Effects of Music Therapy on the Stress of Adults: a Systematic Review and Meta-Analysis

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Abstract: Objectives: Music therapy, has been used to alleviate stress, but there is still little evidence of how to use it. Therefore, in this study, we tried to find the clinical trials that have been done in the past and provide the evidence for them. Methods/Statistical analysis: Six national and international databases were used to retrieve and collect RCT literature published up to March 9 of 2017.The research was independently selected by two researchers based on core questions, selection and exclusion criteria, and the flow chart of PRISMA was used to describe the status of the literature selection process in detail. Ten articles were included in the qualitative analysis and seven articles were included in the quantitative synthesis using the RevMan software ver. 5.3. Findings: Comparisons between the music listening group and the non-treated control group resulted in a reduction of 1.08 points of subjective stress(n=257; mean difference, -1.08; confidence interval (CI) 95%, -1.55 to -0.60), and the effect size between the group and the control group was statistically significant (Z=4.41, p<.00001, Higgins I2=0%). The experimental group treated with music therapy found that the pulse were decreased by 0.47 points (n=274; mean difference, -0.47; confidence interval (CI) 95%, -0.83 to -0.11)showing a statistically significant difference between the control group and experimental group(Z=2.54, p=.01, Higgins I2=44%).

Applications: Effects of music listening on stress and anxiety in healthy adults. However, this study also has some limitations given the insufficient number of studies used in the meta-analysis, which warrants a more stringent experimental study in the future.

Keywords: Music; Stress; Health Adult; Systematic Review; Meta-analysis

I. INTRODUCTION

The emergence of global endemics including Middle Eastern Respiratory Syndrome and Ebola, increased population aging due to individuals' improved life expectancy, and various social changes have contributed to increased disease diversity. Consequently, more patients are now exposed to acute and chronic stress situations depending on the severity of their condition and/or as a result of screening tests and various treatments [1]. Controlling individuals' stress is vital for health improvement; however, individuals may react differently to the same stressor [2].

From a physiological perspective, stress reactions may manifest in the form of an increased heart rate, increased blood pressure, digestive changes, increased muscle tension, and catecholamine secretion [3]. Psychological reactions may involve changes in individuals' emotional state such as depression, rage, emotional unrest, anxiety, or low self-evaluation [4]. Moreover, persistent and excessive stress may cause physical reactions—including difficulties maintaining homeostasis or cardiovascular or musculoskeletal issues—as well as emotional instability, immune functioning instability, hypertension, or sleep disorders. These issues may cause both personal and societal losses [5].

Although various sedatives are administered to relieve stress, their excessive use may affect patients' cardiac functioning, cause negative side effects, and increase the risk of medical accidents. Further, administering sedatives itself may serve as a stressor [6]. However, inducing a state of calm in patients is a key part of stress management, and integrated care is commanding increased attention, which is driven by a growing interest in complementary and alternative therapies as a non-pharmacological intervention method for stress relief in addition to pharmacological treatment [7].

Extant literature has examined the impact of Thai massage on stress control [8], the effects of aroma massage and oil massage on cortisol and serotonin blood levels [9], and the effects of music therapy on stress and relaxation [10]. However, massage therapy presents many challenges as a long-term intervention method because it is time-consuming and must be performed by a trained massage therapist [11], and in some cases, requires a separate location or specific equipment [12]. Moreover, massage is not an ideal intervention method when patients are stressed by surgery or treatment.

Music therapy, a complementary and alternative therapy, is a non-invasive method that direct affects patients' brains without excessive intervention. It not only frees care providers from the constraints of time or location, it is also convenient to use, offers a quick outcome, and has almost no side effects [13]. Music induces reactions from the autonomic nervous system through the brain as the patient listens; it thus boasts remarkable effectiveness and improves psychological and physiological relaxation [14]. Recent studies have shown that music therapy positively affects the cardiovascular system, autonomic nervous system, and brainwaves [15], and the regular rhythm of music synchronizes with the rhythm of the human body [16].

Consequently, we examined the effects of listening to various types of music on reducing stress in healthy adults and investigated its effectiveness among intervention types through a systematic review of existing literature. Through this study, we advance the development of an effective, evidence-based,

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intervention method for practical nursing settings and guide future research endeavors concerning stress interventions.

II. MATERIALS AND METHODS

2.1. Research Design

This systematic review analyzed the effects of music listening on stress among healthy adults.

2.2. Core Question

We employed the PICO (Patients, Intervention, Comparator, Outcome) framework, which is described in detail below.

1) Research Participants

This study involved healthy adults without any illnesses. We used "adult" as a search term, which was defined as individuals aged 18–64 years.

2) Intervention

Of the diverse music therapy intervention methods, we selected studies that adopted music listening as the intervention method. We applied no restrictions concerning music type.

3) Comparative Intervention

We selected and compared studies with a control group and a placebo group who were not given the experimental treatment.

4) Intervention Results

The primary intervention results intended to validate the effects of music listening on objective and subjective stress. The secondary intervention results addressed the effects on anxiety.

2.3. Data Search, Collection, and Screening Procedure

2.3.1. Data Search

We included all searchable data, dated before March 9, 2017, in the data search. International databases that were used in the search included PubMed, CINAHL, and CENTRAL, and domestic databases included RISS, KISS, and DBpia. All academic papers published in these databases were searched.

To improve sensitivity, we performed a manual search on Google Scholar for grey literature. For the search formula, AND/OR and truncation operators were applied to MeSH terms and text words. First, we extracted all data that contained "music" [MeSH] and "music therapy" [MeSH] as the intervention method and searched all studies that addressed "stress, psychological" [MeSH] as the presenting symptoms, using "health" [MeSH] and "adult" [MeSH] as research participants. The concepts of music, music therapy, music listening, adult, and stress were also applied in domestic databases using the same search method.

