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The effect of music therapy on postoperative pain and physiological parameters in pulmonary lobectomy patients

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ABSTRACT

Aim: This study aimed to determine the effect of music therapy on postoperative pain and physiological parameters in patients undergoing lobectomy.
Method: This prospective and randomized controlled study was conducted between January 2023 and September 2024 in the Thoracic Surgery Clinic of Trakya University. The study was determined to be performed with at least 20 patients in each group and 60 patients in total. Patients were divided into Group 1 (nature-based sound therapy), Group 2 (music of the patient's own choice), and Group 3 (control group).
Results: According to the 1st, 2nd, and 3rd measurement values of the pain variable of the patients participating in the study, it was determined that the pain score of the nature-based sound therapy group was statistically significantly lower than the music and control group ($p = 0.000$; $p = 0.002$; $p = 0.002$; $p = 0.000$; $p < 0.05$).
Conclusion: It was determined that the pain score of the nature-based sound therapy group of the patients participating in the study was lower than the music and control group in the first minutes after surgery. In addition, it was determined that the pain level of the nature-based sound therapy group was lower in the 8th hour after the intervention compared to before.

1. Introduction

Music has a profound psychological impact on individuals, influenced by mental, social, psychological, and physiological factors.[1–3] It uniquely addresses human emotions and thoughts through language, structure, and expressive elements.[2] Various factors, including education level, age, and social and cultural contexts, shape patients' perception of music.[4] Historically and currently, music has found its place in healthcare settings for various purposes.[2] It enhances communication between individuals and their surroundings, including family and healthcare teams. Music promotes mobility, encourages positive thinking, and helps individuals derive meaning from life. It contributes to well-being and fosters a more favorable hospital atmosphere.

While music has the potential to alleviate insomnia by promoting deep relaxation, its effects are subjective and can vary considerably among patients. Facilitating patient involvement in their care empowers individuals, allowing them to maintain control and autonomy. Soothing, languid rhythms can further aid in relaxation and calmness.[5] Research indicates that music therapy can reduce the perception of discomfort by diverting attention away from pain.[4] One of the fundamental principles of music therapy is "distraction," which helps divert attention away from pain or discomfort. Music therapy positively impacts physiological vital signs such as blood pressure, heart rate, and respiration and may prevent cardiac arrhythmias by reducing the body's neuro-endocrine response to stress. This normalization of physiological parameters, achieved by reducing catecholamine secretions through activating the parasympathetic nervous system, provides reassurance to healthcare providers and patients.[5]

Music therapy, a natural and cost-effective intervention, is crucial in empowering patients in their pain management journey. Helping patients regain self-control and actively participate in their care instills a sense of autonomy and empowerment.[6] This aspect of music therapy benefits patients and inspires healthcare providers to explore innovative ways to empower their patients. From a music therapy perspective, three

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types of pain may be defined: procedural, acute, and chronic. Procedural pain involves tissue damage associated with a medical procedure ranging from simple needle insertion to major surgery. Music therapy aiming for procedural support for adults may include receptive interventions such as music listening, imagery, and music relaxation, active approaches such as improvisational meditative drumming and singing, or compositional music therapy such as songwriting. In the study conducted by Twiss et al.,[7] seven patients listened to music of their own choice to evaluate the effect on patient anxiety, the intensity of pain experienced, and the duration of intubation in intensive care patients who underwent cardiovascular surgery. The results of the study were evaluated by taking mean values during and after the operation and showed that the pain intensity of the patients who received music therapy decreased, anxiety scores were lower than the patients who did not receive music therapy, and the duration of intubation was longer in the group that did not receive music therapy. Postoperative pain after a primary surgical intervention such as thoracotomy is carried by the intercostal nerves after incision of skin, tissue, and muscles, parietal pleural injury, retraction of the costae, and chest drain placement.[8] After an injury to the bronchi, pain is carried by the phrenic and vagus nerves. The lateral decubitus position and preoperative anxiety have been identified as factors that may also contribute to the experience of pain.[9] However, the most severe pain is caused by bony structures, damage to costal articular joints, stretching of ligaments, and intercostal nerve damage.[8,9] Today, although postoperative pain is predictable and new drugs and application methods have been developed, it is reported that approximately half of the patients have moderate or severe pain complaints.[10–12] It is reported that patients have complaints of severe pain ranging from 21 to 67 % after thoracotomy.[13] Studies have shown that music therapy positively affects pain level, systolic and diastolic blood pressure, respiratory rate, and heart rate.[14,15] This study aimed to determine the effect of music therapy on postoperative pain and physiological parameters in patients undergoing lobectomy.

