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REVIEW

The Effect of Music Therapy on Adult Patients' Heart Rate: A Meta-Analysis

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Abstract

Background: Music can be used as a complementary intervention to bring about a positive effect on the quality of life. It has been widely employed in clinical practice as one of the earliest forms of treatment. Despite the fact that music therapy is widely utilized and practiced in clinical and educational contexts, it has received little attention in formal medical settings. In addition, contradictory findings about the effect of music deserve further investigation.
Purpose: This meta-analysis is conducted to examine the effect of music therapy on heart rates among adult patients.
Methods: The MEDLINE, CINAHL, PsycInfo, Cochrane Library, and PubMed databases were used for searching the literature. The literature review was conducted by two independent researchers using the following Medical Subject Headings terms: musicotherapy OR music therapy, AND heart rate OR vital signs AND clinical trials as the topic. Standard mean difference (SMD) with 95% confidence interval (CI) values was used to evaluate the effect of music therapy on heart rates.
Results: Out of 194 studies, 12 studies were included with 1,118 patients. According to the results of the meta-analysis, the heart rates in the experimental groups in which music therapy was used with various diagnoses of adult patients were found to be significantly different in comparison with the control group (SMD=-0.450, 95% CI=-8.86 to -0.31, *p*=0.04).
Conclusion: The results established that using music therapy for adult patients reduced their heart rates. However, the heterogeneity among the studies was high. Therefore, it is recommended that high-quality trials are warranted to confirm the benefits of music therapy interventions among adult patients.

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1. Introduction

Music has an influence on cultures. It is one of the most delightful aspects of the human experience, as it influences the human body and mind. Music is a universal language that breaks down barriers between different cultures. Melody, harmony, rhythm, and dynamics are some aspects of music that make people feel a certain way. Music can be a powerful tool for eliciting emotions and modifying physiological states (Arjmand et al., 2017; Liang et al., 2021). It has been widely employed in clinical practice as one of the earliest forms of treatment (Ramalingam et al., 2022). Pythagoras, a Greek philosopher, was the first to propose music therapy (Hole et al., 2015). In the 1940s, the United States formally recognized music therapy as an adjuvant therapy (Taylor, 1981).

Music therapy is the practice of utilizing music to help people improve and maintain their overall well-being. It has been shown to be useful in reducing patients' negative feelings, easing pain, and altering their physiological state (Liang et al., 2021). The American Music Therapy Association (2006) defined music therapy as "the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program". Many studies related to the benefits of music therapy have been conducted. Most of them have focused on its use to relieve anxiety, stress, depression, pain, and insomnia (de Witte et al., 2020; Ding et al., 2021; Erkkilä et al., 2021; Liang et al., 2021).

Music therapy has been shown to be effective in a variety of diseases, including dementia, multiple sclerosis, depression, and schizophrenia (Abe et al., 2022; Impellizzeri et al., 2020; Geretsegger et al., 2017; Leubner & Hinterberger, 2017). According to Fancourt and Finn (2019), music can make a substantial contribution to health and well-being. Finn and Fancourt (2018) claimed that listening to music in both clinical and non-clinical settings lowered cortisol levels, which led to a lower level of stress and lower blood glucose levels.

Heart rate is one of the vital signs and it has important physiologic and prognostic significance. According to the American Heart Association, as cited in Mason et al. (2007), the normal sinus heart rate is between 60 and 100 beats per minute. Heart rate variability is influenced by the parasympathetic and sympathetic nervous systems. The parasympathetic nervous system suppresses the heart rate and restores the body to a restful state after stress by releasing acetylcholine. Sympathetic stimulation increases heart rate by releasing norepinephrine (Gordan et al., 2015). Relaxation techniques stimulate parasympathetic nervous system effects and decrease cortisol, epinephrine, and norepinephrine levels as a result of regulating heart rate. Using music in relaxation techniques has been shown to promote cognitive and emotional relaxation (Bradt et al., 2015).

Several studies have examined the effect of music therapy on heart rate. A randomized controlled trial conducted by Uggla et al. (2016) proved that music therapy dramatically reduced children's heart rates following hematopoietic stem cell transplantation. Another study conducted among pre-hypertensive young adults revealed that there was a significant reduction in heart rate after four weeks of music therapy sessions (Mir et al., 2021). Furthermore, Chang et al. (2011) explored the effects of music on psychophysiological parameters among cardiac patients, but they found no significant effect of music therapy on heart rate. A systematic review conducted by Loomba et al. (2012) concluded that music has the positive effect of decreasing heart rate. Despite the fact that music therapy is widely utilized and practiced in clinical and educational contexts, it has received little attention in formal medical settings (Loomba et al., 2012; Pickard, 2022), particularly in Arab countries where utilizing music therapy remains stagnant. Additionally, it is difficult to determine the effect of music therapy on an individual's quality of life, especially when compared to other health interventions. According to Maldonado-Resto (2021), contradictory findings about the effect of music deserve further investigation. Since the effect of music therapy was inconsistent, examining the effect needs further verification (Lu et al., 2021). This presents clear challenges to the national and international incorporation of music into health policies and care (Bickerdike et al., 2017). Formulation of more evidence-based music therapy prescriptions on heart rate promotes music therapy program development within hospital settings. Therefore, this meta-analysis is conducted to examine the effect of music therapy on heart rate among adult patients. It sets the stage for further research into whether music therapy can help decrease heart rates.

