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The effect of music and white noise on patients' anxiety and pain during surgery for impacted mandibular third molar: a single-blind randomized controlled trial

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Abstract

Background Anxiety during oral surgery adversely affects patients' compliance with treatment and patient–doctor cooperation. Therefore, various treatment protocols have been developed to reduce anxiety. This study aimed to evaluate the effects of music and white noise on patients' anxiety and pain during surgery for impacted third molars.

Methods According to the Consolidated Standards of Reporting Trials statement, this single-blind, randomized, controlled trial with parallel groups involved 66 patients who met the eligibility criteria and were randomly assigned to one of three groups. Group 1 listened to preselected songs played against a pre-prepared standard "white noise" through noise-isolating headphones that block ambient noise during the procedure. Group 2 listened only to music through noise-isolating headphones during the procedure. Group 3 listened to natural ambient noise during the procedure. All surgical procedures were performed in a standard operating room. All patients completed the State-Trait Anxiety Inventory-State (STAI-S) form and indicated their anxiety on a Visual Analog Scale (VAS) preoperatively and postoperatively. They also indicated the pressure/pain level they felt during the procedure on a VAS. The primary predictor variable was the music and white noise intervention. The primary outcome variables were the STAI-S and VAS scores. Sex was included as a covariate.

Results Anxiety VAS scores were significantly lower postoperatively than preoperatively in Groups 1 ($p<0.001$), 2 ($p<0.001$), and 3 ($p=0.002$). Similarly, STAI-S scores were significantly lower postoperatively than preoperatively in Groups 1 ($p<0.001$), 2 ($p<0.001$), and 3 ($p=0.012$). The change in STAI-S scores ($p=0.053$) did not differ significantly between groups.

Conclusion Although not statistically significant, listening to music alone or with white noise reduced the anxiety experienced by patients during the procedure and increased their comfort. As a simple, inexpensive, and non-invasive method, listening to self-selected music in the preoperative and perioperative periods could benefit patients.

Keywords Tooth extraction, Anxiety, White noise

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Background

The extraction of impacted third molars is one of the most common surgeries in oral and maxillofacial surgery practice. Compared to other procedures, tooth extraction and oral surgical interventions have been reported to cause patients the greatest concern [1–3]. Anxiety

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impairs patients' treatment adherence and adversely affects patient–physician cooperation [4].

Patients usually experience anxiety at a level that increases their perception of pain when undergoing surgery. Therefore, achieving excellent perioperative pain control is one of the most important goals in dentistry [5]. Local anesthesia forms the basis of pain control in oral surgery, especially in outpatient procedures [6]. When used at low intensity, local anesthesia inhibits C fibers and thin and medium-thickness A-δ fibers, blocking pain and temperature sensation, but does not affect touch, proprioception, and motor functions [7]. Therefore, while pain is not felt during tooth extractions under local anesthesia, tooth pressure and dislocation may be felt.

Music therapy has been used since the sixth century, making it one of the oldest treatment methods [8]. Many studies have shown that music positively affects pain and anxiety and improves the quality of life of sick and healthy individuals [9–11].

Music is also a very effective stimulus in distracting attention from pain. Sound stimulation effectively distracts patients and provides a cognitive strategy for pain control and suppressing the pain response [12, 13]. In studies investigating the effects of music on intraoperative sedation requirements in patients undergoing surgery under spinal anesthesia, it has been found that those who listened to music of their choice were more relaxed and less anxious, and required less intraoperative propofol compared to those who did not listen to music [14, 15]. Satisfaction was significantly higher among patients who underwent surgery while listening to music, and most stated that they would like to listen to music again if they underwent a similar surgery in the future [9, 15, 16].

White noise comprises a mixture of continuous monotonous sounds of diverse frequencies from the environment, such as trees, waterfalls, or ocean waves [17]. It has been used to mask other sounds, treat tinnitus and insomnia, and facilitate relaxation [18, 19]. Studies have shown that listening to white noise reduced the crying, screaming, and awake times of babies with colic compared to before[17, 20].