2. Methods

2.1. Sample and setting

This prospective and randomized controlled study was conducted between January 2023 and September 2024 in the Thoracic Surgery Clinic of Trakya University. Patients who underwent lung lobectomy with open surgery volunteered to participate in the study and were orientated to place, time, and person were included in the study. This randomized controlled study was conducted and reported in accordance with the CONSORT (Consolidated Standards of Reporting Trials) guidelines

Randomization: Computer software, the Researcher Randomizer program, was used to assign patients to the experimental and control groups. It was planned to include 69 patients in the study. However, patients who required respiratory support after surgery, those who used non-routine analgesics (epidural analgesia; A bolus dose of 10 ml of 0.25 % bupivacaine (Bustesin 0.5 %, Vem Pharmaceutical, Turkey), was administered from the thoracic epidural catheter before surgical closure. Afterwards, 0.25 % bupivacaine was infused at a rate of 0.1 ml/kg/h from the inserted catheter, paracetamol 1000 mg IV 1 × 1, tenoxicam 20 mg 2 × 1 IV), approaches other than open surgery and general anesthesia, patients who underwent bilobectomy and pneumonectomy, patients who used anxiolytic drugs, and patients who developed any complications (hemorrhage, pneumothorax, etc.) after surgery were excluded from the study criteria, so the study was conducted with 60 patients. Additionally, in the study, to ensure comparability of analgesic use across study groups, all postoperative opioid and non-opioid analgesics were documented and, where applicable, converted into intravenous morphine equivalents (mg). This allowed for a standardized assessment of pharmacological pain management in addition to the non-pharmacological intervention (music therapy). The necessary literature was reviewed for sample calculation, and the data of the study titled 'The effect of music therapy on pain, anxiety, and depression in patients after coronary artery bypass grafting' (Dai et al., 2020)[15] were used. The study was determined to be conducted with at least 20 patients in each group and 60 patients in total, with an effect size of 1.60, 95 % confidence interval, and 95 % power. Sample calculation was performed in the G*Power 3.1 program. Patients were divided into Group 1 (nature-based sound therapy), Group 2 (patient-preferred), and Group 3 (control group) (Fig. 1).

2.2. Data collection tools

Patient Introduction Form, Stateful and Trait Anxiety Scale, and Pain and Physiological Parameters Monitoring Form were used.

Patient Introduction Form It includes questions about age, gender, education level, duration of surgery, smoking status, American Society of Anaesthesiologists (ASA) score, presence of pain in the immediate environment, and pain management.

2.3. Stateful and trait anxiety scale

It was developed by Spielberger et al. (1970) .[16] Öner and Le Compte (1977)[17] performed its validity and reliability in the Turkish population. The scale consists of 40 items determining transient-state (20 items) and trait (20 items) anxiety levels. The state anxiety inventory assesses how the individual feels at a certain moment and under certain conditions, and the trait anxiety inventory assesses how the individual usually feels. In the State Anxiety Inventory, each item is scored as 'never,' a little,' 'quite,' or 'completely.' In the Trait Anxiety Inventory, each item is scored with four options: ' rarely',' sometimes,'' most of the time,' and 'always.' The 1st, 2nd, 5th, 8th, 10th, 11th, 15th, 16th, 19th, 20th, 21st, 26th, 27th, 33rd, 36th, and 39th items in the scale are reverse scored. Increasing scores indicate a high level of anxiety.

Pain and physiological parameters Monitoring Form: Pain status was evaluated with the Visual Analogue Scale (VAS) by giving a score between 0 and 10. A zero score indicates no pain, and a ten score suggests that the pain is very severe. Physiological parameters included systolic-diastolic blood pressure, pulse rate, saturation, and respiratory rate.

2.4. Data collection

In the study, interventions were performed after the patients were divided into three groups.

Group 1 (nature-based sound therapy): In the study, patients were exposed to natural sounds consisting of bird songs accompanied by the sound of water.

Group 2 (music chosen by the patient): Patients were asked to select a favorite music by filling out a music information form before the operation. In this form, patients were asked what kind of music they listened to in order to distract their attention from pain, anxiety, etc., in an effort to ensure homogeneity.

Group 3 (control group): No intervention was made.

In the study, Group 1 and Group 2 were exposed to music twice: after leaving the operating room and 8 hours later. In the experimental group patients, pain (according to VAS) and physiological parameters were evaluated and recorded before music therapy (0. min), immediately after music therapy (30. min after music therapy), and 60. minutes after music therapy, the patients came to the ward 8 hours later. The control group patients were evaluated for pain (according to VAS) and physiological parameters without any intervention, as were the patients in the experimental group. The preoperative trait anxiety scale and postoperative, pre-intervention personal information form, and state anxiety scale were completed.

