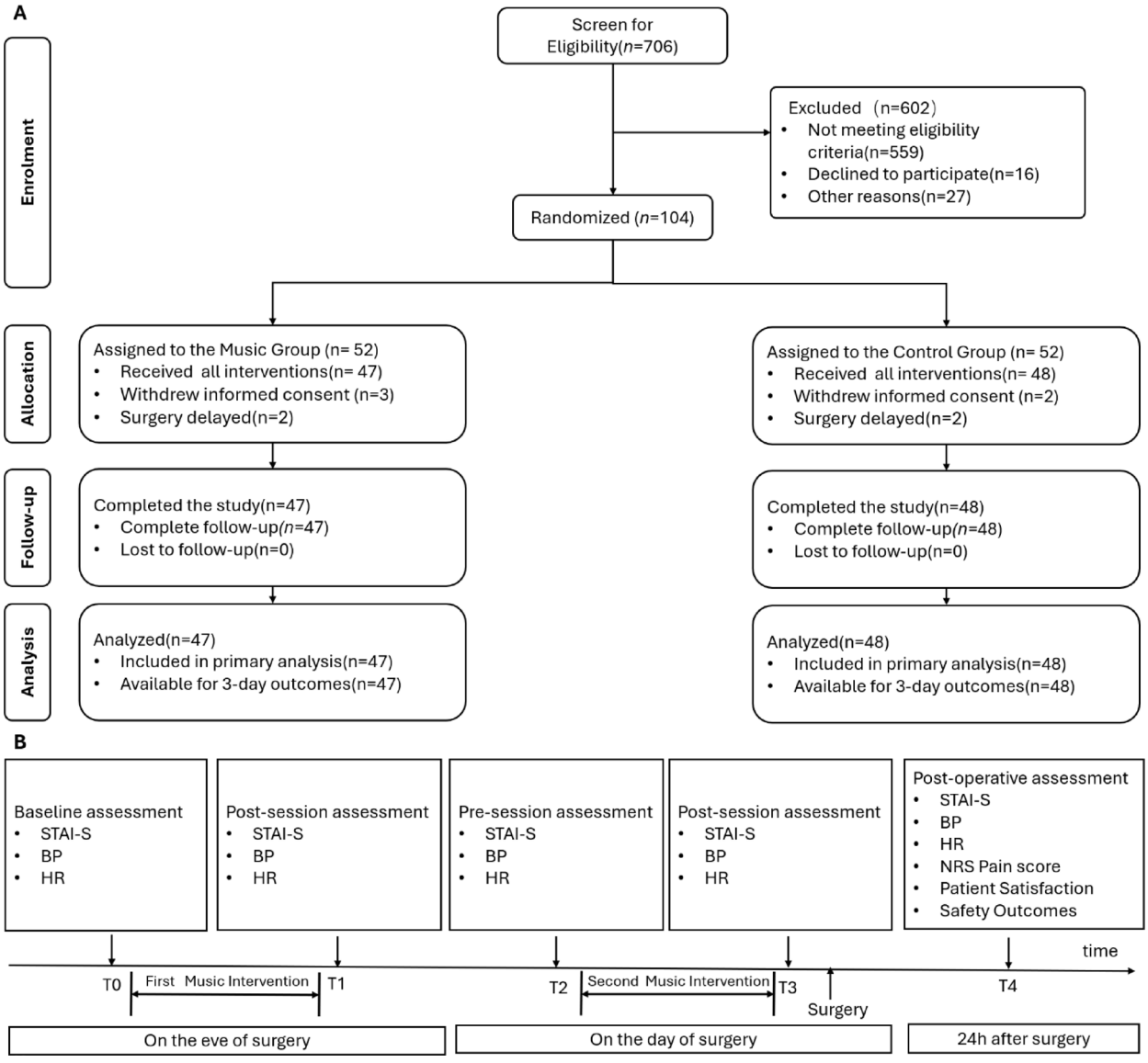

Fig. 1. Trial flow diagram. (A) Trial flow diagram. (B) Timeline of interventions and assessments. Participants underwent music or headphone-only sessions at T0 and T2. Anxiety (STAI-S), heart rate (HR), and blood pressure (BP) were assessed at all perioperative time points (T0–T3). Postoperative outcomes including pain, satisfaction, safety outcomes were assessed at 24 h after surgery (T4).

delivered as planned. Music sessions were completed by all participants in the intervention group, and no cross-over or deviations occurred. No group-specific concomitant treatments were administered during the trial.