Many studies have shown that music has favorable effects on anxiety and pain and increases the quality of life of sick and healthy individuals [9–11]. Studies have also shown that white noise reduces pain and anxiety [17, 19, 21, 22]. Many studies have examined this effect, with a few examining it during impacted tooth extraction. However, no study has examined the effects of combining white noise and music during impacted tooth extraction. Therefore, this study's primary aim was to evaluate the effect of music and white noise on patients' anxiety and pain during the extraction of impacted third molars. Its secondary aim was to evaluate the effect of music and white noise on pain control. We hypothesized that anxiety and pain levels would be lower among patients who listen to music with or without white noise during the procedure than among those who listen to ambient noise.

Methods

Participants

This single-blind, randomized, controlled trial with three parallel groups was conducted in 2018 in the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ankara University, and is reported according to the Consolidated Standards of Reporting Trials (CONSORT) guidelines. It received ethical approval from the Ethics Committee at Ankara University (decision number: 09/01-18) and was performed according to the Declaration of Helsinki. All subjects provided written informed consent during study enrollment.

The inclusion criteria were as follows: impacted mandibular third molars, no medical history that could affect third molar surgery, no mental health problems, and consenting to surgery. The exclusion criteria were as follows: pregnancy or lactating, refusal to participate in this study, an existing psychiatric disorder, antidepressant or anxiolytic drug use, inability to cooperate with the surgery, having a disease that could prevent the surgery, a severe infection around the impacted third molar, and a prior tooth extraction, as it was thought that the good or bad experiences of such patients might affect their anxiety.

The primary predictor variable was the perioperative music intervention. Two music interventions were considered: music with white noise and music alone. The primary outcome variables were the State-Trait Anxiety Inventory-State (STAI-S) score, anxiety measured on a Visual Analog Scale (VAS) and pain measured on a VAS. Sex was included as a covariate.

This study involved 66 patients who were randomly assigned to three groups ($n=22$/group) via an online randomizer (http://www.randomizer.org) that differed in what was heard during the surgical procedure, which was performed in a standard operating room.

Group 1 listened to a preselected playlist played against a pre-prepared standard white noise through headphones that prevent ambient noise during the procedure. The playlist consisted of popular songs of the time. The patient could choose the music they wanted to listen to from the playlist using a hand-held tablet.

Group 2 listened to the same preselected playlist without white noise through noise-isolating headphones during the procedure. The patient could choose the music they wanted to listen to from the playlist using a hand-held tablet. Group 3 listened to the natural ambient noise during the procedure.

The patients completed the STAI-S form and indicated their anxiety level on a VAS preoperatively and postoperatively. Postoperatively, they also indicated the pain/pressure they felt during the procedure on a VAS and their desire to undergo the procedure again (1 = never, 2 = maybe/not sure, 3 = willing).

STAI-S

The STAI-S is a form that assesses a patient's current anxiety level and has shown reliability and validity in Turkish. It evaluates abrupt changes in emotional reactions through 20 items that evaluate how the patient currently feels, rated on a four-point Likert scale from 1 (not at all) to 4 (very much so). Its total score ranges from 20 to 80, with higher scores indicating greater anxiety [23].

VAS

The VAS is an ideal measurement tool when words and digital data cannot be used. This study used a closed-ended 10-cm scale (0 = no anxiety, 10 = maximum imaginable anxiety). Subjects were asked to mark their current degree of anxiety and perioperative pain on separate VAS [24].

Surgical procedure

All patients were given a mouthwash containing chlorhexidine gluconate before the surgery. Before the procedure, all patients received nervus alveolaris inferior block anesthesia and buccal infiltrative anesthesia with 2.5% articaine hydrochloride (Ultracain D-S Forte Ampoule, Sanofi Aventis) containing 1/100,000 epinephrine as a local anesthetic. In all three groups, a mucoperiosteal triangular flap was raised to reach the bone, and the tooth was removed from the socket using a bein elevator after sufficient bone had been removed. The original position of the flap was preserved, and the wounds were closed primarily using an atraumatic silk suture.

Statistical analysis

The sample size required for this study was estimated as at least 22 patients per group, considering a power of 0.80, a significance level of 0.05, and a difference of 5 units, using the G*Power 3.1.9.2 program. The data were analyzed using the SPSS Statistics software (version 17.0; IBM Corp., Armonk, NY, USA). Unless otherwise stated, a $p < 0.05$ was considered statistically significant. However, a Bonferroni correction was performed to control for type I errors in all multiple comparisons.

