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The Effect of Different Auditory Stimuli on Vital Signs and Consciousness Level in Intensive Care Patients: Music, Nature-Based Sound and Voices of Patients' Relatives

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Received: 2 November 2023 | **Revised:** 17 December 2024 | **Accepted:** 27 May 2025

Funding: The authors received no specific funding for this work.

Keywords: consciousness level | intensive care patients | music | nature-based sounds | vital signs | voices of patients' relatives

ABSTRACT

Aim: This study examined the effects of music, nature-based sounds and the voices of patients' relatives on the vital signs and consciousness levels of intensive care patients with different levels of consciousness.

Design: This is a quasi-experimental study with a within-subject design. This study included 43 patients with different levels of consciousness. Patients in the sample group constituted the study's control and intervention groups. The study was conducted on a single sample group using a pre–post design.

Methods: As interventions of the study, the patients were exposed to music, nature-based sounds and voices of relatives of the patients via wearing headphones at intervals of 1 day. To obtain control data, the same patients were wearing silent headphones. The order of auditory stimulus interventions and silent headphone control sessions was determined by randomisation.

Results: Music, nature-based sounds, patient relatives' voices in groups, the difference between the within-group heart rate and the Glasgow Coma Scale mean scores was statistically significant. It was found that the mean scores of the respiratory rate were statistically significant in the case where the patients were made to listen to the voices of their relatives. Music and nature-based sounds decreased heart rate, while patient relatives' sounds increased heart rate and respiratory rate. These different auditory stimuli positively affected the patient's level of consciousness in intensive care patients.

Patient Contribution: Music, nature-based sounds and voices of patient relatives can be used in sensory stimulus programmes as they warn patients and positively affect the level of consciousness. This study revealed the responses of intensive care patients with different levels of consciousness to auditory stimuli. The results of this study may help in the selection of auditory stimuli in patients with different levels of consciousness. It is advisable to provide sensory stimuli by listening to music, nature-based sounds and voices of patients' relatives to patients, and create protocols or evidence-based guides that will help the intensive care nurse.

This study is a doctoral thesis at Atatürk University Institute of Health Sciences Department of Nursing Fundamentals.

1 | Introduction

Every year, millions of people require intensive care. Although survival rates for ICU patients are improving, issues related to an ICU stay remain significant (Tronstad et al. 2023). Hospitalisation in intensive care is a stressful process for patients. Therapeutic interventions, being away from family, pain, the unfamiliar environment, noise or lack of stimulation and the inability to relax are among the essential causes of stress (Froutan et al. 2020; Hoseini et al. 2022) In intensive care units, patients are often exposed to continuous and intense sounds resulting from medical devices, alarms, staff conversations, treatment and care activities. At the same time, these sounds cause sensory overload. Additionally, patients may experience sensory deprivation due to monotonous, minimal, unqualified and inadequate sensory stimulation (Zuo et al. 2021; Bahonar et al. 2019). Sensory overload and sensory deprivation affect the autonomic nervous system and vital functions (Ahmed et al. 2023; Umbrello et al. 2019; Naef et al. 2023). Meaningful, planned and pleasant auditory stimuli reduce the perception of unwanted environmental stimuli and noise. Improving the individual's environment prevents sensory deprivation and overload (Rahimi et al. 2019; Froutan et al. 2020; Hoseini et al. 2022). Environments enriched with sensory stimuli play a significant role in neurorehabilitation. An enriched environment is reported to benefit brain plasticity. Taking measures to prevent sensory problems and support recovery is a crucial aspect of intensive care nursing (Zuo et al. 2021; Cheng et al. 2018). One of the most important interventions is providing auditory stimulation to patients using familiar sounds such as music, nature sounds, or the voice of a family member (Mohammadi et al. 2019; Froutan et al. 2020; Najafi Ghezeljeh et al. 2019).

Music can be a global field with the potential to create a balance between mind, body and spirit (Chahal et al. 2021). The effect of music on the human body is explained as the concord or synchronisation of body rhythms with musical rhythms, affecting atom vibrations throughout the body (Pingle and Ragha 2024). The impact of music depends on the number of vibrations (pitch) of sound waves and the number of beats per minute (60–80 beats per minute). Constant, slow and repetitive rhythms with low pitches have been reported to show a hypnotic or relaxing effect. Music therapy is being used as a stress-reduction strategy. Music therapy initiates a general relaxation response by reducing stress-induced stimuli, synchronising body rhythms such as respiratory rate (RR) and heart rate (HR) and positively influencing the listener's emotional feelings (Umbrello et al. 2019; de Witte et al. 2020). Human life is closely linked to the natural world, and such a relationship benefits human health (Guidolin et al. 2024). Nature sounds relax, inducing positive feelings in individuals, perceived attention restoration, activating the parasympathetic nervous system, and decreasing physiological stress (Van Hedger et al. 2019; Fatehimoghadam et al. 2023).

Currently, there is a growing trend towards involving family members in caregiving. Involving family members in intensive care patients' care helps patients recover (Ahmed et al. 2023). An ideal level of interaction between intensive care patients and their family members may prevent sensory dysfunctions (Fisher et al. 2019). Patients in coma are at high risk for sensory deprivation (Varghese et al. 2021). One of the most essential emotions of intensive care patients is to be with family members (Salmani et al. 2017). Making patients listen to the voices of relatives is a strong and individualised sensory stimulus (Tavangar et al. 2015). In addition, it can have a positive and relaxing effect by increasing patients' perception of social support. It has been reported that sounds that are interesting and have a special meaning for the patient, such as the voice of the patient's relatives, can modulate cognitive processes more strongly than neutral music or the unfamiliar voices (Salmani et al. 2017; Varghese et al. 2021).

Intensive care patients experience a lack of meaningful and qualified stimuli. It is emphasised that determining and using an optimal sensory stimulation program for intensive care patients is crucial. Auditory stimuli are more commonly used to provide sensory stimulation in ICU patients with impaired levels of consciousness compared to other types of sensory stimulation, such as visual, olfactory, gustatory and tactile. Auditory stimulus is one of the essential steps to be taken for a positive environment (Yekefallah et al. 2021). Although many studies investigate the positive effects of different auditory stimuli on physiological parameters and consciousness in intensive care patients, the research results show some inconsistencies (Cheng et al. 2018; Li et al. 2020). Due to inconsistencies in reporting auditory stimulation interventions and the lack of guidelines to guide clinicians on auditory stimulation, auditory stimuli are not fully embraced in the routine care of patients (Iyendo 2017; Fatehimoghadam et al. 2023). Although many studies investigate the effects of music, nature sounds and the voices of relatives on vital signs and consciousness in intensive care patients, the originality of this study is that three different auditory stimuli were applied sequentially to the same patients with varying levels of consciousness. According to Roper, Logan and Tierney's Life Model, it is emphasised that individuals may react differently to the same stimuli and that each individual perceives these stimuli according to their own life experiences and level of consciousness (Holland and Jenkins 2019). Most studies in the literature examined patients by dividing them into experimental and control groups, and these designs made it necessary to ensure equivalence between groups. The literature generally examines auditory stimuli in separate studies in different patient groups. Individual characteristics, emotional state, and culture can influence patients' responses to music (Pingle and Ragha 2024). However, in this study, using each individual as their control and applying all three auditory stimuli to the same patients minimises the effects of differences between individuals (e.g., level of consciousness, vital signs, pain threshold). It allows for a more precise and reliable demonstration of patients' responses to auditory stimuli at different levels of consciousness. The type and characteristics of the sounds and the patient's level of consciousness can affect their perception of the sounds they hear. For this reason, it is essential to understand patients' responses to auditory stimuli at different levels of consciousness in the intensive care unit.