2. Methods

2.1 Research design

This meta-analysis was carried out in stages, starting with the formulation of the research question, followed by the identification of relevant research studies, assessment of study bias, summarization of the evidence, and interpretation of the findings. The preferred reporting items for systematic reviews and meta-analyses (PRISMA) procedure (Moher et al., 2009) was used to extract available data linked to the effect of music therapy on heart rate. This protocol facilitated transparency in reporting meta-analytic research.

2.2 Search method

The primary research question was "What is the reported effects of music therapy on heart rate among adult patients?". In this regard, the search included studies with (P) adult patients investigating the effect of (I) music therapy compared with a (C) control group on (O) heart rate in (S) randomized controlled trials (RCTs). An extensive literature review was conducted using the electronic database searches of MEDLINE, CINAHL, PsycInfo, the Cochrane Library, and PubMed to retrieve studies from 2017 up to March 2022. Each database was searched using the following Medical Subject Headings (MeSH) terms: "musicotherapy" OR "music therapy" AND "heart rate" OR "vital signs" AND "clinical trials" as the topic by the first author (KA).

2.3 Inclusion and exclusion criteria

The inclusion criteria of the studies were as follows: (1) randomized controlled trials (RCTs); (2) available in full text, (3) published in English; (4) conducted among the adult patient population; (5) all the studies had to include mean or median scores; and (6) conducted in the last five years (2017-2022). According to the inclusion and exclusion criteria used during the search, qualitative studies, case studies, dissertations, conference abstracts, systematic reviews, symposiums, and studies on non-human subjects were excluded from this review. If studies compared music therapy with complementary and alternative medicine (CAM), they were also excluded from the review.

2.4 Screening of articles

Two research team members (KA and AA) independently screened the studies, and any disagreements were discussed between the two members. When no agreement was obtained, a third reviewer (OGB) was consulted. Zotero software was utilized to import and manage the search results and reject duplicates. The two members then examined the titles and abstracts of the included RCTs. When both members rejected a study, it would be eliminated from consideration. Insufficient title or abstract information required a full article review based on the inclusion criteria.

2.5 Data extraction

After the final list of articles was identified, two investigators (KA and AA) used a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, WA, USA) to extract the data from each article independently. Each study included in the review had the following information extracted: first author and year of publication, sample size, quantitative data (mean ages, mean score, standard deviation), type and setting of procedure, duration of listening to music, and main findings.

2.6 Quality appraisal

The included studies were independently evaluated by independent reviewers from the research team (KA and AA) using the methodological quality assessment system in review manager (RevMan) version 5.4 (The Nordic Cochrane Center, The Cochrane Collaboration, Copenhagen, Denmark, 2020). The risk of bias for each selected trial was assessed according to seven sources of bias that included selection bias, performance bias, detection bias, attrition bias, reporting bias, and other reported biases. All the items were classified as yes ("low risk of bias"), no ("high risk of bias"), or unclear ("moderate risk of bias"). When the risk of bias for each of the seven components was classified as "low risk of bias", the total risk of bias for the trial was also characterized as "low". Similarly, when one or more of the seven components of bias were rated as high risk, the study was considered as high risk of bias (Higgins et al., 2011). Discrepancies in the evaluation were resolved by a third senior reviewer (OGB). Missing information leads to rating the bias as an unclear risk, which leads to difficulty in assessing the limitations of the trials (Viswanathan et al., 2012).

2.7 Data analysis

The meta-analysis was performed using RevMan software version 5.4 (The Nordic Cochrane Center, The Cochrane Collaboration, Copenhagen, Denmark, 2020) for data synthesis. The means and standard deviation outcomes of the heart rate measurements were extracted from each study. One study provided the adjusted post-test mean (C.H. Lee et al., 2017). The outcome measures of this meta-analysis were presented as the mean differences (MDs) between the music and control groups, with the corresponding 95% confidence intervals (CIs). Random effects models were used to combine the effects from individual studies. Heterogeneity was examined using Cochran's Q test and I^2. The heterogeneity was considered high if the value of I^2 was greater than 50% (Higgins, 2003). When there was significant heterogeneity, a random effects model was used for meta-analysis. A fixed effect meta-analysis was used when there was no significant heterogeneity. Pooled analyses of data from all studies were conducted to determine various outcomes.