Patient characteristics and baseline data were well balanced between the two groups (Table 2 ; raw data in Supplementary Table S1). The median (IQR) age was 43.0 (24.0–57.0) years in the music group and 42.5 (28.0–57.0) years in the control group. The majority of patients were classified as ASA physical status 1 and 2. Preoperative anxiety levels, hemodynamic parameters and the use of antihypertensive medications were comparable between the two groups. The most common type of surgery were laparoscopic procedures in both groups (63.8% vs. 60.4%).

The two groups demonstrated comparable mean arterial pressure and heart rate throughout the perioperative period. Intraoperative anesthetics and analgesics consumptions was similar between groups. The incidence of intraoperative adverse events did not differ significantly. The most pathological diagnoses were benign in both groups (89.3% vs. 85.4%).

Primary outcome

In the music group, the median (IQR) changes in anxiety scores between T3 (post-intervention on the day of surgery) and T0 (baseline) was −5.0 (-13.0 to 3.0); while the change in the control group was 3.0 (-4.0 to 10.0) (Table 3; raw data in Supplementary Table S3). From T0 to T3, the change in anxiety scores differed significantly between groups (median difference=-8.0; 95% CI, -14.0 to -2.5; $P=0.003$), supporting the efficacy of the music intervention in alleviating preoperative anxiety.

In the prespecified subgroup analyses, the treatment effects of music intervention on anxiety increase did not differ significantly across subgroups, including age (<60 vs. ≥60 years), BMI (<25 vs. ≥25), history of hypertension (no vs. yes), history of prior surgery (no vs. yes), and type of surgery (hysteroscopy vs. laparoscopy vs. laparotomy) (Fig. 2).

Secondary outcomes

The median (IQR) changes in anxiety scores between T4 and T0 was comparable between the music and control group (median, -17.0 vs. -16.5; median difference=-0.5; 95% CI, -8.0 to 6.0; $q=0.991$).

From T0 to T3, the music group exhibited smaller changes in SBP (median change, 1.0 vs. 8.0), MBP (median change, 0 vs. 4.1), and DBP (median change, -1.0 vs. 3.0) compared with the control group; however, none of

	Music group ($n=47$)	Control Group ($n=48$)	P-value
Age (yr)	43.0 (24.0 to 57.0)	42.5 (28.0 to 57.0)	0.523
BMI (kg m^{-2})	24.3 (3.4)	24.2 (3.9)	0.548
ASA physical status			0.987
I	13 (27.6)	14 (29.1)	
II	33 (70.2)	33 (68.7)	
III	1 (2.1)	1 (2.1)	
Comorbidities			
Hypertension	11 (23.4)	12 (25.0)	1.000
Diabetes	5 (10.6)	6 (12.5)	1.000
History of thyroid disease	3 (6.4)	5 (10.4)	0.735
Anaemia	4 (8.5)	3 (6.2)	0.977
Anxiety (STAI)	50 (45 to 58)	49 (41 to 57)	0.772
Haemoglobin (g dl^{-1})	11.9 (1.5)	12.3 (1.5)	0.230
SBP (mmHg)	115.0 (91.0 to 139.0)	114.5 (91.0 to 138.0)	0.705
DBP (mmHg)	75.0 (60.0 to 112.0)	74.0 (57.0 to 99.0)	0.652
MBP (mmHg)	87.7 (71.0 to 104.5)	86.8 (68.3 to 105.5)	0.915
Heart rate (beats min^{-1})	74 (51 to 87)	74 (50 to 88)	0.565
Surgical history	22 (46.8)	29 (61.7)	0.261
Hypertensive medication			0.682
ARB/ACEI	3 (6.3)	1 (2.0)	
CCB	4 (8.5)	5 (10.4)	
Others	4 (8.5)	6 (12.5)	
Type of surgery			0.934
Hysteroscopy	12 (25.5)	13 (27.0)	
Laparoscopy	30 (63.8)	29 (60.4)	
Laparotomy	5 (10.6)	6 (12.5)	

Table 2. Patient baseline characteristics. Data are shown as no. (%), mean (SD) or median (IQR). BMI, body mass index; ASA, American society of anesthesiologists; SBP, systolic blood pressure; DBP, diastolic blood pressure; MBP, mean blood pressure; ARB, angiotensin Ll receptor blocker; ACEI, angiotensin-converting enzyme inhibitor; CCB, calcium channel blocker; IQR, interquartile range; SD, standard deviation.