Therefore, this study was conducted to examine the effects of music, nature-based sounds and the voices of patients' relatives on the patient's vital signs, including HR, systolic blood pressure (SBP), diastolic blood pressure (DBP), RR and consciousness

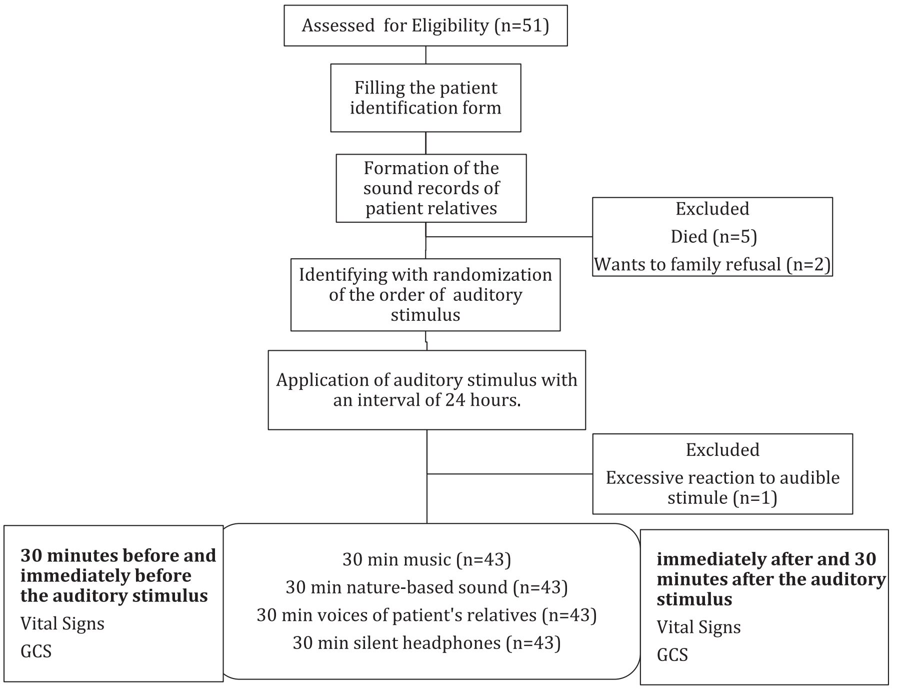

FIGURE 1 | Research plan.

level in intensive care patients with neurological and metabolic diseases, with different levels of consciousness.

2 | Methods

2.1 | Study Design, Setting, Participants

This is a quasi-experimental study with a within-subject design. Patients in the sample group constituted the study's control and intervention groups. The study was conducted on a single sample group using a pre-post design. The study population consisted of patients hospitalised in a university hospital's Anaesthesiology and Reanimation Unit in Türkiye. The patients included in the study had various neurologic and metabolic diseases. The ward included patients who needed intensive care due to neurological and metabolic reasons. In this intensive care unit, the visit time of patients with their relatives is limited. During the visit, it was observed that the relatives of the patients had poor verbal communication with them and often looked at their relatives from afar. Furthermore, except for routine care and treatment services, audible stimulants such as music are not used to stimulate the patient in this intensive care unit. Before determining the study sample, a priori power analysis was performed in GPOWER 3.1.9.7 Package Programme based on analysis of variance in repeated measures (Faul et al. 2007). It was determined that the sample size should be 36 for the study exceeded 90% power at a significance level of 0.05 with a 95% confidence interval and a medium effect size. Considering the possibility of data loss for various reasons, 51 patients who met the research criteria were included in the study. However, the study was completed with 43 patients due to death (5 patients), relatives' request to withdraw (2 patients) and excessive reaction to audible stimuli (1 patient). This study included 43 patients with different levels of consciousness. After completing the study, the post hoc power analysis was applied to calculate the adequacy of the sample size. It was determined that the study's effect size was 2.91, and the study power was 0.99. This result indicated the sample adequacy (Figure 1).

Inclusion criteria were being older than 18 years without psychiatric disorders, being admitted to the intensive care unit for > 48 h, receiving no sedation and drugs (e.g., digoxin, adrenaline and dopamine) that affect blood pressure (BP) and HR and having no hearing problem.

2.2 | Data Collection Tools

Age, gender, reason for and duration of hospitalisation information for the patients were recorded. In evaluating the effect of auditory stimuli, vital signs and level of consciousness were considered dependent variables. Vital signs include parameters such as HR, SBP, DBP and RR. These parameters were obtained automatically from the bedside hospital monitor as the patient was monitored. The monitor measured these parameters continuously with sensors and automatic cuffs and recorded the data in real time. The monitors are calibrated.

The patient's level of consciousness was evaluated with the Glasgow Coma Scale (GCS). The scale was developed by Teasdale and Jennett (1974). The GCS consists of three components: eye-opening, motor response and verbalisation, and the total score ranges between 3 and 15. It measures eye-opening (1–4), motor activity (1–6) and verbalisation (1–5). A total score of 3–7, 8–12 and 13–15 signifies a severe, moderate and mild neurological problem, respectively (Teasdale and Jennett 1974). The GCS had high internal consistency with a Cronbach's alpha of 0.85 (Sadaka et al. 2012).

2.3 | Determining the Sounds

2.3.1 | Music

The music was determined by receiving expert opinion from the Centre for the Research and Promotion of Turkish Music. A piece of segah, a tune in classical Turkish music, was proposed because it eliminates sleeplessness and decreases HR (Centre for the Research and Promotion of Turkish Music (TÜMATA) 2024). All of the patients included in the study listened to the segah maqam. The expert opinion of nursing faculty members was obtained on the suitability of segah maqam for intensive care patients. Thus, the music was decided.

2.3.2 | Creation of Nature Sounds

An arranger helped create the nature sounds. A 30-min record was compiled from sounds of birds, light rain, flowing rivers, waterfalls, sea waves, mild breeze, a walk in the forest and the sounds of some farm animals. Nature-based sounds were presented to the expert opinion of the faculty members of the Faculty of Nursing. Thus, nature sounds were decided.

2.3.3 | Creation of the Voice Records of Patients' Relatives

Voice recordings from the relatives of each patient were obtained from the patient's parents or siblings. It was decided together with the family members from whom the voice recordings would be obtained. The 30-min audio recording of the selected family member was recorded in a quiet room. The patient's relatives were informed that they should not cry for the patient during the voice recording. The research team listened to the voice recording of the patient's relatives, and its suitability for the patient was evaluated. While creating the voice recordings, special attention was paid to selecting the person who emotionally connected with the patients. The voice of the family member with whom the patient had problems, resentment, or bad memories was not played to the patient. Relatives of the patients were asked to answer the following open-ended question: 'If you were with your patient right now, what would you say to him?' A record of 30 min created by the sounds of the patients' relatives included:

- Introduction of the patient's relatives.
- Informal addressing of the patients with their names.
- Feelings as expressed by the patient's relatives.
- Information about the family members and friends with their names.
- Feelings as expressed by the other family members.
- Brief information about the current condition of the patients.
- A pleasant memory from both the distant and recent past.
- Narration of the experience of a day that they would spend together after being discharged from the hospital.
- Thoughts that provide moral support, motivation, love, confidence and social support.

Thus, the voices of relatives are individually prepared for each patient.

2.4 | Sound Interventions and Silent Headphone Procedure

Consent for the study was obtained from the patients or their legal representatives before the interventions. Auditory stimuli were provided to the patients between 16:00 and 18:00 h when environmental stimuli were less, and no intervention other than routine care was performed. Patients ($n = 43$) listened to music, nature-based sounds and the voices of the patients' relatives for 30 min once a day at 1-day intervals by the researchers.

2.4.1 | Carryover Effects and Washout Period

A 1-day washout period was applied between each auditory intervention to alleviate concerns about possible carryover effects due to the sequential application of all auditory stimuli and the silent headphones. This period was determined as a sufficient time for the impact of the previous stimulus to disappear and the subsequent intervention to be unaffected. Furthermore, randomisation of the order of the stimuli was an additional measure to reduce the risk of bias due to the order of the interventions.

2.5 | Randomisation and Blinding

The order of application of three different sound stimuli and silent headphones was randomised to avoid bias. The methods were categorised as A, B, C and D. The researcher wrote the names of the methods on four pieces of paper to determine which methods would be A, B, C and D and drew them in order. Accordingly, Method A: nature-based sounds, Method B: music, Method C: silent headphones and Method D: voices of the patient's relatives. The pieces of paper on which Methods A, B, C and D were written separately for each patient were drawn by lot by an independent nurse from a bag. Thus, the patient-specific application order of the three different sound stimuli and silent headphones was determined.

In this study, although randomisation of the sequence of auditory stimuli was achieved, researchers and patients were not completely blinded. This is because during the study, patients directly experience which auditory stimuli they listen to, and the researchers perform the interventions. Therefore, blinding of researchers and patients was not practically possible. However, the person performing the statistical analyses was blinded. The data were analysed by an independent statistician who was not involved in other stages of the study.