3. Results

3.1 Literature search

One hundred and ninety-four articles were identified through database searching via the following search engines: Cochrane Library, EBSCO, MEDLINE PubMed, and PsycInfo. Twenty-six articles were removed due to duplication. The deleted records have the same title, author, and publication year. The remaining records (*n*=168) were exported to an Excel file. The extensive screening by two independent reviewers (KA and AA) using the inclusion and exclusion criteria resulted in the elimination of 125 articles, leaving a total of 43 full-text articles that were downloaded for consideration. Thirty-one articles were excluded for the following reasons: study conducted among healthy participants (*n*=7), comparison to another type of CAM intervention (*n*=8), lack of appropriate statistical data (*n*=12), and non-RCT (*n*=4). Ultimately, 12 articles met all the inclusion criteria and were included in the qualitative synthesis (Figure 1).

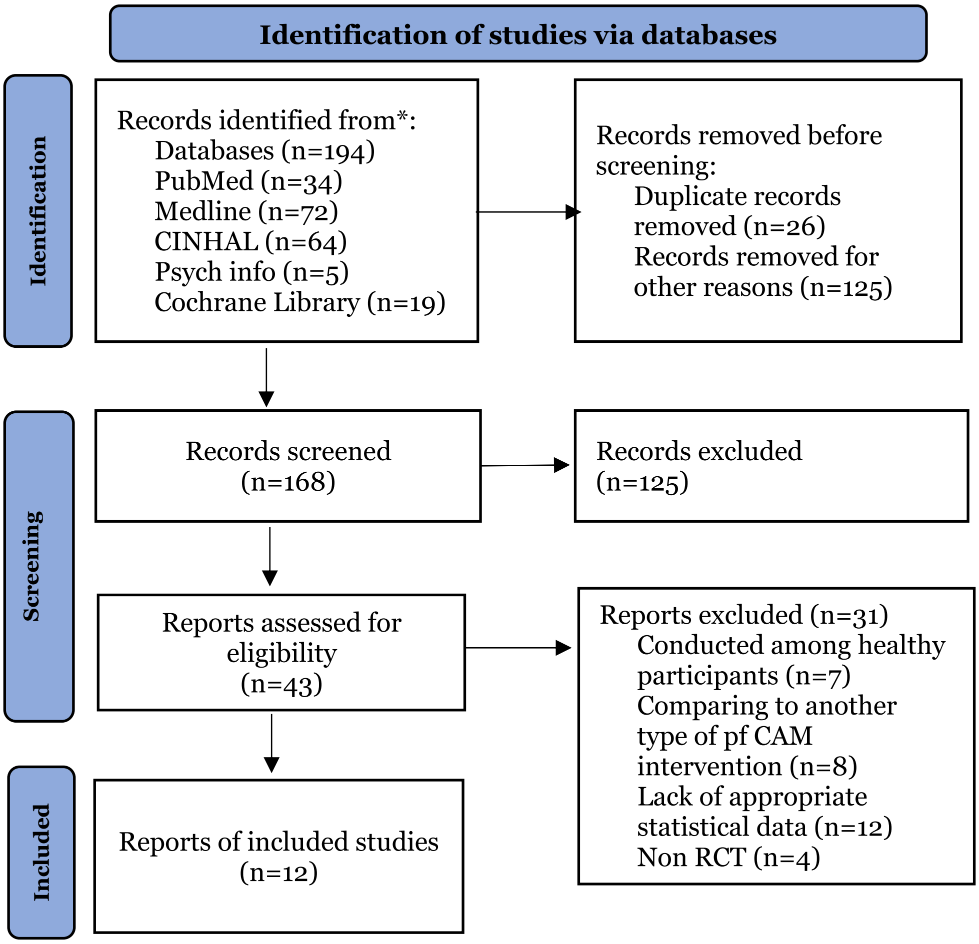


Figure 1. Study selection methodology

3.2 Risk of bias for the included studies

According to the risk of bias that was evaluated using the Cochrane Collaboration's software RevMan 5.4 (Figure 2), in general, the methodology of the included trials was less than ideal, with significant flaws (Figure 2a). Figure 2b illustrates the risk of bias summary of each study. In terms of the randomization process, 11 studies described the process of randomization and were assessed as having a low risk of bias, and one study as high risk of bias (W. L. Lee et al., 2017). The authors decided to include the high-risk study as including only the studies at low risk of bias may produce a result that is imprecise (Boutron et al., 2019). Four studies did not provide information about the allocation of concealment and were judged as having a high risk of bias (Cakmak et al., 2017; Lopez-Yufera et al., 2020; W. L. Lee et al., 2017; W. P. Lee et al., 2017), and one study was assessed as unclear bias (Hamidi & Ozturk, 2017). In addition, seven studies failed to blind the participants and investigators (Cakmak et al., 2017; Lopez-Yufera et al., 2020; Mackintosh et al., 2018; Tolunay et al., 2018; Wazzan et al., 2022; W. L. Lee et al., 2017; W. P.