The normality of the distribution of discrete numerical variables was assessed using the Kolmogorov–Smirnov test, and the homogeneity of variances among groups was assessed using Levene's test. Discrete numerical variables are presented as the mean ± standard deviation (SD) or median (25–75th percentiles), and categorical variables are presented as the number (*n*; percentage [%]). Ages were compared between groups using one-way analysis of variance (ANOVA). Discrete numerical variables, which did not meet parametric test assumptions, were compared between two groups using the Mann–Whitney U test and the three groups using the Kruskal–Wallis test. If the Kruskal–Wallis test was significant, the groups were compared pairwise using Conover's multiple comparison test to determine which drove the difference. Categorical variables were compared between groups using Pearson's Chi-square test.

Results

Of the 80 patients examined, 10 patients did not meet the inclusion criteria, and 4 patients did not consent to participate in the study, leaving 66 who fulfilled the inclusion criteria and consented to participate in the study. The patient admission process is explained in the flowchart of the Reporting Trials Consolidation Standards (Fig. 1).

This study involved 66 patients, of which 42 were female and 24 were male. Their age ranged from 18 to 55 years, and the age distribution did not differ significantly between groups ($p = 0.605$). The sex distribution did not differ significantly between groups ($p = 0.822$; Table 1).

As evaluated using a VAS, anxiety levels did not differ significantly between groups preoperatively ($p = 0.158$) or postoperatively ($p = 0.158$). Anxiety levels were significantly lower postoperatively than preoperatively in Groups 1 ($p < 0.001$), 2 ($p < 0.0010$, and 3 ($p = 0.002$). The preoperative to postoperative change in anxiety levels did not differ significantly between groups ($p = 0.055$). The subjects' anxiety levels are presented by group and time point in Table 2.

As evaluated using a VAS, preoperative anxiety levels were significantly higher among females than among males ($p = 0.015$).

STAI-S scores did not differ significantly between groups preoperatively ($p = 0.305$) or postoperatively ($p = 0.645$). STAI-S scores were significantly lower postoperatively than preoperatively in Groups 1 ($p < 0.001$), 2 ($p < 0.001$), and 3 ($p = 0.012$). The preoperative to postoperative change in STAI-S scores did not differ significantly between groups ($p = 0.053$). The subjects' STAI-S scores are presented by group and time point in Table 3.

Perioperative pain levels did not differ significantly between groups ($p = 0.341$; Table 4).

Among all cases, no statistically significant correlation was found between age and other scoring characteristics of the cases ($p > 0.05$).