The volume of the auditory stimuli was set to 50 dB. All auditory stimuli were played to the patient for 30 min. These sounds were provided to the patients with over-ear headphones to prevent environmental stimuli and noise. To obtain the control data of the study, the same patients wore headphones for 30 min, but no sound was provided. Auditory stimuli and silent headphones were given to the patients while they were supine or semi-supine in their beds. During the auditory stimulus and silent headphone application, the patients were not intervened, touched and visitors were not allowed near the patients unless there was an emergency and no medical intervention was required. Vital signs and GCS were measured 30 min before, immediately before, immediately after and 30 min after auditory stimulus and silent headphone application.

2.6 | Statistical Analysis

Statistical analyses were performed using SPSS. The data were first subjected to descriptive statistics to obtain mean and percentage distribution. The Kolmogorov–Smirnov test was used to assess the normal distribution of the variables ($p > 0.05$). While the difference between the means of normally distributed repeated measures was determined using ANOVA, the Bonferroni test performed its advanced analysis. While the difference between the means of repeated measures showing no normal distribution was determined using the Friedman test, its advanced analysis was performed using the Wilcoxon test. Statistical significance was declared at $p < 0.05$.

2.7 | Ethical Considerations

Official permissions were obtained from the Atatürk University Faculty of Health Sciences Ethics Committee before the study began. Informed consent was obtained from the families of patients before starting the research. In addition, verbal consent was obtained from the conscious patients themselves to participate in the study.

The patient's vital signs and consciousness levels were carefully monitored during the intervention. No emergency developed in the patients; therefore, the predetermined emergency response plan was not used. Within the scope of safety protocols, sound levels were kept at 50 dB, and the patient's comfort was constantly monitored. In addition, a medical staff member authorised to stop the intervention in case of an adverse patient reaction was always present. Patient safety was prioritised during all interventions. Only one patient had a behavioural overreaction to the sound stimulus, and the intervention was terminated, and the patient was excluded from the study.

3 | Results

The patients (51.2% female) were aged an average of 56.93 ± 19.10 years and had a mean GCS of 7.44 ± 3.27. The frequency of patients with severe, moderate and mild unconsciousness was 51.2%, 37.2% and 11.6%, respectively, on the first day of data collection. The patients were hospitalised in the intensive care unit due to neurological (25.6%), metabolic (53.5%) and both neurological and metabolic reasons (20.9%) (Table 1).

TABLE 1 | Patient's clinical characteristics.

Characteristics	Mean	SD
Age (year)	56.93	19.10
On the day of hospitalisation	8.58	9.23
GCS score[a]	7.44	3.27
Gender	*n*	%
Male	21	48.8
Female	22	51.2
Consciousness level[a]		
3–7	22	51.2
8–12	16	37.2
13–15	5	11.6
Reason for hospitalisation		
Neurological causes[b]	11	25.6
Metabolic causes[cs]	23	53.5
Neurological and metabolic causes	9	20.9

[a]On the first day of data collection.
[b]Head injury, subarachnoid haemorrhage, brain tumours and encephalopathy.
[c]Cancer, heart failure, diabetes, hypertension, cirrhosis, poisoning, chronic renal failure, myocardial infarction and cardiac arrest.

The difference between the mean HR scores of the patients who listened to the music stimulus was found to be statistically significant ($p = 0.020$). In addition, a statistically significant difference was found between the GCS score averages of the patients who listened to music ($p < 0.001$). There was no statistically significant difference between the mean SBP, DBP and RR of the patients who listened to music ($p > 0.05$).

The difference between the mean HR scores of the patients who listened to the nature sound stimulus between the measurements within the group was found to be statistically significant ($p = 0.009$). A statistically significant difference was found between the mean GCS scores of the patients who listened to the nature sound stimulus ($p = 0.001$). There was no statistically significant difference between the mean SBP, DBP and RR of the patients who listened to nature sounds ($p > 0.05$).

A statistically significant difference was found between the measurements of HR ($p = 0.001$), RR ($p = 0.001$) and GCS score averages ($p < 0.001$) of the patients who listened to the voice of relatives stimulus ($p = 0.001$). No statistically significant difference was found in the SBP, DBP mean scores between measurements in the stimulus of the voice of relatives ($p > 0.05$) (Table 2).

The difference between the within-group HR mean scores of the patients belonging to the music group who had a consciousness level score of 8–12 ($p = 0.038$) and the total GCS mean scores of the patients who were included in the music group and had consciousness level scores of 3–7 ($p = 0.014$) and 8–12 ($p = 0.035$) was statistically significant.

TABLE 2 | Within-group comparison of vital signs and GCS mean scores of the patients.

		First (30 min before) $\bar{X} \pm SD$	Second (immediately before) $\bar{X} \pm SD$	Third (immediately after) $\bar{X} \pm SD$	Fourth (30 min after) $\bar{X} \pm SD$	**Test, p, η^2**	**Advanced analysis**	**MD, (95% CI)**
Music group	HR	100.74 ± 17.51	102.74 ± 19.06	98.95 ± 17.95	99.05 ± 18.56	$F = 3.393$, $p = \mathbf{0.020}$, $\eta^2 = 0.075$	2 > 3, 2 > 4[a]	3.79 (0.02 to 7.56) 3.69 (0.30 to 7.08)
	SBP	119.28 ± 22.53	121.35 ± 23.98	119.28 ± 24.38	119.63 ± 24.76	$\chi^2 F = 1.636$, $p = 0.651$, $\eta^2 = 0.013$		
	DBP	67.28 ± 11.31	69.21 ± 11.87	69.00 ± 12.03	68.74 ± 13.29	$F = 0.920$, $p = 0.423$, $\eta^2 = 0.021$		
	RR	25.53 ± 7.92	26.63 ± 7.62	25.53 ± 7.38	24.86 ± 7.12	$\chi^2 F = 6.030$, $p = 0.110$, $\eta^2 = 0.047$		
	GCS	7.49 ± 3.85	7.58 ± 3.74	7.98 ± 3.70	7.86 ± 3.77	$\chi^2 F = 23.607$, $\mathbf{p < 0.001}$, $\eta^2 = \mathbf{0.183}$	1 < 3, 1 < 4, 2 < 3, 2 < 4*	
Nature-based sound group	HR	99.65 ± 22.74	99.30 ± 22.29	96.14 ± 22.15	97.91 ± 22.56	$F = 5.086$, $p = \mathbf{0.009}$, $\eta^2 = \mathbf{0.108}$	1 > 3, 2 > 3[a]	3.51 (0.07 to 6.94) 3.16 (0.01 to 6.31)
	SBP	118.63 ± 20.86	116.44 ± 21.56	118.60 ± 21.06	117.47 ± 21.81	$F = 1.213$, $p = 0.308$, $\eta^2 = 0.028$		
	DBP	68.88 ± 12.19	67.28 ± 12.23	68.37 ± 13.19	67.81 ± 13.90	$F = 1.050$, $p = 0.367$, $\eta^2 = 0.024$		
	RR	24.58 ± 7.75	24.44 ± 7.42	22.51 ± 6.87	24.00 ± 8.12	$F = 2.259$, $p = 0.113$, $\eta^2 = 0.051$		
	GCS	7.58 ± 3.84	7.77 ± 3.76	8.09 ± 3.71	8.05 ± 3.76	$\chi^2 F = 20.294$, $\mathbf{p < 0.001}$, $\eta^2 = \mathbf{0.157}$	1 < 3, 1 < 4, 2 < 3, 2 < 4*	

(Continues)

TABLE 2 | (Continued)