	Music group ($n=47$)	Control Group ($n=48$)	Odds ratio or Median difference (95% CI)	*P*-value	q-value
Primary outcome					
Change in anxiety (T3-T0)	-5.0 (-13.0 to 3.0)	3.0 (-4.0 to 10.0)	-8.0 (-14.0 to -2.5)	0.003	NA
Secondary outcomes					
Change in anxiety (T4-T0)	-17.0 (-23.5, -8.0)	-16.5 (-21.3, -8.0)	-0.5 (-8.0 to 6.0)	0.944	0.991
Change in blood pressure (mmHg) (T3-T0)					
SBP	1.0 (-8.0 to 10.0)	8.0 (1.0, 17.3)	-7.0 (-14.0 to -3.0)	0.020	0.093
MBP	0.0 (-3.3 to 3.8)	4.1 (-2.8 to 9.3)	-4.2 (-6.7 to -1.0)	0.025	0.093
DBP	-1.0 (-6.5 to 4.0)	3.0 (-6.0 to 7.3)	-4.0 (-9.0 to -0.5)	0.119	0.286
Change in heart rate (beats/min) (T3-T0)	-1.0 (-8.5 to 5.0)	2.0 (-3.3 to 9.3)	-3.0 (-9.0 to 1.0)	0.031	0.093
Change in blood pressure (mmHg) (T4-T0)					
SBP	-4.0 (-11.0 to 4.0)	-4.0 (-8.3 to 2.0)	0.00 (-6.4 to 4.5)	0.991	0.991
MBP	-3.3 (-7.2 to 4.7)	-2.2 (-7.8 to 3.4)	-1.2 (-4.8 to 4.5)	0.806	0.939
DBP	-1.0 (-7.0 to 6.0)	-1.5 (-8.0 to 4.0)	0.5 (-4.0 to 6.5)	0.626	0.933
Change in heart rate (beats/min) (T4-T0)	-2.0 (-6.0 to 3.5)	-0.5 (-7.0 to 4.3)	-1.5 (-7.2 to 1.5)	0.491	0.933
24-h rest pain	3.0 (1.0, 5.0)	3.0 (1.0, 4.0)	0.0 (-2.7 to 1.0)	0.544	0.991
24-h movement-evoked pain	5.0 (2.5, 6.0)	4.0 (2.8, 6.0)	1.0 (-1.0 to 2.0)	0.856	0.991
Patient's satisfaction	9.0 (7.5, 10.0)	7.0 (7.0, 8.0)	2.0 (0.0 to 2.0)	<0.001	<0.001
Safety outcomes					
PONV	13 (27.6)	23 (47.9)	0.42 (0.17–0.98)	0.068	NA
Fever	6 (12.7)	3 (6.2)	2.1 (0.5 to 11.3)	0.317	NA
Dizziness	9 (19.1)	12 (25.0)	0.7 (0.3 to 1.9)	0.660	NA
Headache	2 (4.2)	1 (2.0)	2.0 (0.2 to 62.8)	0.617	NA
Insomnia	11 (23.4)	20 (41.6)	0.4 (0.2 to 1.0)	0.093	NA

Table 3. Study outcomes. Data are shown as median (IQR), mean (SD) or n (%). CI, confidence interval; T0, pre-intervention on the eve of surgery; T3, post-intervention on the day of surgery; T4, 24 h after surgery; SBP, systolic blood pressure; DBP, diastolic blood pressure; MBP, mean blood pressure; PONV, postoperative nausea and vomiting; IQR, interquartile range; SD, standard deviation. q-values represent false discovery rate–adjusted p-values calculated using the Benjamini–Hochberg procedure, with $q < 0.05$ indicating statistical significance.

these differences remained statistically significant after adjustment for multiple comparisons. From T0 to T4, no significant between-group differences were observed in changes in hemodynamic parameters (SBP, MBP, DBP, and heart rate). Both 24-h rest pain and movement-evoked pain scores were similar between groups. Patient satisfaction scores were significantly higher in the music group than in the control group (median difference = 2.0; 95% CI, 0.0 to 2.0; $q < 0.001$).