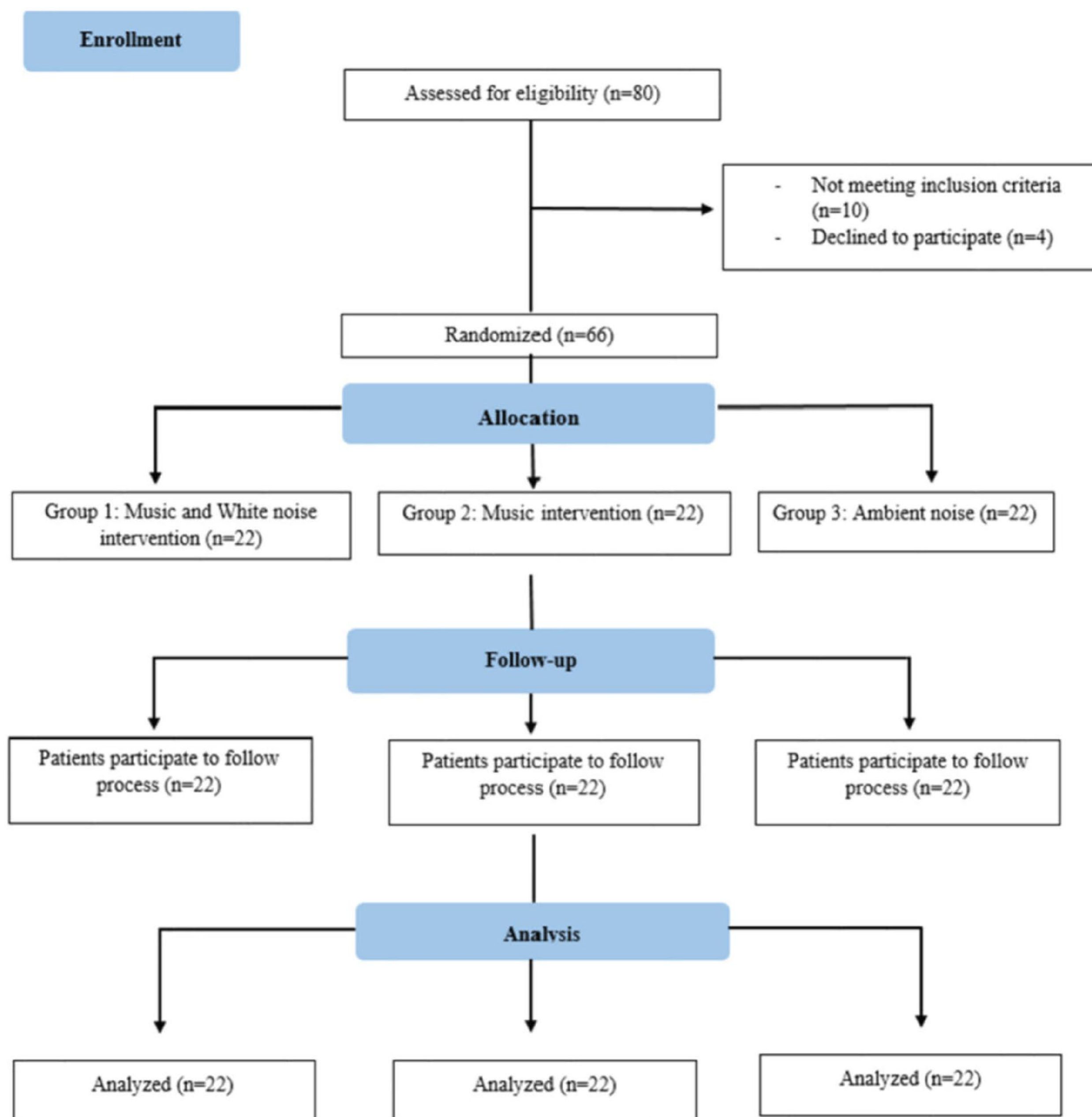

Fig. 1 Flow diagram of study

Table 1 Subjects' demographic characteristics by group

	Group 1 (*n* = 22)	Group 2 (*n* = 22)	Group 3 (*n* = 22)	*p*-value
Age (years), mean ± SD	22.6 ± 7.2	22.9 ± 5.6	25.0 ± 8.7	0.605†
Sex, *n* (%)				0.822‡
Female	15 (68.2%)	13 (59.1%)	14 (63.6%)	
Male	7 (31.8%)	9 (40.9%)	8 (36.4%)	

Group 1(white noise and music), Group 2 (music only), Group 3(ambient noise [control])

† One-way ANOVA

‡ Pearson's Chi-square test

Table 2 Subjects' anxiety levels (VAS) by group and time point

	Preoperative	Postoperative	*p*-value[†]	Change
Group 1	6.0 (1.75–8.00)	1.0 (0–3.00)	< 0.001	− 3 (− 6.00–0)
Group 2	7.0 (4.75–8.00)	2.5 (0.75–4.00)	0.001	− 4 (− 6.25– − 1.00)
Group 3	4.0 (1.75–7.00)	2.0 (1.00–4.00)	0.002	− 1 (− 4.25–0)
p-value[‡]	0.158	0.214		0.055

Group 1 (white noise and music), Group 2 (music only), Group 3 (ambient noise [control]). Descriptive statistics: mean ± SD or median (25–75th percentile)

[†] Within-group preoperative and postoperative comparisons were considered significant based on a Bonferroni-corrected *p*-value of < 0.0167 in a Wilcoxon signed-rank test

[‡] Between-group differences were considered significant based on a Bonferroni-corrected *p*-value of < 0.025 (preoperative and postoperative) or < 0.05 (preoperative to postoperative change) in a Kruskal–Wallis test

Discussion

This study examined the effects of music and white noise on patients' current anxiety, pain, and comfort during surgery for impacted third mandibular molars. Its hypothesis was rejected. Studies have shown that music positively affects anxiety and improves patients' perioperative and postoperative quality of life [9–11]. While it has been reported that white noise positively affects anxiety, like for music, there is no clear evidence for its beneficial effects during surgery for impacted third molars.