Lee et al., 2017). In terms of detection bias, five studies were considered as high risk (Cakmak et al., 2017; Mackintosh et al., 2018; Tolunay et al., 2018; Wazzan et al., 2022; W. L. Lee et al., 2017), and the risk of bias was unclear for one study (Wu et al., 2017). The remaining six studies were evaluated as low risk of bias. For attrition bias, most of the studies were rated as low risk of bias, except for four studies that were judged as high risk of bias (Froutan et al., 2020; Schaal et al., 2021; Tolunay et al., 2018; W. L. Lee et al., 2017). In terms of reporting bias, all of the studies were assessed as low risk, except for three studies for which the risk of bias was not clear (Cakmak et al., 2017; Hamidi & Ozturk, 2017; W. L. Lee et al., 2017). Regarding the other bias, the studies by Lee et al. (2017) and Lopez-Yufera et al. (2020) were deemed high-risk since the participants have not been able to select their preferred genre of music for the intervention. Thus, it is possible that the effects of the music intervention were lessened.

3.3 Characteristics of the study

The total number of patients in all studies was 1,118, with sample sizes ranging from 38 to 200 for each study. A total of 554 patients were included in the music therapy groups, while 564 patients were enrolled in the control groups. The maximum mean age was 68.3 years, and the minimum mean age was 30 years. The study settings varied between inpatient and outpatient settings. Two studies played music in an intensive care unit (ICU) (Froutan et al., 2020; C. H. Lee et al., 2017), and three studies provided music in a preoperative room (Lopez-Yufera et al., 2020; Schaal et al., 2021; Wu et al., 2017). One study provided music in a cardiac ward (Cakmak et al., 2017), one study in an interventional room in an outpatient clinic (Hamidi & Ozturk, 2017), one study in a dental clinic (Wazzan et al., 2022), and one in a cast room (Tolunay et al., 2018). There was one study in a radiology department that provided meditative music during tomography scans (W. L. Lee et al., 2017). One study provided intraoperative music (Mackintosh et al., 2018), and the final study provided music in a post-anesthesia care unit (PACU) (W. P. Lee et al., 2017).

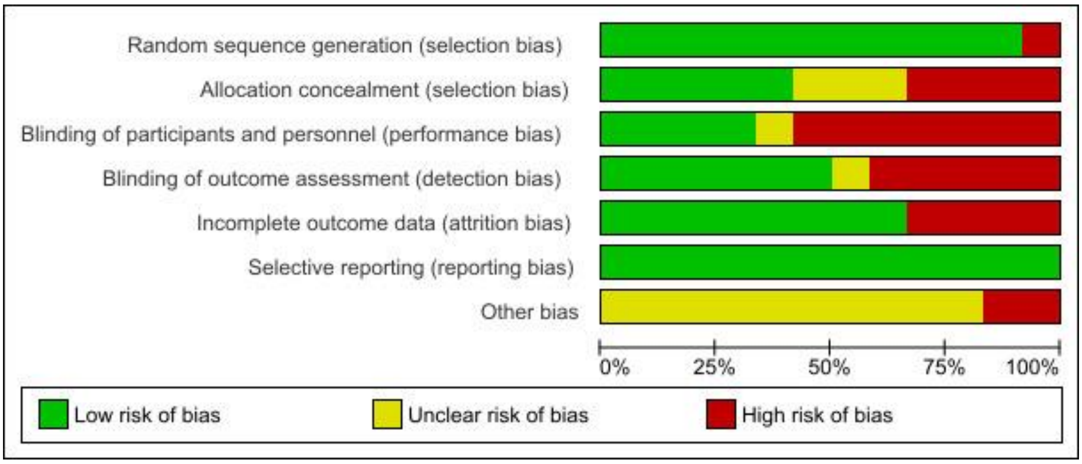
The study by Froutan et al. (2020) provided music during ICU hospitalization until day 6. The duration of the music intervention ranged from 10 to 30 minutes. Conversely, five studies (Cakmak et al., 2017; Hamidi & Ozturk, 2017; Mackintosh et al., 2018; Tolunay et al., 2018; Wazzan et al., 2022) reported that music was played throughout the procedure without specifying the total time of the procedure.

Various genres of music were played throughout the trials. C. H. Lee et al. (2017) used western classical music, Chinese classical music, music of natural sounds, and religious music based on the patients' preferences. Six types of soothing music (such as nature, piano, harp, and jazz) were used among the patients, according to W. P. Lee et al. (2017) and Wu et al. (2017) studies. Cakmak et al. (2017), Hamidi & Ozturk, (2017), and Tolunay et al. (2018) played popular, classical, and slow music or Turkish folk as the patients preferred. Mediative music was used in the W. L. Lee et al. (2017) study to enhance the relaxation feelings among patients who were waiting for Positron Emission Tomography (PET) scans. Relaxing music, as described by Froutan et al. (2020) and Lopez-Yufera et al. (2020), was used among patients with potentially malignant oral disorders and ICU patients. Wazzan et al. (2022) used regular soft music tracks, while Mackintosh et al. (2018) and Schaal et al. (2021) did not specify the music type.