		First (30 min before) $\bar{X} \pm SD$	Second (immediately before) $\bar{X} \pm SD$	Third (immediately after) $\bar{X} \pm SD$	Fourth (30 min after) $\bar{X} \pm SD$	**Test, p, η^2**	**Advanced analysis**	**MD, (95% CI)**
Voices of patients' relatives group	HR	97.70 ± 23.12	97.81 ± 21.46	101.70 ± 21.38	98.05 ± 22.47	$F = 5.868$, $p = \mathbf{0.001}$, $\eta^2 = \mathbf{0.123}$	1 < 3, 2 < 3, 3 > 4[a]	−4.0 (−7.42 to −0.57) −3.88 (−7.18 to −0.57) 3.65 (0.68 to 6.61)
	SBP	116.53 ± 22.46	115.74 ± 23.60	117.63 ± 23.06	117.84 ± 22.96	$F = 0.809$, $p = 0.454$ $\eta^2 = 0.019$		
	DBP	68.77 ± 11.97	66.37 ± 11.82	67.81 ± 11.40	67.37 ± 12.47	$F = 1.190$, $p = 0.311$, $\eta^2 = 0.028$		
	RR	23.28 ± 8.13	23.16 ± 7.72	25.30 ± 8.89	23.93 ± 8.62	$\chi^2F = 15.843$, $\mathbf{p = 0.001}$, $\eta^2 = \mathbf{0.123}$	1 < 3, 2 < 3, 4 < 3*	
	GCS	7.53 ± 4.03	7.81 ± 3.96	8.19 ± 3.98	7.95 ± 3.97	$F = 9.241$, $\mathbf{p < 0.001}$ $\eta^2 = \mathbf{0.180}$	1 < 3, 2 < 3[a]	−0.65 (−1.12 to −0.17) −0.37 (−0.64 to −0.09)
Control group	HR	96.67 ± 21.69	95.84 ± 21.81	98.05 ± 21.31	97.88 ± 20.27	$F = 1.041$, $p = 0.331$, $\eta^2 = 0.024$		
	SBP	118.37 ± 20.51	119.95 ± 21.25	118.65 ± 22.81	120.02 ± 19.04	$\chi^2F = 5.687$, $p = 0.128$, $\eta^2 = 0.044$		
	DBP	67.77 ± 11.27	67.42 ± 12.37	67.09 ± 12.08	68.60 ± 11.84	$F = 0.610$, $p = 0.574$, $\eta^2 = 0.014$		
	RR	24.95 ± 7.33	24.79 ± 8.18	23.86 ± 8.26	25.12 ± 8.48	$\chi^2F = 3.229$, $p = 0.358$, $\eta^2 = 0.025$		
	GCS	7.70 ± 3.99	7.77 ± 3.98	7.93 ± 3.96	7.81 ± 3.99	$\chi^2F = 0.563$, $p = 0.905$, $\eta^2 = 0.004$		

Note: χ^2F = Friedman Test F = ANOVA η^2 = partial eta square. Values are trend estimate (95% CI). Bold value indicates $p < 0.05$.
Abbreviations: CI = confidence interval, CL = consciousness level, DBP = diastolic blood pressure, GCS = Glasgow Coma Scale, HR = heart rate, MD = mean difference, RR = respiratory rate, SBP = systolic blood pressure.
[a]Bonferroni test.
*Wilcoxon signed-rank test.

The difference between the within-group HR ($p < 0.001$) and the total GCS ($p = 0.001$) mean scores of the patients who belonged to the nature sound group who had a consciousness level score of 8–12 was statistically significant.

The difference between the within-group HR ($p = 0.027$) and RR ($p = 0.024$) mean scores of the patients who were included in the patient's relative's sound group and had a consciousness level score of 8–12 and the total GCS mean scores of the patients who had consciousness level scores of 3–7 ($p = 0.024$) and 8–12 ($p < 0.001$) was statistically significant (Table 3).

4 | Discussion

This study dealt with the effects of music, nature sounds and patients' relatives' voices on the vital signs and GCS mean score in intensive care patients. In this study, it was found that the pulse rate of the patients decreased significantly after listening to music. Additionally, the significant difference between the HR mean scores before and 30 min after listening to music indicated the sustaining effect of music. Literature suggests that music decreases HR (Golino et al. 2023). Music used in these studies is typically observed to be classical, wordless, slow-tempo, mild-tone, fluent, rhythmic and relaxing. Music affects the autonomic nervous system, causing physiological changes by increasing parasympathetic activity (Mojtabavi et al. 2020). These changes vary according to the music's rhythm, tone and tune. Music tempo is one of the most important regulators of music-related arousal and relaxation. Music with a slow tempo (60–80 bpm), such as meditative music, is often associated with reductions in HR. Soothing music with a relatively low rhythm and mild tone activates the parasympathetic nervous system. Stimulating the parasympathetic nervous system decreases physiological indicators such as HR, BP and RR (de Witte et al. 2020). A significant decrease in the HR mean scores of the patients in the study was associated with the relaxing characteristics of the tune segah (Centre for the Research and Promotion of Turkish Music (TÜMATA) 2024). The relaxation response is facilitated as the body's rhythms are synchronised with the rhythm of the segah maqam. The rhythm of music can directly affect emotions and modulate behaviour by altering physiological functions such as HR, blood pressure and respiration. Music also affects other parts of the brain, which in turn affects mood through the release of neurotransmitters such as dopamine. Music affects the autonomic nervous system and the cardiovascular system by triggering relaxation of the body. Under the influence of music without soft, slow, non-lyrical, harmonic and percussive instruments, the parasympathetic system predominates over the sympathetic system, leading to regular deep breathing and a decrease in HR with muscle relaxation responses on electroencephalogram alpha brain wave frequency (Darki et al. 2022). Conversely, this indicates that faster-paced music may stimulate the autonomic nervous system more intensely, leading to heightened cardiovascular responses, whereas the slower has a more calming effect. Thus, music genre plays a crucial role in influencing physiological parameters (Sharma et al. 2024). Music therapy has been proven effective in modulating the stress response, reducing anxiety symptoms and promoting relaxation in critical patients. A systematic review found a consistent association between music therapy and a reduction in anxiety and stress in critical patients (Umbrello et al. 2019). One study found that music therapy significantly reduced SBP, HR and anxiety levels in hypertensive patients (Lorber and Divjak 2022). One study reported that music therapy was highly effective in reducing anxiety and stabilising physiological parameters in conscious intensive care patients. Music is a unique stimulus because it causes both physiological and psychological responses in the individual (Chahal et al. 2021).

The study found that the mean scores of SBP, DBP and RR of the patients did not change with the effect of music. A meta-analysis of music interventions found that music had a more significant effect on HR than blood pressure (de Witte et al. 2020). A study in patients with peripherally placed central catheters showed that the patients in the experimental group receiving passive music therapy had a statistically significant decrease in anxiety, DBP and HR over time compared to the control group, but no significant difference was identified in SBP and RR (Mou et al. 2020). On the other hand, a meta-analysis found that music interventions reduced anxiety in intensive care patients but had no effect on systolic/DBP, respiration, or HR levels related to physiological stress (Erbay Dalli et al. 2023).

In this study, it was determined that the mean total GCS scores of the patients increased significantly after listening to music. An increase in the total GCS scores of the patients was associated with the stimulating effect of music. It was found that music stimuli given to intensive care patients with head trauma for 15 min each for 7 days increased the level of consciousness of the patients (Yekefallah et al. 2021). In a systematic meta-analysis examining music interventions for disorders of consciousness, it was found that music therapy was significantly associated with facial expression and SBP but had no significant effect on electroencephalogram indices (Li et al. 2020). It is stated that music therapy as a neuromodulation method can help increase the cognitive levels of patients with impaired consciousness (Shou et al. 2021). Music plays an important role in emotional, cognitive and motor functions. Due to the effect of music on the brain, listening to music is widely used in neurological rehabilitation of disorders of consciousness (Li et al. 2020; Bender et al. 2023). Brain imaging studies have shown that listening to music produces neural activity in many frontal, temporal, subcortical and cerebellar regions, cortical and subcortical areas of the brain associated with limbic and paralimbic regions, attention, memory and motor functions (Chan and Han 2022). It is stated that sensory stimulation with music can stimulate neural networks, accelerate brain plasticity and prevent sensory deprivation (Spaccavento et al. 2024). This study shows that providing music to intensive care patients is an alternative that can be used in sensory stimulation programmes.

In this study, intensive care unit patients' HRs decreased significantly after listening to nature sounds. This may be due to the relaxing effect of nature sounds. One study found that nature-based sound therapy significantly reduced stress levels, SBP and HR in patients with myocardial infarction (Fatehimoghadam et al. 2023). Rajora et al. (2019) found that nature sounds lowered anxiety and agitation levels in mechanically ventilated patients. Kurt and Celik (2019) found that nature-based sound therapy applied in the process of separation from the mechanical ventilation process of intensive care patients effectively

TABLE 3 | Within-group comparison of significant variables according to the level of consciousness.