Despite the technical advances in contemporary dentistry, strategies for managing anxiety related to dental procedures and apprehension about discomfort during treatment remain an area of investigation. One study investigating the association between anxiety and postoperative pain in dental procedures found that patients with greater anxiety experienced greater surgical and postoperative pain [25]. Compared to other procedures, tooth extraction and oral surgery have been reported to cause patients the greatest concern [3]. Anxiety-reducing approaches during dental procedures include providing confidence by informing the patient, providing pharmacological support by applying premedication or sedation, and teaching coping strategies such as distraction, relaxation, and hypnosis [4]. However, insufficient studies have evaluated the joint effects of music and white noise on reducing anxiety and pain during tooth extraction.

Various studies have investigated the effect of music on anxiety, which is one of the cognitive emotions. These studies used the VAS and STAI alone or in combination to evaluate the effects of music on patients' anxiety [23, 26, 27]. One study using the STAI to assess anxiety in dental procedures concluded that it was a highly reliable, easy-to-administer, and easy-to-evaluate instrument, recommending it to achieve the best balance between dental treatment and anxiety, thereby maximizing patient satisfaction and oral hygiene [28]. Additionally, the VAS is a simple, crude, and widely used measure of anxiety that can reliably predict STAI-S scores [26]. Therefore, our study used the VAS and STAI-S together.

In this study, STAI-S scores significantly decreased from preoperative to postoperative. Many studies evaluating the effect of music on anxiety have reported that patients' STAI scores were significantly lower postoperatively [26, 29, 30]. Although it was observed that the clinical postoperative values decreased more than third group in group 1 in which white noise and music were listened to together, and in group 2, which listened to music only, in accordance with these studies, it was determined that this decrease was not statistically significant. The current

Table 4 Subjects' perioperative pain levels (VAS) by group

	VAS
Group 1	1 (0–2.25)
Group 2	1 (0–2.25)
Group 3	2 (1.00–4.00)
p-value[‡]	0.341

Group 1 (white noise and music), Group 2 (music only), Group 3 (ambient noise [control])

[†] Kruskal–Wallis test

Table 3 Subjects' anxiety levels (STAI-S) by group and time point

	Preoperative	Postoperative	*p*-value[†]	Change
Group 1	47.0 (39.75–53.25)	32.5 (24.00–39.00)	< 0.001	− 14.5 (− 24.25– − 7.50)
Group 2	46.5 (37.00–50.75)	34.0 (25.75–41.00)	< 0.001	− 13.5 (− 19.25– − 1.75)
Group 3	42.0 (31.25–50.25)	34.0 (29.75–41.00)	0.012	− 5.0 (− 14.50– − 0.25)
p-value[‡]	0.305	0.645		0.053

Group 1 (white noise and music), Group 2 (music only), Group 3 (ambient noise [control])

Descriptive statistics: mean ± SD or median (25th–75th percentile)

[†] Within-group preoperative and postoperative comparisons were considered significant based on a Bonferroni-corrected *p*-value of < 0.0167 in a Wilcoxon signed-rank test

[‡] Between-group comparisons were considered significant based on a Bonferroni-corrected *p*-value of < 0.025 (preoperative and postoperative) in a Kruskal–Wallis test: Group 1 vs. 2 ($p < 0.001$) and Group 1 vs. 3 ($p = 0.037$)

study suggested that the decrease in anxiety scores of all patients after surgery is related to the relief felt due to the cessation of surgical anxiety.