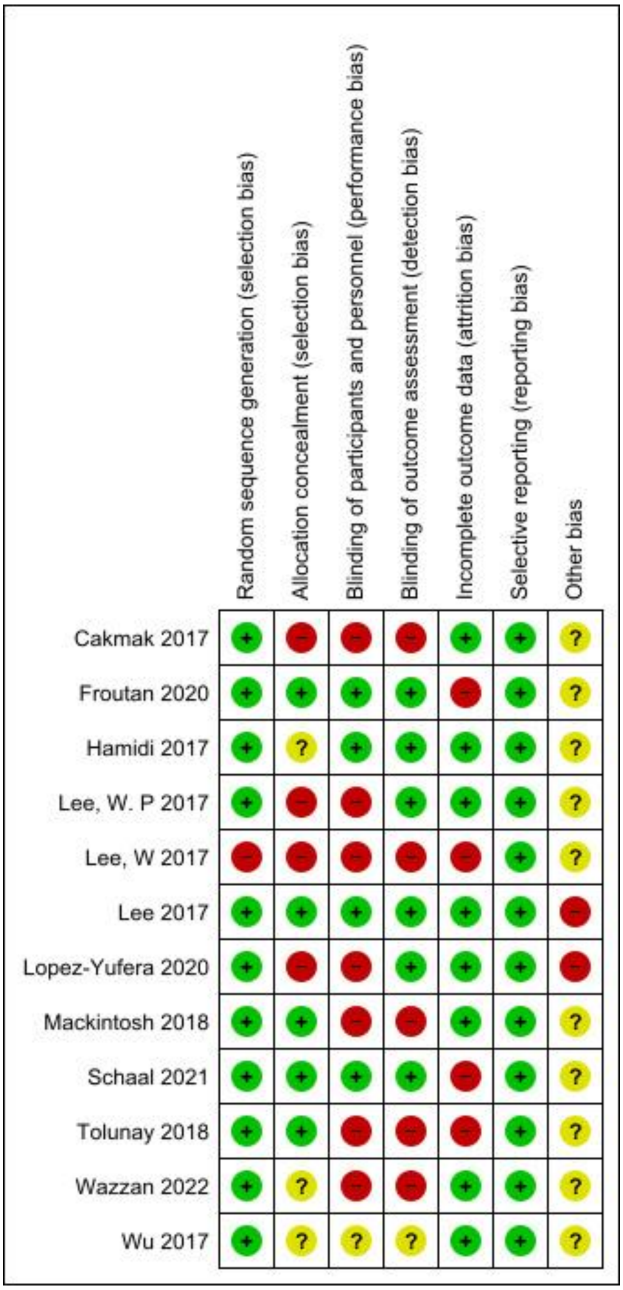
Four studies were carried out in Taiwan (C. H. Lee et al., 2017; Wu et al., 2017; W. L. Lee et al., 2017; W.P. Lee et al., 2017), three studies in Turkey (Cakmak et al., 2017; Hamidi & Ozturk, 2017; Tolunay et al., 2018), and one study in Spain (Lopez-Yufera et al., 2020), Iran (Froutan et al., 2020), Australia (Mackintosh et al., 2018), Germany (Schaal et al., 2021), and the United Arab Emirates (Wazzan et al., 2022) (Table 1).

3.4 The effect of music intervention on heart rate

In this analysis, data from various other subjective variables were pooled together using the standardized mean difference (*SMD*) statistic. The music intervention showed a significant and small to medium effect in decreasing heart rate (n=1118, *SMD*=-0.450, 95% *CI*=-8.86 to -0.31, p=0.04) when compared with the control group, with evidence of heterogeneity (p=0.00001, I^2=98%) (Figure 3). The heterogeneity was best resolved by excluding Wu et al. (2017), C. H. Lee et al. (2017), and Froutan et al. (2020). The results favored music therapy after exclusion (n=941, *SMD*=-1.56, 95% *CI*=-2.75 to -0.37, p=0.01), with p=0.68, and I^2=0% (Figure 4).



(2a) Risk of bias graph



(2b) Risk of bias summary

Figure 2. Risk of bias

3.5 The effect of music intervention on heart rate

In this analysis, data from various other subjective variables were pooled together using the standardized mean difference (SMD) statistic. The music intervention showed a significant and small to medium effect in decreasing heart rate (*n*=1118, SMD=-0.450, 95% CI=-8.86 to -0.31, *p*=0.04) when compared with the control group, with evidence of heterogeneity (*p*=0.00001, I^2=98%) (Figure 3). The heterogeneity was best resolved by excluding Wu et al. (2017), C. H. Lee et al. (2017), and Froutan et al. (2020). The results favored music therapy after exclusion (*n*=941, SMD=-1.56, 95% CI=-2.75 to -0.37, p=0.01), with *p*=0.68, and I^2=0% (Figure 4).