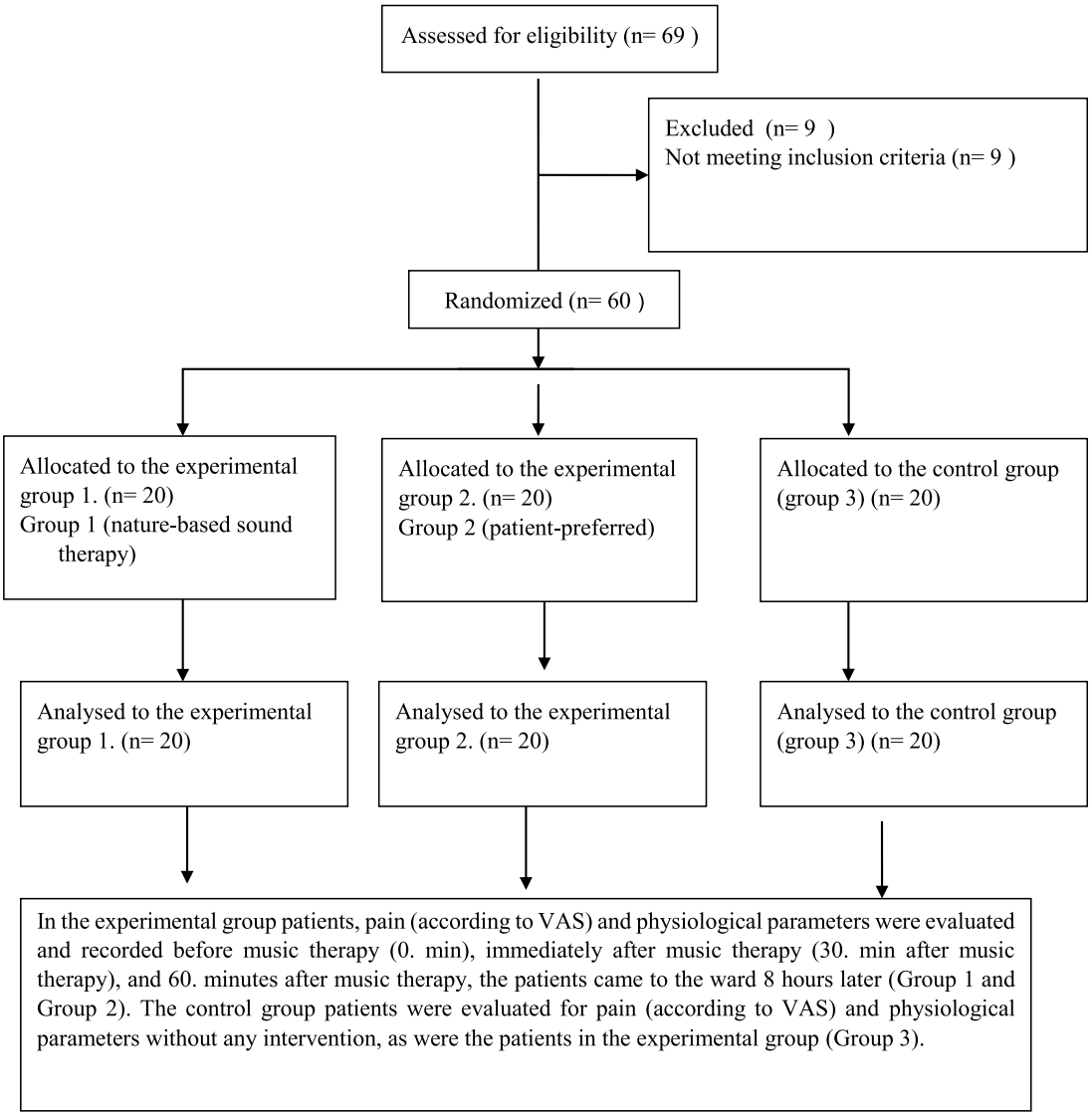


Fig. 1. Flow diagram of the study.

2.5. Statistical analysis

The data analysis was conducted with the Statistical Package for Social Sciences (SPSS) for Windows version 20.0 program (IBM, Armonk, NY, USA). Descriptive analysis included means, standard deviations, and percent values where appropriate. Intergroup comparisons were made by analysis of variance (ANOVA). Post-hoc pairwise comparisons included Student's *t*-test or Mann-Whitney U test. Categorical data were tested by chi-square test. The value of $p < 0.05$ was considered statistically significant.

2.6. Ethics statement

To perform the study, the necessary written permissions were obtained from the University of Kırklareli University Faculty of Medicine Non-Invasive Scientific Research Ethics Committee (decision number: E-35,523,585- 302.99- 69.458/date: 10 November 2022). The Declaration of Helsinki, Good Clinical Practice guidelines, and Kırklareli University Ethics Committee standards were followed during the study.

3. Results

The mean ages of the patients were 61.8 ± 6.5 years in the nature-based sound therapy listening group, 59.6 ± 13.2 years in the music listening group, and 59.7 ± 13.4 years in the control group. Duration of surgery was 156.3 ± 55.0 min in the nature-based sound therapy listening group, 160.0 ± 56.0 min in the music listening group, and 158.0 ± 62.5 min in the control group. There was no statistically significant difference ($p > 0.05$) between the groups in terms of age, duration of surgery, gender, education level, smoking, pain experience of those around them, and pain management (Table 1).

The data in Table 2 show the findings related to music therapy in the first minutes after surgery.

No significant difference was found between the nature-based sound therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the systolic blood pressure variable of the patients participating in the study ($p = 0.938$; $p = 0.564$; $p = 0.564$; $p = 0.553$; $p > 0.05$) (Table 2). According to the 1st, 2nd, and 3rd measurement values of the diastolic blood pressure variable of the patients participating in the study, no significant difference was found between the nature-based sound therapy, music, and control groups ($p = 0.475$; $p = 0.564$; $p = 0.564$; $p = 0.054$; $p > 0.05$). Statistical significance was determined between the 1st and 3rd measurements of the diastolic blood pressure variable of the patients in the nature-based sound therapies listening group ($p^{1-3} = 0.011$ $p < 0.05$) (Table 2).