Sensitivity analyses

The music group exhibited greater reductions in anxiety scores during both the T1–T0 and T3–T2 intervals compared to the control group (Fig. 3A). From T2 to T3, the SBP, DBP, MBP, and heart rate all decreased in the music group. During this interval, the changes in these parameters differed significantly between the music and control groups (Fig. 3B–E; raw data in Supplementary Table S4).

Safety outcomes

Safety outcomes were comparable between groups (Table 3). Postoperative nausea and vomiting occurred in 13 (27.6%) in the music group and 23 (47.9%) in the control group. Insomnia was reported by 23.4% of patients in the music group and 41.6% in the control group.

Discussion

In this single-center randomized clinical study, a two-session music intervention reduced preoperative anxiety among patients with high baseline anxiety undergoing elective gynecological surgery, without evidence of a sustained effect after surgery. No differences were observed between groups in perioperative blood pressure and heart rate changes, or postoperative pain scores after adjustment for multiple comparisons. The music group had significantly higher patient satisfaction scores. To our knowledge, this is the first study to evaluate the impact of music intervention on preoperative anxiety among patients with high baseline anxiety level.

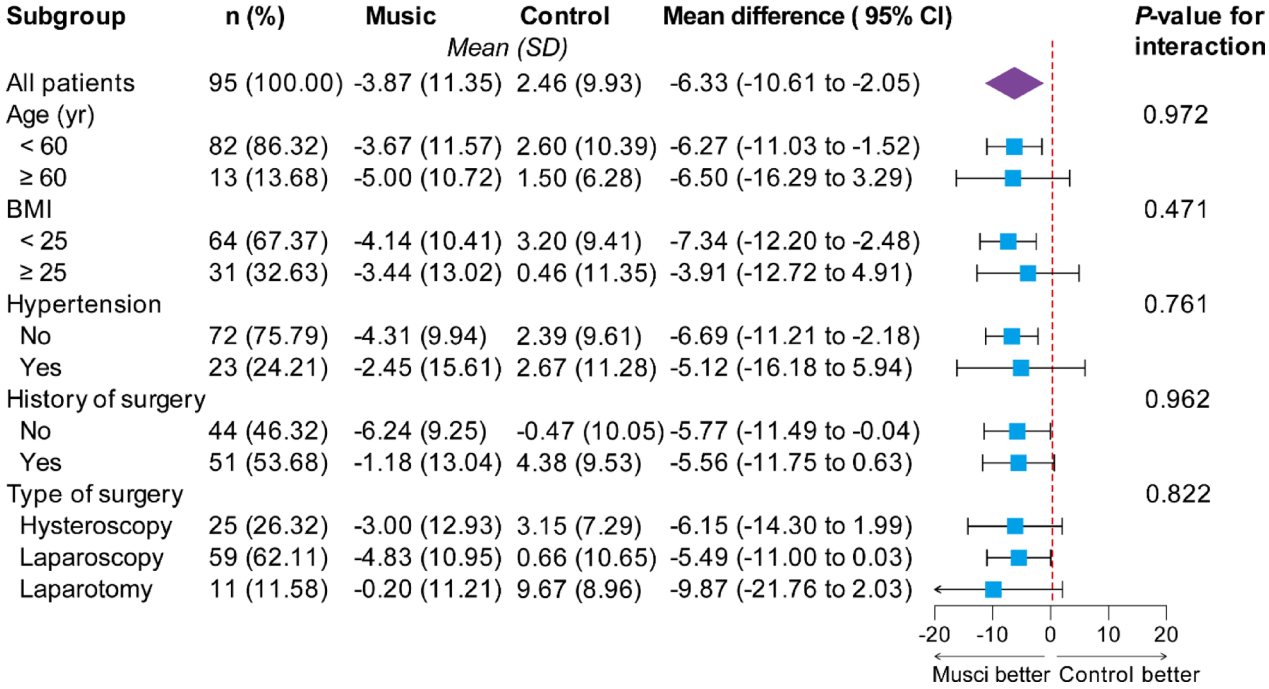

Fig. 2. Subgroup analysis of difference in anxiety (T3-T0). BMI, body mass index; CI, confidence interval; SD, standard deviations.