	Experimental			Control				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Cakmak 2017	79.5	6.3	95	80.7	5.8	105	9.1%	-1.20 [-2.88, 0.48]
Froutan 2020	78.18	2.12	28	95.5	1.8	28	9.2%	-17.32 [-18.35, -16.29]
Hamidi 2017	75.5	8	50	79.4	8.7	50	8.8%	-3.90 [-7.18, -0.62]
Lee 2017a	-3.91	0.65	41	0.25	0.7	44	9.2%	-4.16 [-4.45, -3.87]
Lee 2017b	54.77	9.41	35	58.84	11.06	37	8.3%	-4.07 [-8.80, 0.66]
Lee 2017c	66.02	10.67	50	68.5	12.88	50	8.4%	-2.48 [-7.12, 2.16]
Lopez-Yufera 2020	72.1	10.7	40	72.6	12.4	40	8.2%	-0.50 [-5.58, 4.58]
Mackintosh 2018	89	19	30	86	16	30	6.7%	3.00 [-5.89, 11.89]
Schaal 2021	73.1	12.2	44	74.8	14.6	40	8.0%	-1.70 [-7.48, 4.08]
Tolunay 2018	82.24	15.3	100	81.61	13.1	99	8.6%	0.63 [-3.33, 4.59]
Wazzan 2022	75	11	23	76	13	23	7.5%	-1.00 [-7.96, 5.96]
Wu 2017	62.84	7.33	19	81.84	10.13	19	8.0%	-19.00 [-24.62, -13.38]
Total (95% CI)			**555**			**565**	**100.0%**	**-4.50 [-8.86, -0.13]**

Heterogeneity: Tau² = 53.56; Chi² = 643.83, df = 11 (P < 0.00001); I² = 98%
Test for overall effect: Z = 2.02 (P = 0.04)

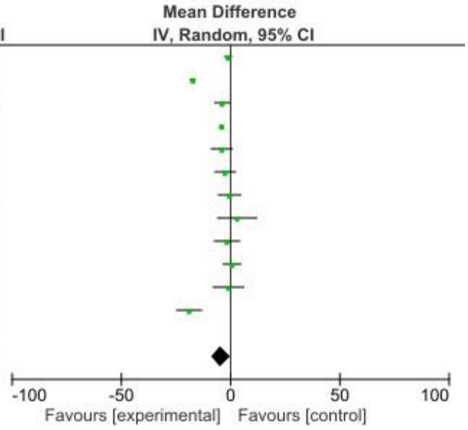


Figure 3. Mean difference in the effect of music on heart rates

	Experimental			Control				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Cakmak 2017	79.5	6.3	95	80.7	5.8	105	50.2%	-1.20 [-2.88, 0.48]
Froutan 2020	78.18	2.12	28	95.5	1.8	28	0.0%	-17.32 [-18.35, -16.29]
Hamidi 2017	75.5	8	50	79.4	8.7	50	13.3%	-3.90 [-7.18, -0.62]
Lee 2017a	-3.91	0.65	41	0.25	0.7	44	0.0%	-4.16 [-4.45, -3.87]
Lee 2017b	54.77	9.41	35	58.84	11.06	37	6.3%	-4.07 [-8.80, 0.66]
Lee 2017c	66.02	10.67	50	68.5	12.88	50	6.6%	-2.48 [-7.12, 2.16]
Lopez-Yufera 2020	72.1	10.7	40	72.6	12.4	40	5.5%	-0.50 [-5.58, 4.58]
Mackintosh 2018	89	19	30	86	16	30	1.8%	3.00 [-5.89, 11.89]
Schaal 2021	73.1	12.2	44	74.8	14.6	40	4.3%	-1.70 [-7.48, 4.08]
Tolunay 2018	82.24	15.3	100	81.61	13.1	99	9.1%	0.63 [-3.33, 4.59]
Wazzan 2022	75	11	23	76	13	23	2.9%	-1.00 [-7.96, 5.96]
Wu 2017	62.84	7.33	19	81.84	10.13	19	0.0%	-19.00 [-24.62, -13.38]
Total (95% CI)			**467**			**474**	**100.0%**	**-1.56 [-2.75, -0.37]**

Heterogeneity: Tau² = 0.00; Chi² = 5.75, df = 8 (P = 0.68); I² = 0%
Test for overall effect: Z = 2.56 (P = 0.01)