No significant difference was found between the nature-based sound

Table 1
Patients' sociodemographic characteristics ($n = 60$).

Characteristics		Nature-based voice therapy group ($n = 20$)	Music group ($n = 20$)	Control group ($n = 20$)	Value of statistical
Age_{year} (Mean ± SD)		61.8 ± 6.5	59.6 ± 13.2	59.7 ± 13.4	$U = 187.000$ $p = 0.725$
Duration of $surgery_{min}$ (Mean ± SD)		156.3 ± 55.0	160.0 ± 56.0	158.0 ± 62.5	$t = 0.089$ $p = 0.930$
			n(%)	n(%)	n(%)	
Gender	Female		3 (15.0)	3 (15.0)	6 (30.0)	$X^2 = 1.745$[a]
	Male		17 (85.0)	17 (85.0)	14 (70.0)	$p = 0.552$
Education level	Primary education		14 (70.0)	16 (80.0)	16 (80.0)	$\chi^2 = 2.788$[a]
	High school		6 (30.0)	3 (15.0)	3 (15.0)	$p = 0.695$
	University		0(0.0)	1(5.0)	1(5.0)	
Smoking	Yes		9 (45.0)	10 (50.0)	14 (70.0)	$X^2 = 1.589$[b]
	No		11 (55.0)	10 (50.0)	6 (30.0)	$p = 0.207$
ASA score	1		1(5.0)	2 (10.0)	2 (10.0)	$X^2 = 4.951$[b]
	2		17 (85.0)	15 (75.0)	11 (55.0)	$p = 0.303$
	3		2 (10.0)	3 (15.0)	7 (35.0)	
Presence of people experiencing pain around	Yes		3 (15.0)	0(0.0)	4 (20.0)	$X^2 = 4.471$[a]
	No		17 (85.0)	20 (0.0)	15 (80.0)	$p = 0.144$
Pain management	Pharmacological		2 (10.0)	1(5.0)	4 (20.0)	$X^2 = 8.159$
	Nonpharmacological		2 (10.0)	1(5.0)	6 (30.0)	$p = 0.067$
	No		16 (80.0)	18 (90.0)	10 (50.0)	

SD: Standard Deviation, n: Number of the patient, ASA: American Society of Anesthesiologists t: Student t-test.
[a] Fisher's exact test
[b] χ2 test

therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the pulse rate of the patients participating in the study ($p = 0.258$; $p = 0.583$; $p = 0.490$; $p > 0.05$). There was a statistically significant difference between the 1st and 3rd measurements of the pulse rate of the patients in the music group and the control group ($p^{1-3} = 0.015$; $p^{1-3} = 0.001$; $p < 0.05$) (Table 2). No significant difference was found between the nature-based sound therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the respiration variable ($p = 0.501$; $p = 0.705$; $p = 0.346$; $p > 0.05$) (Table 2). No significant difference was found between the nature-based sound therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the saturation variable of the patients participating in the study ($p = 0.616$; $p = 0.599$; $p = 0.273$; $p > 0.05$) (Table 2).

According to the 1st, 2nd, and 3rd measurement values of the pain variable of the patients participating in the study, it was determined that the pain score of the nature-based sound therapy group was statistically significantly lower than the music and control group ($p = 0.000$; $p = 0.002$; $p = 0.000$; $p < 0.05$) (Table 2). In addition, a significant difference was found between the 1st and 3rd measurements and between the 2nd and 3rd measurements of the pain variable in the nature-based sound therapy group ($p < 0.05$) (Table 2). In the control group, a statistically significant difference was found between the 1st and 3rd measurements of the pain variable ($p = {}^{1-3} = 0.007$; $p < 0.05$) (Table 2). No significant difference was found between the mean values of the state and trait anxiety scale of the patients participating in the study and the nature-based sound therapy, music, and control groups ($p = 0.636$; $p = 0.183$; $p > 0.05$) (Table 2).

The data in Table 3 show the findings related to music therapy at the 8th hour after surgery.