Considering the VAS measurements in this study, postoperative VAS scores for anxiety decreased significantly in all groups. While greater decreases were observed in Groups 1 (music and white noise) and 2 (music only) than in Group 3 (ambient noise [control]), the differences were not significant. In contrast, studies evaluating the effects of binaural beats and music on reducing preoperative anxiety in dental procedures found that VAS-based anxiety scores decreased in the experimental groups [27, 31]. Like our study, Gaberson evaluated the effect of music on preoperative anxiety in 46 patients undergoing outpatient surgery using a VAS, finding no significant difference between those who listened to music and those who did not [32]. The current study suggests that the postoperative decrease in anxiety VAS scores of all subjects is associated with the relief felt due to the cessation of surgical anxiety, consistent with the STAI-S scores.

A review of the effects of music interventions on patients undergoing biopsy found that VAS pain scores decreased after the procedure [26]. In the current study found no significant differences in perioperative pain levels between groups. Kim et al. examined how listening to their favorite music affected patients' anxiety and pain during surgery for impacted third molars, finding no significant differences in VAS-based perioperative pain measurements between groups [10]. Today, pain is successfully controlled during dental surgical procedures with local anesthetics when the proper medication and dosage are chosen. The current study suggests that there was no statistically significant differences in VAS measurements due to the successful application of anesthesia.

Our study found no significant correlations between subjects' age and anxiety and pain scores. Many factors affect anxiety with dental procedures. It has been reported that the tests used to determine anxiety with dental procedures are affected by sociodemographic factors such as age, sex, education, oral health, frequency of visiting the dentist, past treatment experiences, and the type and duration of the dental procedure [33]. Several studies have examined the relationship between patients' anxiety with dental procedures and age [34, 35]. They suggested that there may be a relationship between anxiety with dental procedures and age due to patients' cognitive and emotional development. Indeed, the ability to cope with stressful situations has been reported to increase with age [36]. However, some studies found no relationship between age and anxiety. Therefore, it has been argued that factors other than age influence anxiety, and sociocultural differences should also be considered [3, 37, 38]. Studies evaluating the effect of music on anxiety during colonoscopy and endoscopy procedures found that it was independent of age [39, 40], consistent with our study.

Our study observed greater VAS-based preoperative anxiety in females than in males. However, preoperative STAI-S scores did not differ significantly between males and females. Studies on anxiety have found greater anxiety among females than males [41, 42]. Several studies have attributed this difference to female patients' propensity to be more honest in their responses or enhanced ability to articulate their emotions [43, 44].

This study had some limitations. Firstly, it did not examine patients' vital signs. Anxiety could be assessed by measuring parameters such as blood pressure, pulse, and oxygen saturation. Secondly, it did not include a group in which the procedure was performed in complete silence by wearing headphones that suppress ambient noise. Its inclusion would have allowed the practitioner to be blinded to the intervention and the effects of music, white noise, and ambient noise on anxiety to be compared to complete silence.

Conclusion

While our results were not statistically significant, listening to music with or without white noise reduced patients' anxiety during the procedure and increased their comfort. Therefore, in addition to pharmacologic methods, it is beneficial for patients to listen to their chosen music during the preoperative and perioperative periods as a simple, inexpensive, and non-invasive method to reduce anxiety. Further comprehensive studies with larger sample sizes, with better-standardized environments and frequencies of music, and using dental anxiety-specific scales are needed to provide more statistically significant results.

Abbreviations

VAS Visual analog scale
STAI Spielberger's state-trait anxiety inventory
STAI-S STAI-state anxiety inventory

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Author contributions

MA and SA contributed equally to this work. MA and SA designed the study. MA collected and analyzed the data. MA and SA wrote the manuscript. MA and SA read and approved the final, published version of the manuscript.