		CL	First (30 min before) $\bar{X} \pm SD$	Second (immediately before) $\bar{X} \pm SD$	Third (immediately after) $\bar{X} \pm SD$	Fourth (30 min after) $\bar{X} \pm SD$	Test, p, η^2	Advanced analysis*
Music group	HR	3–7	97.91 ± 20.10	99.17 ± 21.84	96.78 ± 21.08	96.43 ± 21.48	$\chi^2F = 3.284$, $p = 0.350$, $\eta^2 = 0.048$	
		8–12	107.92 ± 11.85	108.38 ± 11.55	102.31 ± 11.01	104.31 ± 9.97	$\chi^2F = 3.762$, $\mathbf{p = 0.038}$, $\boldsymbol{\eta^2 = 0.239}$	2 > 3
		13–15	96.71 ± 14.96	104.00 ± 20.22	99.86 ± 18.41	97.86 ± 20.81	$\chi^2F = 1.629$, $p = 0.653$, $\eta^2 = 0.078$	
	GCS	3–7	4.39 ± 1.55	4.57 ± 1.53	5.04 ± 1.71	4.83 ± 1.58	$\chi^2F = 10.607$, $p = \mathbf{0.014}$, $\boldsymbol{\eta^2 = 0.154}$	1 < 3 2 < 3
		8–12	9.69 ± 1.49	9.69 ± 1.18	10.00 ± 1.08	10.00 ± 1.08	$\chi^2F = 8.600$, $p = \mathbf{0.035}$, $\boldsymbol{\eta^2 = 0.221}$	2 < 3, 2 < 4
		13–15	13.57 ± 0.53	13.57 ± 0.53	13.86 ± 0.90	13.86 ± 0.90	$\chi^2F = 6.000$, $p = 0.112$, $\eta^2 = 0.286$	
Nature-based sound group	HR	3–7	99.00 ± 24.74	98.05 ± 23.39	97.00 ± 23.71	97.67 ± 23.39	$\chi^2F = 3.563$, $p = 0.313$, $\eta^2 = 0.057$	
		8–12	104.31 ± 20.24	104.06 ± 20.17	97.06 ± 19.76	101.75 ± 22.14	$\chi^2F = 17.742$, $\mathbf{p < 0.001}$, $\boldsymbol{\eta^2 = 0.370}$	1 > 3, 2 > 3, 4 > 3
		13–15	89.50 ± 21.76	91.00 ± 24.52	90.67 ± 25.66	88.50 ± 21.51	$\chi^2F = 0.684$, $p = 0.877$, $\eta^2 = 0.038$	
	GCS	3–7	4.52 ± 1.36	4.57 ± 1.28	4.95 ± 1.56	4.81 ± 1.32	$\chi^2F = 6.273$, $p = 0.099$, $\eta^2 = 0.100$	
		8–12	9.00 ± 2.09	9.44 ± 1.41	9.81 ± 1.37	9.88 ± 1.50	$\chi^2F = 17.038$, $p = \mathbf{0.001}$, $\boldsymbol{\eta^2 = 0.355}$	1 < 3, 1 < 4, 2 < 3, 2 < 4
		13–15	14.50 ± 0.54	14.50 ± 0.54	14.50 ± 0.54	14.50 ± 0.54	—	

(Continues)

TABLE 3 | (Continued)

		CL	First (30 min before) $\overline{X} \pm SD$	Second (immediately before) $\overline{X} \pm SD$	Third (immediately after) $\overline{X} \pm SD$	Fourth (30 min after) $\overline{X} \pm SD$	Test, p, η^2	Advanced analysis*
Voices of patients' relatives group	HR	3–7	94.18 ± 25.62	95.73 ± 24.22	96.41 ± 23.16	95.59 ± 24.33	$\chi^2F = 3.146$, $p = 0.370$, $\eta^2 = 0.048$	
		8–12	103.15 ± 22.51	101.77 ± 20.36	110.00 ± 18.53	103.15 ± 22.56	$\chi^2F = 9.192$, $\mathbf{p = 0.027}$, $\mathbf{\eta^2 = 0.236}$	1 < 3, 2 < 3 4 < 3
		13–15	98.50 ± 16.57	97.13 ± 15.84	102.75 ± 18.07	96.50 ± 17.62	$\chi^2F = 2.850$, $p = 0.415$, $\eta^2 = 0.119$	
	RR	3–7	21.82 ± 8.43	21.14 ± 7.48	22.32 ± 7.76	21.86 ± 8.49	$\chi^2F = 3.565$, $p = 0.312$, $\eta^2 = 0.054$	
		8–12	23.46 ± 7.52	24.15 ± 7.23	26.62 ± 8.79	24.69 ± 8.42	$\chi^2F = 9.467$, $\mathbf{p = 0.024}$, $\mathbf{\eta^2 = 0.243}$	1 < 3, 2 < 3
		13–15	27.00 ± 7.98	27.13 ± 8.20	31.38 ± 9.38	28.38 ± 8.45	$\chi^2F = 7.560$, $p = 0.056$, $\eta^2 = 0.315$	
	GCS	3–7	4.50 ± 1.53	4.64 ± 1.52	4.95 ± 1.86	4.73 ± 1.57	$\chi^2F = 9.441$, $\mathbf{p = 0.024}$, $\mathbf{\eta^2 = 0.143}$	1 < 3
		8–12	8.38 ± 1.60	9.08 ± 0.64	9.77 ± 0.83	9.38 ± 0.87	$\chi^2F = 20.042$, $\mathbf{p < 0.001}$, $\mathbf{\eta^2 = 0.514}$	1 < 3, 1 < 4, 2 < 3, 4 < 3
		13–15	14.50 ± 0.75	14.50 ± 0.75	14.50 ± 0.75	14.50 ± 0.75	—	

Note: χ^2F = Friedman Test. Bold value indicates $p < 0.05$.
Abbreviations: CL = consciousness level, GCS = Glasgow Coma Scale, HR = heart rate, RR = respiratory rate.
*Wilcoxon signed-rank test, $p < 0.05$.

maintains the arterial BP, HR and RR in the normal range and reduces pain and anxiety. In this study, nature-based sounds decreased HR due to decreased sympathetic nervous system activity. A systematic review emphasised the potential of nature-based sounds to reduce agitation in adult intensive care patients (Adams et al. 2023). Nature-based sounds reduce physiological responses to stress (Fatehimoghadam et al. 2023). It is believed that natural sounds decrease the perception of environmental sounds and noise, protect patients from environmental stressors, support the feeling of relaxation and decrease the stress response. These suggest that nature-based sounds are important sensory stimuli for unconscious and conscious patients. A comprehensive review emphasises that exposure to nature's visual and auditory stimuli in the hospital has a real but small therapeutic effect and positively affects pain, anxiety and patient satisfaction, with more exposure to nature providing more beneficial effects (Guidolin et al. 2024). In this study, the GCS scores of the patients who listened to nature-based sounds were increased. This situation may be related to the sensory input of nature sounds. Nature sounds can affect cognition and emotional states and play an important role in stimulating brain and neurotransmitter cycles (Bahonar et al. 2019). It was determined that nature sounds played to comatose patients with head trauma increased the level of consciousness and decreased the duration of coma, causing a sudden and short-term decrease in physiological indices such as pulse, SBP and mean arterial pressure (Najafi Ghezeljeh et al. 2019). A systematic review emphasises that exposure to the natural environment increases feelings of relaxation and recurrence, improves cognitive functions and mental health (Bolouki 2022).

According to the findings of this study, an increase in the patients' HR and RR mean scores after listening to their relatives' voices could be associated with the excitement caused by hearing the sounds of their world. Auditory stimuli provided by family members are considered emotional and sensory stimuli for patients. The voices of family members have a special meaning for the patient. Listening to the voice recordings of family members provides patients with meaningful sensory stimuli. Emotional stimulation provided by the voices of family members can stimulate the sympathetic nervous system, particularly affecting the reticular activating system. Activation of this system increases norepinephrine levels and causes arousal and consciousness (Cheng et al. 2018; Salmani et al. 2017). In this study, the recorded sound stimulus provided to patients was provided by the family member closest to the patient, as recommended in the literature (Salmani et al. 2017). On the other hand, in a study conducted on patients with brain injuries, a recorded combination of family members' voices and light instrumental music led to a significant decrease in SBP, DBP, RR and HR in the intervention group (Froutan et al. 2020). In one study, it was determined that the anxiety levels of patients with myocardial infarction hospitalised in coronary intensive care decreased significantly after listening to the voice recording of their relatives (Ugurlu and Alemdar 2025). In a study in which coma patients were made to listen to the voice stimulation of close relatives for 5 days, no change was observed in their physiological parameters (Varghese et al. 2021). It is observed that familiar sounds, such as those of family members, affect vital signs differently in intensive care patients. This may be due to different numbers of days, the nature of the family voice and the duration of the intervention. One study found that auditory and tactile sensory stimulation provided by the family once a day for 2 weeks stabilised physiological parameters. This was explained by the balancing effects of the stimuli on both the sympathetic and parasympathetic nervous systems (Ahmed et al. 2023). It is thought that if the patients were provided with planned and regular verbal communication with their relatives, this excitement would be replaced by calmness and relaxation. In the intensive care unit where the patient is a stranger, hearing voices from his/her familiar world may help him/her gain control and build trust. Providing sensory stimuli to intensive care unit patients with voice recordings of family members may offer new opportunities to ensure patients' comfort and provide family-oriented care.