No significant difference was found between the nature-based sound therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the systolic blood pressure variable of the patients participating in the study ($p = 0.834$; $p = 0.608$; $p = 0.668$; $p > 0.05$). It was determined that the systolic blood pressure variable of the patients in the nature-based sound therapy listening group was statistically significantly higher in the 3rd measurement compared to the 2nd measurement ($p^{2-3} = 0.026$; $p < 0.05$) (Table 3). No significant difference was found between the nature-based sound therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the diastolic blood pressure variable of the patients participating in the study ($p = 0.718$; $p = 0.960$; $p = 0.688$; $p > 0.05$). It was determined that the diastolic blood pressure variable of the patients in the nature-based sound therapies listening group was statistically significantly higher in the 2nd measurement compared to the 1st measurement ($p^{2-3} = 0.026$; $p < 0.05$) (Table 3). No significant difference was found between the nature-based sound therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the pulse rate variables of the patients participating in the study ($p = 0.998$; $p = 0.913$; $p = 0.798$; $p > 0.05$) (Table 3). There was no significant difference between the nature-based sound therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the respiratory variables of the patients participating in the study. No significant difference was found between the nature-based sound therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the respiratory variables of the patients participating in the study ($p = 0.986$; $p = 0.736$; $p = 0.758$; $p > 0.05$). It was determined that the 2nd measurement of the respiratory rate of the patients in the music and control group was statistically significantly lower than the 1st measurement ($p^{1-2} = 0.028$; $p^{1-2} = 0.000$; $p < 0.05$) (Table 3). No significant difference was found between the nature-based sound therapy, music, and control groups according to the 1st, 2nd, and 3rd measurement values of the saturation variable of the patients participating in the study ($p = 0.874$; $p = 0.655$; $p = 0.567$; $p > 0.05$) (Table 3).

According to the 1st, 2nd, and 3rd measurement values of the pain variable of the patients participating in the study, no statistically significant difference was found between the pain score of the nature-based sound therapy group and the music and control group ($p = 0.365$; $p = 0.455$; $p = 0.455$; $p = 0.213$; $p > 0.05$) (Table 3). In addition, a significant difference was found between the 1st and 3rd measurements and the 2nd and 3rd measurements of the pain variable in the nature-based sound therapy group ($p < 0.05$) (Table 3). In the control group, a statistically significant difference was found between the 1st and 2nd measurement and between the 1st and 3rd measurement of the pain variable ($p < 0.05$) (Table 3).

No significant difference was found between the mean values of the state and trait anxiety scale of the patients participating in the study and the nature-based sound therapy, music, and control groups ($p = 0.636$; $p = 0.183$; $p > 0.05$) (Table 3).

4. Discussion