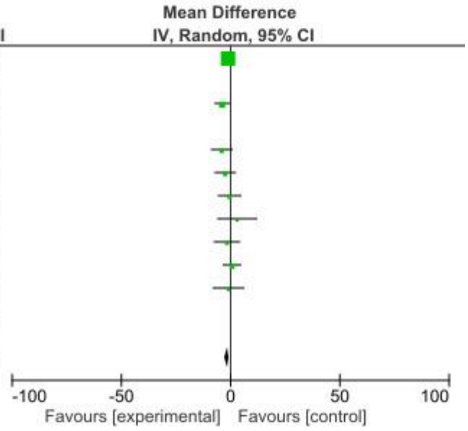


Figure 4. Mean difference after heterogeneity was resolved

4. Discussion

This meta-analysis of 1,118 participants in 12 RCTs aims to examine the effect of music therapy on heart rate among adult patients. The results revealed that the heart rates of the patients assigned to the music therapy groups decreased significantly with small to medium effect (SMD=-0.450) compared to the control group patients. This reflects the significant effect of music therapy, although this result shows high heterogeneity. The heterogeneity may be raised due to differences in the participants' diagnoses, characteristics, and perceptions of the populations based on their countries and study settings (inpatient or outpatient). Two studies were in an ICU setting, and three were in preoperative care units. There was one study in each of the following settings: an intraoperative setting, PACU, procedural room, dental clinic, cardiac unit, radiology department, and cast room. This conclusion regarding the effect of music therapy is consistent with what was reported previously by Loomba et al. (2012) and de Witte et al. (2020) in pooled analyses of 432 and 9,617 participants, respectively.

Music therapy is a complementary treatment for a wide range of medical disorders because its effects have the potential to promote whole-body coordination (Mojtabavi et al., 2020).

Listening to music enhances parasympathetic activities, as the parasympathetic system is the most active under restful conditions, which leads to a decrease in the heart rate (Gordan et al., 2015). According to Suhartini (2011), the human energy field receives oscillations produced by music, and numerous physiological reactions synchronize with or match the music's oscillations. In this aspect, patients believe the music intervention to be more effective and enjoyable.

The hospitalization process is a potential source of stress that may increase the risk of physiological complications. Stressed patients with an activated sympathetic nervous system may be predisposed to increased epinephrine secretion, which influences physiological functioning, including elevating the heart rate (Vaseghi & Shivkumar, 2008). Considering the individual studies, the greatest decrease in heart rate was obtained with 30 minutes of listening to music among patients undergoing awake craniotomy (-19.12 beats per minute in heart rate, 95% CI=-24.62 to -13.38) (Wu et al., 2017) followed by a study of Frountan et al. (2020) with reduction of 17. 32 beats per minute, among patients with traumatic brain injury. A less pronounced reduction in heart rate was found among adult patients with potentially malignant oral disorders who listened to relaxing music with headphones (Lopez-Yufera et al., 2020) (-0.50 beats per minute in heart rate, 95% CI=-5.58 to 4.58). Mir et al. (2021) used music among pre-hypertensive young adults and suggested that 30 minutes of music listening has a significant effect on reducing heart rates. This finding is in line with Wu et al. (2017) findings that suggest the length of music therapy affects heart rate reduction.

Considering other outcomes, various meta-analyses have shown the positive effects of music therapy on pain, depression, anxiety, and sleep quality (Li et al., 2022; Lin et al., 2020; Sorkpor et al., 2021). The overall results indicated that music therapy is an effective intervention that is relatively affordable, safe, and simple to administer. Our findings support the use of music therapy as an empirically supported intervention for lowering heart rates among adult patients. The mechanism by which music affects heart rate is not clear. However, its use can be justified, as the music appears to have the ability to reduce physiological arousal, which is elevated during times of stress (de Witte et al., 2020). Reduced physiological arousal is associated with reductions in heart rate. Music listening is a therapeutic strategy and relaxation technique that has the ability to modulate autonomic nervous system activity and decreases cortisol, adrenaline, and norepinephrine levels, hence regulating the heart rate (Bradt et al., 2015; McCrary & Altenmüller, 2021).

Ibn Sina (Avicenna) is one of the most significant physicians and philosophers of the Islamic age indicates that listening to music is one of the most efficient medical treatment methods, which proves the value of music therapy in medical treatment (Sidik et al., 2021). Although, to the best of our knowledge, music therapy has been overlooked and ignored throughout the Arab world, despite its numerous benefits. During our search and screening, only two studies were discovered that examined the effect of music therapy on patients undertaken by Luis et al. (2019) in the Aswan Heart Center in Egypt and Wazzan et al. (2022) in the Urgent Care Dental Department, the University of Sharjah Dental Hospital in the United Arab Emirates. The reason for ignoring music therapy in the Arab world can be justified as the disagreement and debate of being music permitted or prohibited (Alamer, 2015).

5. Implications and limitations

This meta-analysis demonstrates that music therapy is an effective intervention that can improve people's health, which opens the door for future research studies on the benefits of music therapy, particularly in the Arab world. However, this study has some limitations. First, the search was limited to studies conducted among adult patients. Including diverse populations, such as pediatric patients and healthy adults, might provide a more comprehensive view of the effects of music therapy on heart rates. Second, studies with significant selection and performance biases were also included, which may have resulted in an overestimation of the results. Finally, because the types and lengths of music therapy were so varied, how different music genres and durations affected patients' heart rates could not be determined.