Preoperative anxiety is frequently observed in patients awaiting surgery, often stemming from fears related to anesthesia and uncertainty about the surgical procedure[14–16]. Elevated levels of preoperative anxiety have been shown to adversely affect both the induction and maintenance of anesthesia[16–18]. Furthermore, excessive preoperative anxiety is associated with heightened pain perception, a greater risk of postoperative infections, and increased risk of mortality in patients with coronary artery disease[16,18–20].

Music therapy is a recognized nonpharmacologic intervention that employs music-based techniques to address physical, emotional, cognitive, and social needs. It has shown potential in alleviating preoperative anxiety. A meta-analysis of 26 randomized trials involving 2025 participants demonstrated that music interventions significantly reduced preoperative anxiety[2]. Furthermore, a recent randomized controlled trial involving 100 patients indicated that music therapy may serve as an effective adjunct to standard surgical care in gynecologic settings, as it significantly reduced preoperative anxiety in women undergoing total laparoscopic hysterectomy for benign conditions[21]. However, that study was limited to benign surgical cases and implemented only a single music intervention session prior to surgery. In contrast, our study specifically enrolled gynecologic patients with elevated baseline anxiety levels and supports the therapeutic efficacy of music interventions in this high-risk population.

Given the multidimensional effects of music, patients who enjoy music may derive greater benefit from music-based interventions[22–25]. In the present study, participants were given the option to select their preferred music from a curated collection of traditional Chinese instrumental pieces and Western classical works. The capacity of music to induce relaxation through modulation of the autonomic nervous system has been substantiated by numerous studies and forms the theoretical basis for its use as a therapeutic intervention in clinical settings[26–30]. Cooke suggests that auditory stimulation from music engages multiple neurotransmitter systems that play a central role in the neurobiological mechanisms of anxiety within the central nervous system, thereby mitigating anxious responses, promoting relaxation and attenuating physiological arousal[29]. Building upon this framework, Taylor-Piliae proposes that neural impulses generated by music may modulate cardiovascular and affective parameters—such as blood pressure, heart rate, anxiety, and mood—by influencing the release of corticotropin-releasing hormone from the hypothalamus or norepinephrine, a principal stress hormone, from the sympathetic nervous system[30]. In this study, preoperative hemodynamic fluctuations tended to less pronounced in the music group, consistent with the theoretical basis underlying music-based interventions. Previous studies have suggested that music therapy may help to reduce postoperative PONV and improve sleep quality in patients with insomnia[31,32]. In this study, the music intervention was also associated with a favorable trend toward lower rates of PONV (27.6% vs. 47.9%) and insomnia (23.4% vs. 41.6%); however, these differences did not reach statistical significance. This may be attributed to an insufficient sample size, resulting in inadequate statistical power to detect between-group differences. In addition, extending the duration of the postoperative intervention may further improve the outcomes.

This study has several limitations. First, physiological biomarkers such as salivary cortisol levels and heart rate variability, which reflected activation of the hypothalamic–pituitary–adrenal axis and autonomic nervous system respectively, were not collected. This might limit the objective assessment of stress-related physiological