In this study, the consciousness level of the patients increased when they listened to the voices of their relatives. For this reason, we think that the voice of the patient's relatives is an important, powerful and meaningful emotional stimulus for patients. In a study, early family-centered auditory emotional stimulation was more effective in improving consciousness levels than sensory stimulation provided by an unfamiliar trained individual in patients with brain injuries (Salmani et al. 2017). In a study, it was determined that coma patients who were given auditory stimuli with the voice of their close relatives had a positive effect on the level of consciousness and behavioural responses (Varghese et al. 2021). The quality of the stimulus is important in sensory perception. Family-centered emotional stimulation is more effective than sensory stimulation in improving consciousness levels in patients in a coma. Significant stimuli decrease the risk of sensory deprivation and cause a strong response towards the stimulus (Salmani et al. 2017). A meta-analysis found that sensory-emotional stimulation provided by family members was more effective in enhancing consciousness levels in patients with traumatic brain injury than routine care and sensory stimulation applied by nurses (Zuo et al. 2021). It has been reported that verbal stories/messages delivered to patients with impaired consciousness by family members or loved ones seem to be simpler and more economical than multiple stimulation programmes in practice (Lancioni et al. 2022). Stimuli may be considered effective on the consciousness level of the patients given that it holds emotional value and meaning for them. Since unconscious patients have no control over themselves and their environment, talking to comatose patients has therapeutic value.

In this study, the sounds of music and nature sounds significantly decreased the HR of patients with only a level of consciousness of 8–12. Music and nature sounds decreased the pulse rate in patients in a state of stupor and lethargia, whereas the pulse rate was not affected in comatose patients. One study found that natural sounds, classical music, can help patients feel less anxious by lowering cortisol levels, blood pressure and HR (Ugraş et al. 2018). In addition, the HR and RR of patients with a level of consciousness of 8–12 increased only by the voice of their relatives. The voice of relatives as a strong sensory stimulus is thought to initiate activation of the sympathetic nervous system. This result shows that different auditory stimuli may have different effects on patients, which should be considered when choosing auditory stimuli. In a meta-analysis, it was determined that patients with impaired consciousness who received music intervention showed a significant increase in facial expression and a decrease in SBP, while no significant effect was observed in DBP, pulse and respiration (Li et al. 2020). In particular, the reason why the pulse rates, SBP, DBP and respiration rates of comatose patients in this study were not affected by music, nature sounds and the voices of relatives may be due to individual differences in coma patients participating in similar studies. As noted in the literature, the rhythm, tone and personal meaning of music can shape an individual's emotional state and physiological responses. For example, while it may provide relaxation in some individuals, it may create a neutral or stimulating effect in others (Umbrello et al. 2019).

This study revealed that the music and the voice of the patient's relatives increased the consciousness level of the patients whose GCS scores were 3–7 and 8–12. On the other hand, nature-based sounds increased the level of consciousness of only those with a GCS score of 8–12. One study found that nature sounds played twice a day for 2 weeks in traumatic coma patients increased the level of consciousness and reduced the duration of the coma (Bahonar et al. 2019). Tavangar et al. (2015) also provided the sounds of family members for patients with a GCS score of ≤8 and observed a significant increase in the GCS mean scores at the end of the tenth day, as compared to the control group In another study conducted on coma patients with head injuries, a significant increase in consciousness level was found in the experimental group, where recordings of family members' voices were played (Mohammadi et al. 2019). A study found that organised auditory and tactile stimulation administered by family members once a day for 2 weeks increased the level of consciousness and reduced the incidence of physiological adverse events and the average length of intensive care unit stay of patients with traumatic brain injury (Ahmed et al. 2023). Sensory stimuli, including auditory stimuli, stimulate the brain by increasing cognitive function and activating the reticular activation system, helping the patient to come out of the coma (Bahonar et al. 2019). Emotional stimulation provided by family members affects the reticular activating system in the brain, increases sympathetic activity, increases norepinephrine levels in nerve terminals and leads to arousal and consciousness. In Cheng et al. (2018) study, it is stated that sensory stimulation programs may not be sufficient to restore consciousness in coma patients. In the same study, higher coma recovery score, arousal and oromotor functions were observed in patients with minimal consciousness state. This study showed that auditory stimulation with music and a familiar voice, such as that of family members, is effective in increasing the level of consciousness in comatose patients. In this study, the effect of all three auditory stimuli increased the level of consciousness in patients with a level of consciousness of 8–12, indicating that it may reduce problems such as sensory deprivation and sensory overload in these patients. Therefore, intensive care nurses can use the auditory stimuli in this study to provide a healing environment for patients.

In the literature, most studies examine the effect of auditory stimuli by dividing them into experimental and control groups, which may cause differences between individuals in the perception of stimuli. According to Roper, Logan and Tierney's Life Model, individuals may react differently to the same stimuli according to their life experiences (Holland and Jenkins 2019). In this study, the same sample was used as both control and intervention groups. Three auditory stimuli (music, nature sounds and sounds of relatives) and silent headphones were applied to the same patients. This design minimises individual differences in the control and intervention groups and enables more reliable comparisons to be made according to their level of consciousness. However, using the same sample in both the control and intervention groups may lead to potential biases such as the carryover effect. A 1-day washout period was applied between each auditory intervention to minimise this bias. This period was considered sufficient for the impact of the previous stimulus to disappear and for the new stimulus to be evaluated independently. In addition, intervention sequences were randomised, which reduced potential biases due to intervention order.

4.1 | Limitations of the Study

The present study has some limitations. This study was conducted with only one type of music, and the patient's preferences were not considered. The perception of relaxing music may vary according to each patient. Segah maqam is a type of music specific to Turkish culture, and patients' reactions to it may vary in different cultural contexts. For this reason, it is essential to give patients the possibility to choose their music. Due to the strong emotional components of the music experience, listening to the patient's preferred music may be more meaningful and rewarding for the patient. This situation was not taken into account in our study, and we suggest that music choices based on patients' personal and cultural preferences should be taken into consideration in future studies.

Furthermore, our study was limited to intensive care unit patients with neurological and metabolic diseases. Therefore, generalisation of the findings to other patient populations is limited. Patients with different medical conditions may respond differently to auditory stimuli, especially regarding their level of consciousness and vital signs. In order to generalise the findings to larger patient groups, similar studies with different populations are necessary.

In addition, pain levels of the patients were not measured in the study. However, pain is an important factor in vital signs and level of consciousness. Measurement of pain level is another important factor that should be considered in future studies.

5 | Conclusion

In conclusion, this study demonstrated that the HR of patients with a level of consciousness of 8–12 decreased when they listened to music and nature-based sounds, while their HR and RR increased when they listened to the voices of their relatives. Moreover, it was found that music and the voice of their relatives increased the GCS score of patients with a level of consciousness of both 3–7 and 8–12, while nature-based sounds increased the GCS score of those with only a level of consciousness of 8–12. Auditory stimuli are selected because music –the tune segah– and nature sounds stimulate the parasympathetic nervous system, whereas the sounds of the patients' relatives stimulate the sympathetic nervous system. It has been found that different types of audible stimuli can have different effects, in which vital functions are affected by sounds. Music, nature-based sounds and sounds of the patients' relatives support sensory functions and affect the patients' level of consciousness positively.