6. Conclusion

This meta-analysis revealed that music therapy has a beneficial effect on heart rate reduction in patients with a range of diagnoses in a variety of hospital settings. This study recommends that additional high-quality clinical trials in a variety of settings are required to prove music therapy's influence on heart rate.

Acknowledgment
None

Author contribution

KA participated in the investigation, methodology, project administration, and roles/writing-original draft, and independently reviewed trials for meeting the inclusion criteria and extracted data. OGB supervised in writing, reviewing, and editing. AAl contributed to formal analysis, visualization, and software. AA independently reviewed trials for meeting inclusion criteria and extracted data. All authors discussed the results and contributed to the writing and editing of the manuscript.

Conflict of interest

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Appendix 1

Table 1. Included studies characteristics

Author (Publication year)	Country	Sample size per group	Mean age	Intervention	Duration of music listening	HR outcome
Cakmak et al. (2017)	Turkey	EG: 95 CG: 105	42.9	EG: listening to music during the shock wave lithotripsy session. CG: No music	Throughout the procedure	HR was significantly higher in patients who did not listen to music (p=0.0001)
Froutan et al. (2020)	Iran	EG: 28 CG: 28	EG: 42.46 CG: 40.32	EG: music therapy integrated with family recollection. CG: No music	twice a day for 15 minutes for 6 consecutive days	Significant decrease in heart rate for the patients in the intervention group as compared to the patients in the control group (p<0.0001)
Hamidi et al. (2017)	Turkey	EG: 50 CG: 50	EG: 46.5 CG: 48.1	EG: listening to music during the Percutaneous Nephrostomy Tube Placement. CG: No music	Throughout the procedure	Heart rates EG patients were significantly lower than CG patients (p=0.01)
C. H. Lee et al. (2017)	Taiwan	EG: 41 CG: 44	EG: 59.46 CG: 59.52	EG: listening to music through headphones. CG: No music	30 minutes	Heart rates EG patients were significantly lower than CG patients (p<.001)
W. L. Lee et al. (2017)	Taiwan	EG: 35 CG: 37	EG: 59.03 CG: 60.27	EG: listening to mediative music Positron Emission Tomography (PET) scans. CG: No music	30 minutes	Significant decrease in heart rate for the patients in the intervention group as compared to the patients in the control group (p<0.001)
W. P. Lee et al. (2017)	Taiwan	EG: 50 CG: 50	EG: 47.8 CG: 51.36	EG: patients listened to soothing music of their choice using mp3 player and over-ear headphones to reduce outside interference. CG: No music	30 minutes	Heart rate (t=2.61, p=0.012) decreased among intervention group
Lopez-Yufera et al. (2020)	Spain	EG: 40 CG: 40	68.3	EG: listening to relaxing music with headphones from an MP3 player and with access to the volume control. CG: resting in silence with headphones on but without music	10 minutes	Heart rates EG patients were significantly lower than CG patients (p<.001)

Table 1. Continued

Author (Publication year)	Country	Sample size per group	Mean age	Intervention	Duration of music listening	HR outcome
Mackintosh et al. (2018)	Australia	EG: 30 CG: 30	EG: 65 CG: 68	EG: Participants listened to the music via ear-bud headphones and the music was played during the entire duration of the pleural procedure and for an additional 10 minutes before and 10 minutes after the pleural procedure. CG: No music	Throughout the procedure and for an additional 10 minutes before and 10 minutes	Participants in the music group had reductions in heart rate (*p*=0.04).
Schaal et al. (2021)	Germany	EG: 44 CG: 40	EG: 56.1 CG: 57.2	EG: Participants listened to the music during port catheter placement. CG: No music	Throughout the procedure	Music group displayed a significant reduction in heart rate (*p*=0.035)
Tolunay et al. (2018)	Turkey	EG: 100 CG: 99	EG: 52.50 CG: 51.85	EG: listened to music during cast room procedures on normal speaking level (40–50 dB) with headsets covering the ear and minimizing noises from the environment. CG: No music	Throughout the procedure	No statistically significant difference was identified for the HR among both groups (*p*=0.939)
Wazzan et al. (2022)	United Arab Emirates	EG: 23 CG: 23	30	EG: The group was exposed to the music throughout the entire endodontic procedure. CG: No music	Throughout the procedure	No statistically significant difference was identified for the HR among both groups (*p*=0.74)
Wu et al. (2017)	Taiwan	EG: 19 CG: 19	40	EG: Patients were asked to choose their preference of music from 6 types of soothing music (Close to heartbeat) while are lying on the operating table. CG: No music	30 minutes	Music group displayed a significant reduction in heart rate (*p*<.001)

Notes. EG: experimental group; CG: control group