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Availability of data and materials

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This study received ethical approval from the Ethics Committee of Ankara University (decision number: 09/01-18) and was performed according to the Declaration of Helsinki. All subjects provided written informed consent during study enrollment.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Yusa H, Onizawa K, Hori M, Takeda S, Takeda H, Fukushima S, et al. Anxiety measurements in university students undergoing third molar extraction. Oral Surg Oral Med Oral Pathol Oral Radiol Endodontol. 2004;98(1):23–7.
2. Kazancioglu HO, Tek M, Ezirganli S, Demirtas N. Does watching a video on third molar surgery increase patients' anxiety level? Oral Surg Oral Med Oral Pathol Oral Radiol. 2015;119(3):272–7.
3. Muglali M, Komerik N. Factors related to patients' anxiety before and after oral surgery. J Oral Maxillofac Surg. 2008;66(5):870–7.
4. De Jongh A, Adair P, Meijerink-Anderson M. Clinical management of dental anxiety: what works for whom? Int Dent J. 2005;55(2):73–80.
5. Malamed SF. Is the mandibular nerve block passé? J Am Dent Assoc. 2011;142:3S-7S.
6. Meechan J. G. Local anaesthesia. Oral Surgery. 2008;1(1):3-10.
7. Butterworth, J. F., Mackey, D. C., & Wasnick, J. D. Morgan & Mikhail's clinical anesthesiology. 5th ed. New York; McGraw-hill. 2013; p. 263-277.
8. Moris DN, Linos D. Music meets surgery: two sides to the art of "healing." Surg Endosc. 2013;27:719–23.
9. Ilkkaya NK, Ustun FE, Sener EB, Kaya C, Ustun YB, Koksal E, et al. The effects of music, white noise, and ambient noise on sedation and anxiety in patients under spinal anesthesia during surgery. J Perianesth Nurs. 2014;29(5):418–26.
10. Kim YK, Kim SM, Myoung H. Musical intervention reduces patients' anxiety in surgical extraction of an impacted mandibular third molar. J Oral Maxillofac Surg. 2011;69(4):1036–45.
11. Lee HY, Nam ES, Chai GJ, Kim DM. Benefits of music intervention on anxiety, pain, and physiologic response in adults undergoing surgery: a systematic review and meta-analysis. Asian Nurs Res. 2023;17(3):138–49.
12. Lin YJ, Lu KC, Chen CM, Chang CC. The effects of music as therapy on the overall well-being of elderly patients on maintenance hemodialysis. Biol Res Nurs. 2012;14(3):277–85.
13. Hartling L, Shaik MS, Tjosvold L, Leicht R, Liang Y, Kumar M. Music for medical indications in the neonatal period: a systematic review of randomised controlled trials. Arch Dis Child Fetal Neonatal Ed. 2009;94(5):F349–54.
14. Ayoub CM, Rizk LB, Yaacoub CI, Gaal D, Kain ZN. Music and ambient operating room noise in patients undergoing spinal anesthesia. Anesth Analg. 2005;100(5):1316–9.
15. Zhang X, Fan Y, Manyande A, Tian Y, Yin P. Effects of music on target-controlled infusion of propofol requirements during combined spinal-epidural anaesthesia. Anaesthesia. 2005;60(10):990–4.
16. Menegazzi JJ, Paris PM, Kersteen CH, Flynn B, Trautman DE. A randomized, controlled trial of the use of music during laceration repair. Ann Emerg Med. 1991;20(4):348–50.
17. Balcı S. Kolikli bebeklere beyaz gürültünün etkisi: Marmara Universitesi (Turkey). 2006.
18. Handscomb L. Use of bedside sound generators by patients with tinnitus-related sleeping difficulty: which sounds are preferred and why? Acta Otolaryngol. 2006;126(sup556):59–63.
19. Jastreboff PJ. Tinnitus habituation therapy (THI) and tinnitus retraining therapy (THI). Tinnitus handbook. Singular: Norwich; 2000. p. 357–76.
20. Sezici E, Yigit D. Comparison between swinging and playing of white noise among colicky babies: a paired randomised controlled trial. J Clin Nurs. 2018;27(3–4):593–600.
21. Barzegar SL, Mohammadi S, Shamsalinia A, Saberifar M. The effects of white noise on preprocedural anxiety and vital signs among older adults undergoing colonoscopy. J Perianesth Nurs. 2024;39(3):386–90.