When choosing the sound stimuli to give to the patient, the effects of the sound stimuli and the patient's condition should be considered. Music, nature-based sounds and voices of patient relatives can be used in sensory stimulus programmes as they warn patients and positively affect the level of consciousness. It is advisable to create protocols or guides that will help the intensive care nurse to include sound stimuli in daily care. Standard protocols should be developed for applying auditory stimuli in intensive care units. These protocols should consider factors such as the patient's state of consciousness, type of sound, duration of application and individual patient needs. Different auditory stimuli may have different effects on HR and respiration. In addition, further research on the long-term effects of auditory stimuli and the effects of various types of music or nature sounds is recommended. Our findings support the need for a more in-depth investigation of the effect of auditory stimuli on patient outcomes and the development of new hypotheses in this regard. Furthermore, extensive research can be conducted on how long-term music and/or sound stimuli affect brain activation.

Author Contributions

Meltem Şirin Gök: conceptualisation, methodology, data collection, analysis, interpretation, writing original draft and writing – review. **Reva Balci Akpinar:** conceptualisation, methodology, analysis, interpretation, supervision and writing – critical review and editing.

Acknowledgements

We gratefully thank the patients and their families who participated in this study.

Ethics Statement

The official permissions were obtained from the Atatürk University Faculty of Health Sciences Ethics Committee (2014-3/14).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

Adams, A. M. N., D. Chamberlain, M. Grønkjær, C. Brun Thorup, and T. Conroy. 2023. "Nonpharmacological Interventions for Agitation in the Adult Intensive Care Unit: A Systematic Review." *Australian Critical Care* 36, no. 3: 385–400. https://doi.org/10.1016/j.aucc.2022.02.005.

Ahmed, F. R., A. K. Attia, H. Mansour, and M. Megahed. 2023. "Outcomes of Family-Centred Auditory and Tactile Stimulation Implementation on Traumatic Brain İnjured Patients." *Nursing Open* 10, no. 3: 1601–1610. https://doi.org/10.1002/nop2.1412.

Bahonar, E., T. Najafi Ghezeljeh, and H. Haghani. 2019. "Comparison of Single and Combined Effects of Nature Sounds and Foot Sole Reflexology Massage on the Level of Consciousness in Traumatic Comatose Patients: A Randomized Controlled Clinical Trial." *Holistic Nursing Practice* 33, no. 3: 177–186. https://doi.org/10.1097/hnp.0000000000000326.

Bender, A., B. Eifert, I. Rubi-Fessen, R. J. Jox, P. Maurer-Karattup, and F. Müller. 2023. "The Neurological Rehabilitation of Adults With Coma and Disorders of Consciousness." *Deutsches Ärzteblatt International* 120, no. 37: 605–612. https://doi.org/10.3238/arztebl.m2023.0159.

Bolouki, A. 2022. "Neurobiological Effects of Urban Built and Natural Environment on Mental Health: Systematic Review." *Reviews on Environmental Health* 38, no. 1: 169–179. https://doi.org/10.1515/reveh-2021-0137.

Centre for the Research and Promotion of Turkish Music (TÜMATA). 2024. "Turkish Authorities and Effects." Accessed November 4, 2024. https://tumata.com/muzik-terapi/turk-muzigi-makamlari-ve-etkileri/.

Chahal, J. K., P. Sharma, and H. C. L. Rawat. 2021. "Effect of Music Therapy on ICU Induced Anxiety and Physiological Parameters Among ICU Patients: An Experimental Study in A Tertiary Care Hospital of India." *Clinical Epidemiology and Global Health* 11: 100716. https://doi.org/10.1016/j.cegh.2021.1007162021.

Chan, M. M. Y., and Y. M. Y. Han. 2022. "The Functional Brain Networks Activated by Music Listening: A Neuroimaging Meta-Analysis and Implications for Treatment." *Neuropsychology* 36, no. 1: 4–22. https://doi.org/10.1037/neu0000777.

Cheng, L., D. Cortese, M. M. Monti, et al. 2018. "Do Sensory Stimulation Programs Have an Impact on Consciousness Recovery?" *Frontiers in Neurology* 2, no. 9: 826. https://doi.org/10.3389/fneur.2018.00826.

Darki, C., J. Riley, D. P. Dadabhoy, A. Darki, and J. Garetto. 2022. "The Effect of Classical Music on Heart Rate, Blood Pressure, and Mood." *Cureus* 14, no. 7: e27348. https://doi.org/10.7759/cureus.27348.

de Witte, M., A. Spruit, S. van Hooren, X. Moonen, and G. J. Stams. 2020. "Effects of Music Interventions on Stress-Related Outcomes: A Systematic Review and Two Meta-Analyses." *Health Psychology Review* 14, no. 2: 294–324. https://doi.org/10.1080/17437199.2019.1627897.

Erbay Dalli, Ö., C. Bozkurt, and Y. Yildirim. 2023. "The Effectiveness of Music Interventions on Stress Response in Intensive Care Patients: A Systematic Review and Meta-Analysis." *Journal of Clinical Nursing* 32, no. 11–12: 2827–2845. https://doi.org/10.1111/jocn.16401.

Fatehimoghadam, S., S. Molavynejad, D. Rokhafroz, S. M. Seyedian, and A. Sharhani. 2023. "Effect of Nature-Based Sound Therapy on Stress and Physiological Parameters in Patients With Myocardial Infarction." *Iranian Journal of Nursing and Midwifery Research* 28, no. 4: 436–442. https://doi.org/10.4103/ijnmr.ijnmr_221_21.

Faul, F., E. Erdfelder, A.-G. Lang, and A. Buchner. 2007. "G* Power 3: A Flexible Statistical Power Analysis Programme for the Social, Behavioural, and Biomedical Sciences." *Behavior Research Methods* 39, no. 2: 175–191.

Fisher, A., M. Bellon, S. Lawn, S. Lennon, and M. Sohlberg. 2019. "Family-Directed Approach to Brain Injury (FAB) Model: A Preliminary Framework to Guide Family-Directed Intervention for Individuals With Brain İnjury." *Disability and Rehabilitation* 41, no. 7: 854–860. https://doi.org/10.1080/09638288.2017.1407966.

Froutan, R., M. Eghbali, S. H. Hoseini, S. R. Mazloom, M. S. Yekaninejad, and R. Boostani. 2020. "The Effect of Music Therapy on Physiological Parameters of Patients With Traumatic Brain Injury: A Triple-Blind Randomised Controlled Clinical Trial." *Complementary Therapies in Clinical Practice* 40: 101216. https://doi.org/10.1016/j.ctcp.2020.101216.

Golino, A. J., R. Leone, A. Gollenberg, et al. 2023. "Receptive Music Therapy for Patients Receiving Mechanical Ventilation in the Intensive Care Unit." *American Journal of Critical Care* 32, no. 2: 109–115. https://doi.org/10.4037/ajcc2023499.

Guidolin, K., F. Jung, S. Hunter, et al. 2024. "The Influence of Exposure to Nature on Inpatient Hospital Stays: A Scoping Review." *Health*

Environments Research and Design Journal 17, no. 2: 360–375. https://doi.org/10.1177/19375867231221559.

Holland, K., and J. Jenkins. 2019. *Applying the Roper-Logan-Tierney Model in Practice-E-Book: Applying the Roper-Logan-Tierney Model in Practice-E-Book*. Elsevier Health Sciences.

Hoseini, S. H., M. Eghbali, R. Froutan, S. R. Mazloom, M. S. Yekaninejad, and R. Boostani. 2022. "Effectiveness of Auditory Sensory Stimulation on Level of Consciousness and Cognitive Function in Traumatic Brain İnjury Patients: A Randomised Controlled Clinical Trial." *Nursing Practice Today* 9, no. 4: 349–359. https://doi.org/10.18502/npt.v9i4.11206.

Iyendo, T. O. 2017. "Sound as a Supportive Design Intervention for Improving Health Care Experience in the Clinical Ecosystem: A Qualitative Study." *Complementary Therapies in Clinical Practice* 29: 58–96. https://doi.org/10.1016/j.ctcp.2017.08.004.

Kurt, T., and S. Celik. 2019. "Effect of Nature Based Voice Therapy in the Separation From Mechanical Ventilation Process of Intensive Care Patients." *Cukurova Medical Journal* 44, no. Suppl 1: 119–132.

Lancioni, G. E., N. N. Singh, M. F. O'Reilly, J. Sigafoos, and L. Desideri. 2022. "Behavioral Intervention Approaches for People With Disorders of Consciousness: A Scoping Review." *Disability and Rehabilitation* 44, no. 24: 7677–7692. https://doi.org/10.1080/09638288.2021.1985634.