Patients who underwent lung lobectomy were randomized into three groups: nature-based sound therapy group, self-selected music group, and control group. Physiological parameters, pain variables, and mean scores of the trait-persistence anxiety scale were compared within and between groups. The findings were discussed in the light of the

Table 2
Comparison of physiological parameters, pain and anxiety in the first postoperative minutes (1st measurement) ($n = 60$).

	Nature-based voice therapy group ($n = 20$) Mean ± SD	Music group ($n = 20$) Mean ± SD	Control group ($n = 20$) Mean ± SD	Value of statistical
Systolic				
1. measurement	124.8 ± 21.7	123.5 ± 21.7	126.1 ± 25.0	$P = 0.938$ $F = 0.065$
2. measurement	122.4 ± 18.9	129.0 ± 23.9	129.4 ± 25.7	$P = 0.564$ $F = 0.578$
3. measurement	121.7 ± 20.8	126.7 ± 24.9	129.6 ± 23.8	$P = 0.553$ $F = 0598$
Value of statistical	$p^{1-2} = 0.395$ $p^{1-3} = 0.216$ $p^{2-3} = 0.601$	$p^{1-2} = 0.096$ $p^{1-3} = 0.259$ $p^{2-3} = 0.152$	$p^{1-2} = 0.342$ $p^{1-3} = 0.388$ $p^{2-3} = 0.944$	
Diastolic				
1. measurement	74.9 ± 11.2	75.9 ± 12.4	79.5 ± 13.5	$F = 0.754$ $P = 0.475$
2. measurement	73.2 ± 8.8	80.0 ± 16.5	78.4 ± 17.4	$F = 0.578$ $P = 0.564$
3. measurement	70.0 ± 9.2	77.3 ± 9.5	75.9 ± 10.7	$F = 3.069$ $P = 0.054$
Value of statistical	$p^{1-2} = 0.491$ $\mathbf{p^{1-3} = 0.011}$ $p^{2-3} = 0.168$	$p^{1-2} = 0.105$ $p^{1-3} = 0.358$ $p^{2-3} = 0.297$	$p^{1-2} = 0.761$ $p^{1-3} = 0.210$ $p^{2-3} = 0.398$	
heart rate				
1. measurement	79.4 ± 13.3	78.4 ± 14.1	72.8 ± 12.9	$F = 1.389$ $P = 0.258$
2. measurement	80.4 ± 13.6	81.7 ± 14.1	77.4 ± 12.2	$F = 0.544$ $P = 0.583$
3. measurement	76.4 ± 20.1	82.2 ± 13.2	78.2 ± 12.0	$F = 0.723$ $P = 0.490$
Value of statistical	$p^{1-2} = 0.216$ $p^{1-3} = 0.260$ $p^{2-3} = 0.208$	$p^{1-2} = 0.10$ $\mathbf{p^{1-3} = 0.015}$ $p^{2-3} = 0.668$	$\mathbf{p^{1-2} = 0.005}$ $\mathbf{p^{1-3} = 0.001}$ $p^{2-3} = 0.539$	
Respiration				
1. measurement	24.9 ± 2.0	25.6 ± 1.9	25.1 ± 1.8	$F = 0.700$ $P = 0.501$
2. measurement	24.4 ± 1.4	25.0 ± 2.4	24.9 ± 2.3	$F = 0.352$ $P = 0.705$
3. measurement	24.2 ± 1.5	25.2 ± 2.7	24.3 ± 2.4	$F = 1.080$ $P = 0.346$
Value of statistical	$p^{1-2} = 0.227$ $p^{1-3} = 0.221$ $p^{2-3} = 0.425$	$\mathbf{p^{1-2} = 0.039}$ $p^{1-3} = 0.225$ $p^{2-3} = 0.507$	$p^{1-2} = 0.180$ $p^{1-3} = 0.101$ $p^{2-3} = 0.398$	
Saturation				
1. measurement	97.4 ± 2.4	97.6 ± 2.6	96.0 ± 9.3	$F = 0.489$ $P = 0.616$
2. measurement	97.7 ± 2.2	97.6 ± 3.0	98.4 ± 2.2	$F = 0.518$ $P = 0.599$
3. measurement	97.8 ± 2.1	97.2 ± 3.8	98.6 ± 1.7	$F = 1.327$ $P = 0.273$
Value of statistical	$p^{1-2} = 0.186$ $p^{1-3} = 0.167$ $p^{2-3} = 0.666$	$p^{1-2} = 1.000$ $p^{1-3} = 0.408$ $p^{2-3} = 0.366$	$p^{1-2} = 0.266$ $p^{1-3} = 0.219$ $p^{2-3} = 0.287$	
Pain score				
1. measurement	6.0 ± 1.2	7.7 ± 1.0	7.7 ± 1.0	$F = 15.726$ $\boldsymbol{P = 0.000}$
2. measurement	5.6 ± 1.5	7.2 ± 1.6	6.9 ± 1.3	$F = 6.697$ $\boldsymbol{P = 0.002}$
3. measurement	4.9 ± 1.4	7.2 ± 1.6	6.8 ± 1.3	$F = 13.967$ $\boldsymbol{P = 0.000}$
Value of statistical	$p^{1-2} = 0.163$ $\mathbf{p^{1-3} = 0.003}$ $\mathbf{p^{2-3} = 0.019}$	$p^{1-2} = 0.197$ $p^{1-3} = 0.186$ $p^{2-3} = 1.000$	$\mathbf{p^{1-2} = 0.022}$ $\mathbf{p^{1-3} = 0.007}$ $p^{2-3} = 0.649$	
State Anxiety Scale	38.3 ± 4.6	38.6 ± 4.8	38.9 ± 3.9	$t = 0.476$ $p = 0.636$
Trait Anxiety Scale	36.3 ± 4.5	36.4 ± 2.9	38.3 ± 6.3	$U = 151.000$ $p = 0.183$