22. Sm S, Sw K. Effects of white noise in walking on walking time, state anxiety, and fear of falling among the elderly with mild dementia. Brain and behavior. 2020;10(12): e01874.
23. Salehabadi N, Pakravan A, Rasti R, Pourasghar M, Mousavi SJ, Saravi ME. Can binaural beat music be useful as a method to reduce dental patients' anxiety? Int Dent J. 2024;74(3):553–8.
24. Rc A. Measurement of feelings using visual analogue scales. Proc R Soc Med. 1969;62:89–93.
25. Wang TF, Wu YT, Tseng CF, Chou C. Associations between dental anxiety and postoperative pain following extraction of horizontally impacted wisdom teeth: a prospective observational study. Medicine. 2017;96(47): e8665.
26. Song M, Li N, Zhang X, Shang Y, Yan L, Chu J, et al. Music for reducing the anxiety and pain of patients undergoing a biopsy: A meta-analysis. J Adv Nurs. 2018;74(5):1016–29.
27. Menziletoglu D, Guler AY, Cayır T, Isik BK. Binaural beats or 432 Hz music? which method is more effective for reducing preoperative dental anxiety? Medicina oral, patologia oral y cirugia bucal. 2021;26(1): e97.
28. Ayaz A, Bilgin N, Mollaoğlu N. Dental anksiyetede durumluk ve sürekli kaygı ölçeğinin kullanımı. ADO Klinik Bilimler Dergisi. 2017;8(2):1553–60.
29. Kupeli I, Gülnahar Y. Comparing different music genres in decreasing dental anxiety in young adults who underwent third molar surgery in Turkey: randomized controlled trial. J Oral Maxillofac Surg. 2020;78(4):546. e1-e7.
30. Lee WP, Wu PY, Lee MY, Ho LH, Shih WM. Music listening alleviates anxiety and physiological responses in patients receiving spinal anesthesia. Complement Ther Med. 2017;31:8–13.
31. Isik B, Esen A, Büyükerkmen B, Kilinc A, Menziletoglu D. Effectiveness of binaural beats in reducing preoperative dental anxiety. Br J Oral Maxillofac Surg. 2017;55(6):571–4.
32. Gaberson KB. The effect of humorous and musical distraction on preoperative anxiety. AORN J. 1995;62(5):784–91.
33. Bedi R, McGrath C. Factors associated with dental anxiety among older people in Britain. Gerodontology. 2000;17(2):97–103.
34. Ilgüy D, Ilgüy M, Dinçer S, Bayirli G. Reliability and validity of the Modified Dental Anxiety Scale in Turkish patients. J Int Med Res. 2005;33(2):252–9.
35. Ayaz Takal A, Duyan V, Mollaoğlu N. Gömülü alt yirmi yaş dişi operasyonlari ve anksiyete. ADO Klinik Bilimler Dergisi (online). 2021;10(1):20–6.
36. Liddell A, Locker D. Gender and age differences in attitudes fo dental pain and dental control. Commun Dent Oral Epidemiol. 1997;25:314–8.
37. Nakai Y, Hirakawa T, Milgrom P, Coolidge T, Heima M, Mori Y, et al. The children's fear survey schedule–dental subscale in Japan. Commun Dent Oral Epidemiol. 2005;33(3):196–204.
38. Arapostathis KN, Coolidge T, Emmanouil D, Kotsanos N. Reliability and validity of the Greek version of the children's fear survey schedule-dental subscale. Int J Pediatr Dent. 2008;18(5):374–9.
39. El-Hassan H, McKeown K, Muller A. Clinical trial: music reduces anxiety levels in patients attending for endoscopy. Aliment Pharmacol Ther. 2009;30(7):718–24.
40. Martindale F, Mikocka-Walus AA, Walus BP, Keage H, Andrews JM. The effects of a designer music intervention on patients' anxiety, pain, and experience of colonoscopy: a short report on a pilot study. Gastroenterol Nurs. 2014;37(5):338–42.
41. Lee CY, Chang YY, Huang ST. Prevalence of dental anxiety among 5-to 8-year-old Taiwanese children. J Public Health Dent. 2007;67(1):36–41.
42. Fillingim RB. Complex associations among sex, anxiety and pain. Pain. 2013;154(3):332–3.
43. Chaplin TM, Aldao A. Gender differences in emotion expression in children: a meta-analytic review. Psychol Bull. 2013;139(4):735.
44. Chaplin TM. Gender and emotion expression: a developmental contextual perspective. Emot Rev. 2015;7(1):14–21.

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