Li, X., C. Li, N. Hu, and T. Wang. 2020. "Music Interventions for Disorders of Consciousness: A Systematic Review and Meta-Analysis." *Journal of Neuroscience Nursing: Journal of the American Association of Neuroscience Nurses* 52, no. 4: 146–151. https://doi.org/10.1097/JNN.0000000000000511.

Lorber, M., and S. Divjak. 2022. "Music Therapy as an Intervention to Reduce Blood Pressure and Anxiety Levels in Older Adults With Hypertension: A Randomized Controlled Trial." *Research in Gerontological Nursing* 15, no. 2: 85–92. https://doi.org/10.3928/19404921-20220218-03.

Mohammadi, M. K., M. R. Yeganeh, A. M. Ebrahimzadeh, Z. A. Roshan, M. Soodmand, and M. Pouralizadeh. 2019. "The Effects of Familiar Voices on the Level of Consciousness Among Comatose Patients: A Single-Blind Randomised Controlled Trial." *Journal of Pharmaceutical Research International* 27, no. 2: 1–8.

Mojtabavi, H., A. Saghazadeh, V. E. Valenti, and N. Rezaei. 2020. "Can Music Influence Cardiac Autonomic System? A Systematic Review and Narrative Synthesis to Evaluate Its Impact on Heart Rate Variability." *Complementary Therapies in Clinical Practice* 39: 101162. https://doi.org/10.1016/j.ctcp.2020.101162.

Mou, Q., X. Wang, H. Xu, X. Liu, and J. Li. 2020. "Effects of Passive Music Therapy on Anxiety and Vital Signs in Lung Cancer Patients Undergoing Peripherally Inserted Central Catheter Placement Procedure." *Journal of Vascular Access* 21, no. 6: 875–882. https://doi.org/10.1177/1129729820908088.

Naef, A. C., S. M. Gerber, M. Single, et al. 2023. "Effects of Immersive Virtual Reality on Sensory Overload ın A Random Sample of Critically Ill Patients." *Frontiers in Medicine* 10: 1268659. https://doi.org/10.3389/fmed.2023.1268659.

Najafi Ghezeljeh, T., E. Bahonar, and H. Haghani. 2019. "Investigating the Effect of Listening to Nature Sounds on the Level of Consciousness and Physiological Indices of Patients With Traumatic Coma." *Complementary Medicine Journal* 9, no. 2: 3642–3656.

Pingle, Y. P., and L. K. Ragha. 2024. "An In-Depth Analysis of Music Structure and Its Effects on Human Body for Music Therapy." *Multimedia Tools and Applications* 83, no. 15: 45715–45738.

Rahimi, F., K. Salehi, and J. Seidi. 2019. "The Effect of Pleasant Audio Stimulation on the Level of Consciousness of Comatose Patient: A Randomised Clinical Trial." *Acta Medica Mediterranea* 35, no. 2: 985–997.

Rajora, M. A. K., H. Goyal, and R. Guleria. 2019. "Effectiveness of Nature-Based Sounds on Psychological Stress (Agitation and Anxiety) in Patients Under Mechanical Ventilation Support." *International Journal of Advances in Nursing Management* 7, no. 3: 169–175. https://doi.org/10.5958/2454-2652.2019.00041.6.

Sadaka, F., D. Patel, and R. Lakshmanan. 2012. "The FOUR Score Predicts Outcome in Patients After Traumatic Brain Injury." *Neurocritical Care* 16, no. 1: 95–101. https://doi.org/10.1007/s12028-011-9617-5.

Salmani, F., E. Mohammadi, M. Rezvani, and A. Kazemnezhad. 2017. "The Effects of Family-Centered Affective Stimulation on Brain-Injured Comatose Patients' Level of Consciousness: A Randomised Controlled Trial." *International Journal of Nursing Studies* 74: 44–52. https://doi.org/10.1016/j.ijnurstu.2017.05.014.

Sharma, P., A. Jain, K. Singh, A. Kumar, G. Sandhu, and S. Sharma. 2024. "Musical Genres and Their Influence on Heart Rate Variability and Blood Pressure: A Cross-Sectional Study." *European Journal of Cardiovascular Medicine* 14: 601–607.

Shou, Z., Z. Li, X. Wang, M. Chen, Y. Bai, and H. Di. 2021. "Non-Invasive Brain Intervention Techniques Used in Patients With Disorders of Consciousness." *International Journal of Neuroscience* 131, no. 4: 390–404. https://doi.org/10.1080/00207454.2020.1744598.

Spaccavento, S., G. Carraturo, E. Brattico, et al. 2024. "Musical and Electrical Stimulation as Intervention in Disorder of Consciousness (DOC) Patients: A Randomised Cross-Over Trial." *PLoS One* 31: e0304642. https://doi.org/10.1371/journal.pone.0304642.

Tavangar, H., M. Shahriary-Kalantary, T. Salimi, M. Jarahzadeh, and M. Sarebanhassanabadi. 2015. "Effect of Family Members' Voice on Level of Consciousness of Comatose Patients Admitted to the Intensive Care Unit: A Single-Blind Randomised Controlled Trial." *Advanced Biomedical Research* 29: 106. https://doi.org/10.4103/2277-9175.157806.

Teasdale, G., and B. Jennett. 1974. "Assessment of Coma and İmpaired Consciousness. A Practical Scale." *Lancet* 2, no. 7872: 81–84.

Tronstad, O., D. Flaws, S. Patterson, R. Holdsworth, and J. F. Fraser. 2023. "Creating the ICU of the Future: Patient-Centred Design to Optimise Recovery." *Critical Care* 27, no. 1: 402. https://doi.org/10.1186/s13054-023-04685-2.

Ugraş, G. A., G. Yıldırım, S. Yüksel, Y. Öztürkçü, M. Kuzdere, and S. D. Öztekin. 2018. "The Effect of Different Types of Music on Patients' Preoperative Anxiety: A Randomized Controlled Trial." *Complementary Therapies in Clinical Practice* 31: 158–163. https://doi.org/10.1016/j.ctcp.2018.02.012.

Ugurlu, Y. K., and D. K. Alemdar. 2025. "The Effect of Listening to the Voice Recording of Relatives on Chest Pain, Anxiety and Depression in Patients Hospitalized in the Coronary Intensive Care Unit: A Randomized Controlled Trial." *Nursing in Critical Care* 30: 1–10. https://doi.org/10.1111/nicc.13199.

Umbrello, M., T. Sorrenti, G. Mistraletti, P. Formenti, D. Chiumello, and S. Terzoni. 2019. "Music Therapy Reduces Stress and Anxiety in Critically İll Patients: A Systematic Review of Randomised Clinical Trials." *Minerva Anestesiologica* 85, no. 8: 886–898. https://doi.org/10.23736/S0375-9393.19.13526-2.

Van Hedger, S. C., H. C. Nusbaum, S. L. Heald, A. Huang, H. P. Kotabe, and M. G. Berman. 2019. "The Aesthetic Preference for Nature Sounds Depends on Sound Object Recognition." *Cognitive Science* 43, no. 5: e12734. https://doi.org/10.1111/cogs.12734.

Varghese, R., B. Sulochana, and P. J. J. D'Souza. 2021. "Effectiveness of Voice Stimulus on the Level of Consciousness, Physiological Parameters and Behavioural Responses: A Feasibility Study." *Clinical Epidemiology and Global Health* 9: 150–156. https://doi.org/10.1016/j.cegh.2020.08.006.

Yekefallah, L., P. Namdar, J. Azimian, S. D. Mohammadi, and M. Mafi. 2021. "The Effects of Musical Stimulation on the Level of Consciousness

Among Patients With Head Trauma Hospitalized in Intensive Care Units: A Randomized Control Trial." *Complementary Therapies in Clinical Practice* 42: 101258. https://doi.org/10.1016/j.ctcp.2020.101258.

Zuo, J., Y. Tao, M. Liu, L. Feng, Y. Yang, and L. Liao. 2021. "The Effect of Family-Centered Sensory and Affective Stimulation on Comatose Patients With Traumatic Brain İnjury: A Systematic Review and Meta-Analysis." *International Journal of Nursing Studies* 115: 103846. https://doi.org/10.1016/j.ijnurstu.2020.103846.