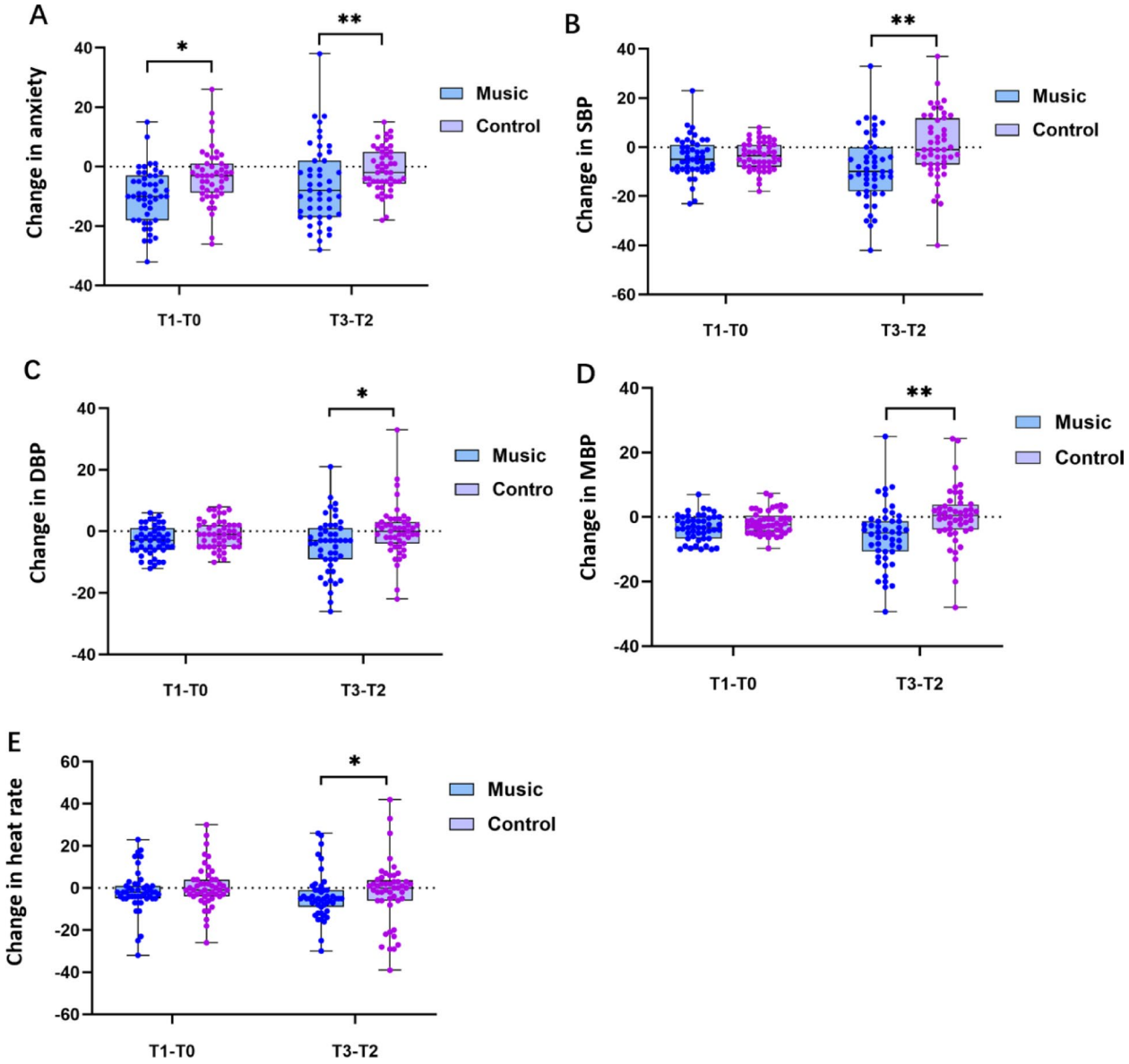

Fig. 3. Effects of music intervention on anxiety and hemodynamic parameters during the intervals: T1–T0 (on the eve of surgery) and T3–T2 (on the day of surgery). Effects of music intervention on anxiety and hemodynamic parameters during the intervals: T1–T0 (on the eve of surgery) and T3–T2 (on the day of surgery). (**A**) Change in anxiety scores; (**B**) change in SBP; (**C**) change in DBP; (**D**) change in MBP; (**E**) change in heart rate. $^{*}p < 0.05$, $^{**}p < 0.01$. SBP, systolic blood pressure; DBP, diastolic blood pressure; MBP, mean blood pressure.

responses. Second, the intervention did not extend into the postoperative period; incorporating postoperative music therapy and a longer intervention duration may enhance therapeutic efficacy. Third, blinding of participants was not feasible, which might introduce bias in self-reported anxiety and other subjective outcome measures.

Conclusion

Two-session music interventions may reduce preoperative anxiety among patients with high baseline anxiety undergoing elective gynecological surgery; however, this effect is not sustained postoperatively.

Data availability

All individual-level data used to generate figures and tables are provided in Supplementary Tables S1–S4.

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Declarations

Competing interests
The authors declare no competing interests.

Ethical approval and consent to participate
This study was approved by the Ethics Committee of the Chinese Clinical Trial Register (Ref: ChiCTR2400089224) on 04/09/2024. Written informed consent was obtained from all participants involved in the study. This work was conducted in accordance with the Declaration of Helsinki.

Additional information
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