F: Two-way analysis of variance test statistics for repeated measures *U*: Mann–Whitney U test t: Student t-test 36.3 ± 4.5.

literature.

When physiological parameters were examined in the first postoperative minutes, diastolic blood pressure and pulse rate variables were measured at different times and found to be significant between the groups. It was determined that the diastolic blood pressure variable of the patients in the nature-based sound therapy listening group was significantly lower in the 3rd measurement compared to the 1st measurement. The patient's pulse rate in the music and control groups increased in the 3rd measurement compared to the 1st When the physiological parameters were examined in the 8th hour after surgery, it was determined that the systolic blood pressure variable of the patients in the nature-based sound therapy listening group was statistically

Table 3
Comparison of physiological parameters, pain and anxiety at the 8th postoperative hour (2 st measurement) ($n = 60$).

	Nature-based voice therapy group ($n = 20$) Mean ± SD	Music group ($n = 20$) Mean ± SD	Control group ($n = 20$) Mean ± SD	Value of statistical
Systolic				
1. measurement	127.6 ± 19.7	125.9 ± 17.5	129.3 ± 16.0	$P = 0.834$ $F = 0.182$
2. measurement	124.9 ± 17.4	126.0 ± 17.3	130.1 ± 17.5	$P = 0.608$ $F = 0502$
3. measurement	127.6 ± 17.6	127.8 ± 16.4	132.0 ± 17.5	$P = 0.668$ $F = 0407$
Value of statistical	$p^{1-2} = 0.182$ $p^{1-3} = 0.983$ **$p^{2-3} = 0.026$**	$p^{1-2} = 0.947$ $p^{1-3} = 0.277$ $p^{2-3} = 0.195$	$p^{1-2} = 0.782$ $p^{1-3} = 0.209$ $p^{2-3} = 0.603$	
Diastolic				
1. measurement	71.9 ± 6.3	73.6 ± 9.6	74.0 ± 8.9	$F = 0.333$ $P = 0.718$
2. measurement	76.4 ± 9.2	75.8 ± 6.4	76.4 ± 7.0	$F = 0.041$ $P = 0.960$
3. measurement	75.0 ± 9.1	75.4 ± 9.9	77.5 ± 10.0	$F = 0.377$ $P = 0.688$
Value of statistical	$p^{1-2} =$ **0.037** $p^{1-3} = 0.089$ $p^{2-3} = 0.386$	$p^{1-2} = 0.121$ $p^{1-3} = 0.189$ $p^{2-3} = 0.812$	$p^{1-2} = 0.152$ $p^{1-3} = 0.051$ $p^{2-3} = 0.558$	
heart rate				
1. measurement	85.7 ± 12.8	85.6 ± 12.8	85.8 ± 10.8	$F = 0002$ $P = 0.998$
2. measurement	85.1 ± 12.5	86.6 ± 12.2	85.9 ± 9.3	$F = 0.091$ $P = 0.913$
3. measurement	85.6 ± 12.6	82.9 ± 14.2	83.8 ± 11.1	$F = 0.226$ $P = 0.798$
Value of statistical	$p^{1-2} = 0.370$ $p^{1-3} = 0.848$ $p^{2-3} = 0.634$	$p^{1-2} = 0.119$ $p^{1-3} = 0.264$ $p^{2-3} = 0.144$	$p^{1-2} = 0.975$ $p^{1-3} = 0.414$ $p^{2-3} = 0.424$	
Respiration				
1. measurement	22.1 ± 2.5	22.2 ± 3.1	22.3 ± 3.0	$F = 0.014$ $P = 0.986$
2. measurement	22.1 ± 2.8	21.5 ± 3.3	21.3 ± 3.1	$F = 0.309$ $P = 0.736$
3. measurement	22.0 ± 2.9	21.2 ± 3.3	21.6 ± 3.1	$F = 0279$ $P = 0.758$
Value of statistical	$p^{1-2} = 0.941$ $p^{1-3} = 0.808$ $p^{2-3} = 0.725$	**$p^{1-2} = 0.028$** $p^{1-3} = 0.059$ $p^{2-3} = 0.467$	**$p^{1-2} = 0.000$** $p^{1-3} = 0.208$ $p^{2-3} = 0.606$	
Saturation				
1. measurement	97.7 ± 2.8	97.6 ± 2.5	97.3 ± 2.2	$F = 0.135$ $P = 0.874$
2. measurement	98.2 ± 2.6	97.5 ± 2.5	98.0 ± 2.2	$F = 0.426$ $P = 0.655$
3. measurement	98.3 ± 2.3	97.5 ± 2.5	97.9 ± 2.1	$F = 0573$ $P = 0.567$
Value of statistical	$p^{1-2} = 0.274$ $p^{1-3} = 0.148$ $p^{2-3} = 0.186$	$p^{1-2} = 0.163$ $p^{1-3} = 0.577$ $p^{2-3} = 0.666$	$p^{1-2} = 0.056$ $p^{1-3} = 0.067$ $p^{2-3} = 0.606$	
Pain score				
1. measurement	4.0 ± 1.3	3.5 ± 1.0	3.6 ± 1.0	$F = 1026$ $P = 0.365$
2. measurement	3.2 ± 1.2	3.6 ± 0.8	3.2 ± 1.1	$F = 0799$ $P = 0.455$
3. measurement	2.7 ± 1.0	3.3 ± 1.0	3.1 ± 1.1	$F = 1592$ $P = 0.213$
Value of statistical	$p^{1-2} = 0.163$ **$p^{1-3} = 0.003$** **$p^{2-3} = 0.019$**	$p^{1-2} = 0.197$ $p^{1-3} = 0.186$ $p^{2-3} = 1.000$	**$p^{1-2} = 0.022$** **$p^{1-3} = 0.007$** $p^{2-3} = 0.649$	
State Anxiety Scale	38.3 ± 4.6	38.6 ± 4.8	38.9 ± 3.9	$t = 0.476$ $p = 0.636$
Trait Anxiety Scale	36.3 ± 4.5	36.4 ± 2.9	38.3 ± 6.3	$U = 151.000$ $p = 0.183$

F: Two-way analysis of variance test statistics for repeated measures *U*: Mann–Whitney U test t: Student t-test.

significantly higher in the 3rd measurement compared to the 2nd measurement.

In addition, it was determined that the diastolic blood pressure variable of the patients in the nature-based sound therapy listening group was statistically significantly higher in the 2nd measurement compared to the 1st measurement. It was determined that the 2nd measurement of the respiratory rate of the patients in the music listening and control groups was statistically significantly lower than the 1st measurement. In their study, Kurt and Çelik (2019)[18] determined that after listening to nature-based sound therapy, the respiratory rate of the patients in the experimental group decreased to average values, while the patients in the control group increased undesirably. Saadatmand

et al. (2015)[19] divided the patients into four groups: natural sounds, classical Turkish music, classical Western music, and the control group study, and it was determined that there was a significant decrease in systolic blood pressure, diastolic blood pressure, heart rate, and cortisol levels in the intervention group compared to the control group. Ahmadabad et al. (2017) ,[20] in the study on coronary artery bypass grafting surgery patients, formed the control group by not intervening in the other group. In the study, it was determined that the pulse rate of the experimental group patients was lower. Kurt and Çelik (2019)[18] found that the systolic blood pressure of patients listening to nature-based sound therapy sounds was lower than the control group. Akarsu et al. (2019)[21] determined no difference in pulse and diastolic blood pressure variables between the group listening to nature-based sound therapy and the control group in their research on patients after percutaneous intervention. Dong et al. (2023)[22] determined a statistically significant decrease in systolic blood pressure, heart rate, and respiratory rate of patients in the music-listening group. It is stated that music therapy positively affects heart rate, blood pressure, body temperature, respiratory rate, and oxygen consumption by providing the secretion of endorphin hormone and thus decreasing the catecholamine level.[23] In our research, it is seen that relaxation is provided by taking advantage of this effect of music, and positive changes are made in physiological parameters.

According to the 1st, 2nd, and 3rd measurement values of the pain variable of the patients participating in the study, it was determined that the pain score of the nature-based sound therapy group was statistically significantly lower than the music and control groups. In addition, a significant difference was found between the 1st and 3rd measurements and the 2nd and 3rd measurements of the pain variable of the nature-based sound therapy group. In the control group, a statistically significant difference was found between the 1st and 3rd measurements of the pain variable. The study found a significant difference between the 1st and 3rd measurements and between the 2nd and 3rd measurements of the pain variable of the nature-based sound therapy group at the 8th hour after surgery. According to the repeated VAS measurements, the pain scores of the nature-based sound therapy group were statistically significantly lower than those of the patient-selected music and control groups, as demonstrated by ANOVA with post-hoc testing ($p < 0.05$). In addition, significant within-group reductions over time further confirmed the effectiveness of nature-based sound therapy in alleviating postoperative pain. In the control group, a statistically significant difference was found between the 1st and 2nd measurement and between the 1st and 3rd measurement of the pain variable. Patiyal et al. (2021)[24] in patients undergoing orthopedic surgery and Lee et al. (2023) ,[25] in a systematic review and meta-analysis, concluded that listening to music reduces the level of pain. Saadatmand et al. (2015)[19] determined that patients listening to nature-based sound therapy in mechanical ventilation in intensive care significantly decreased pain levels. Rohilla et al. (2018)[26] determined that music therapy reduced the pain level and reduced the use of opioids. Ruan et al. (2024)[27] determined that the pain level of the patients in whom nature-based sound therapy was intervened during endotracheal aspiration was significantly lower than the control group. Like our study, Kurt and Çelik (2019)[18] determined that listening to nature-based sound therapy reduced pain. It is stated that nature-based sound therapy or music listening can be used safely to reduce sympathetic activity and, thus, stress.[28] It is known that there are studies in the literature that determine that listening to music causes a decrease in pain levels in the music-listening group.[20,29] In addition to pain scores, physiological parameters such as blood pressure, pulse rate, respiratory rate, and oxygen saturation were monitored because postoperative pain is known to activate the sympathetic nervous system, which can elevate these variables. Nonetheless, it should be emphasized that these parameters are not specific to pain and may be influenced by numerous other factors, including perioperative medications, residual effects of anesthesia, emotional stress, and environmental conditions. Therefore, while changes in physiological parameters may provide indirect support for the presence or reduction of pain, they should be interpreted cautiously and always in conjunction with validated subjective measures such as the VAS. This combined approach strengthens the interpretation of our findings, as the consistently lower pain scores in the nature-based sound therapy group align with the observed trends in certain physiological measures, reinforcing the potential role of such interventions in modulating both pain perception and stress-related responses.

No significant difference was found between the mean values of the state and trait anxiety scales of the patients participating in the study and the nature-based sound therapy, music, and control groups. Gogoularadja et al. (2020)[30] determined a significant decrease in the music therapy group. In the literature, similar to our study, studies indicate no significant difference between the groups.[31–32]

5. Conclusion

When the physiological parameters of the study were examined, it was determined that the patient's systolic and diastolic blood pressure in the nature-based sound therapy listening group and the pulse and respiratory variables of the patients in the music listening and control groups were affected. It was determined that the pain score of the nature-based sound therapy group of the patients participating in the study was lower than the music and control group in the first minutes after surgery. In addition, it was determined that the pain level of the nature-based sound therapy group was lower in the 8th hour after the intervention compared to before. In the postoperative period, nature-based sound therapy should be used in inexpensive interventions, have no side effects, and improve patients' quality of life.

6. Limitations

Our limitation is that the study was conducted in only one hospital. In addition, there is no literature on the 2nd and 3rd measurements after the intervention; therefore, it cannot be discussed, which is another limitation. Furthermore, the inability to control all past experiences, physiological (such as genetic structure), psychological (such as attention and focus), environmental (such as noise and light), social, and cultural factors is also one of the limitations of our research. One of the limitations of this study is the absence of a detailed comparison of analgesic consumption in terms of morphine equivalent doses. Although postoperative analgesics such as epidural bupivacaine, paracetamol, and tenoxicam were administered according to standard protocols, the lack of conversion into morphine equivalents makes it difficult to fully interpret the analgesic-sparing effect of music therapy.

Highlights of the findings and novelties

It was determined that the pain score of the nature-based sound therapy group of the patients participating in the study was lower than the music and control group in the first minutes after surgery.

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Declaration of competing interest

The authors declare no potential conflicts of interest concerning this article's research, authorship, and/or publication.

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