2.3.2. Data Collection and Screening

Study inclusion criteria comprised the following: (1) healthy adults' music listening was the intervention method, (2) randomized controlled trials (RCTs), and (3) papers published in academic journals. Study exclusion criteria comprised the following: (1) targeting adults with a specific disease, (2) if pregnant women participated, (3) animal studies, (4) studies that were not published in Korean or English, (5) pre-clinical or non-comparative studies, (6) unpublished academic theses and/or dissertations, and (7) non-experimental studies including observation studies and reviews.

We screened the searched data based on the core questions and inclusion/exclusion criteria and used the PRISMA flow chart to record the literature selection process in step-by-step detail. Overall, 606 papers were searched; however, after excluding 217 duplicates, 389 papers were reviewed by the two authors of this study. Among these, 351 papers that were unrelated to the core questions, not published in Korean or English, or with a research design that did not match the inclusion criteria were excluded. Hence, 38 papers were selected through the preliminary review. After reviewing the original text of the remaining papers, we excluded six studies in which stress was not the dependent variable, two studies with comparison groups that did not fit the inclusion criteria, 12 studies with a research design that did not fit the inclusion criteria, six studies that did not use music listening as the intervention method, and two studies that did not focus on healthy adults. Hence, 10 studies were selected for the secondary review (Figure 1).

2.4. Literature Quality Assessment

We used the Cochrane Risk of Bias Tool for a critical review of the selected literature [17]. For the quality assessment, we independently reviewed the papers that passed the final selection process. If there was a disagreement, a third-party researcher was consulted, and a consensus was reached after sufficient discussion. In this study, there were no disagreements between the two researchers.

2.5. Data Analyses

Systematic validation, synthesis, statistical merging, and reporting of the results for the selected studies were performed as per the Cochrane Guidelines [17].

2.5.1. Data Extraction

We analyzed, coded, and organized the characteristics of the 10 papers. The coding table included the author; publication year; research design; sample size; intervention methods for the experimental, placebo, and control groups; outcome variables group differences, and the authors' conclusions.

2.5.2. Analysis Model Selection

We chose the random-effect model for analysis because of study heterogeneity, identified through the data extraction process, concerning their intervention methods, time, and period. The random-effect model was based on the presumption that true effects can vary dramatically between samples and studies; it assumes that differences in the effect size among studies arise from errors in sample extraction and study variations. This model is used in the presence of inexplicable heterogeneity between studies or when homogeneity cannot be assumed between studies, even if there is only a small degree of heterogeneity.

2.5.3. Effect Size

The effect sizes were analyzed through means and standard deviations, depending on whether the outcome variables described in the studies were continuous or not. When a single measurement tool was used to obtain the same intervention results,

we calculated the mean difference (MD) using the final mean values of the intervention and control groups. When various measurement tools were used, we calculated the standardized MD (SMD). The effect of each outcome variable and the 95% confidence interval (CI) were analyzed using the inverse variance method.

2.5.4. Heterogeneity

Heterogeneity refers to the differences arising from the diversity between individual groups that must be integrated in a meta-analysis. Heterogeneity is assessed through either a visual method, where commonalities between studies are verified in their CIs and effect estimations through a meta-analysis forest plot, or through validation of statistical values. The I2 is the main variable in the validation method based on statistical values, and this study assessed heterogeneity between studies using the Higgins I2-statistic. If the I2 value was 25%, 50%, or 75%, heterogeneity was considered low, medium, or high, respectively.

2.5.5. Publication Bias

Publication bias was visually assessed through a funnel plot. A funnel plot refers to a visual scatter plot where the horizontal axis shows the estimated values of the intervention effects, such as the odds ratio or relevant risks obtained from each study, and the vertical axis demonstrates the reverse standard error or research sample size that represent the precision of the provided estimated values. A visually symmetrical funnel plot implies a low potential for publication bias, and an asymmetrical plot means a high potential for publication bias.

III. RESULTS AND DISCUSSION

3.1. General Characteristics of the Studies in Systematic Review

Ten studies were included in the systematic review according to the data selection criteria [Table 1]. Figure 1 illustrates the data selection process. Studies were published in or after 2000 and participants varied in age.

In nine studies, researchers selected the intervention music. The types of selected music included stimulating music, relaxing music, and sedating music, among others (relaxing music appeared most frequently, n = five). In one study, participants selected their preferred music, which resulted in a diverse assortment of music across various genres. The intervention period was diverse, ranging from one session to 19 sessions, and the intervention duration was also diverse, ranging from three to 41 minutes. Stress measurement methods also varied. The visual analog scale (VAS) and surveys were used to measure participants' subjective stress. Cortisol concentrations, pulse, and blood pressure were used to measure objective stress.

Table 1.Summary of examining music therapy and stress on health adults.

First author (years)	Sample size age(M/F) experimental stress	Intervention group	Control group	Recorded music Rhythm	Outcome measures	Intergroup difference	Author's conclusion
Lai (2011)	54 nurses 23.4 years old (0/54) No experimental stress (VAS≥6)	(A) Music listening (n=27) Study room, 30min	(B) No treatment (n=27) Study room, 30min	Experimental-selected (relaxing) 60~80beat/min	(1) Perceived stress (VAS-10cm) (2) Serum cortisol (3) MAP (4) Pulse	(1) p<.001 (2) p<.05 (3) p<.001 (4) p<.001	"The findings provided evidence for nurses to use soothing music as a research-based nursing intervention for stress reduction."
		(a) No treatment (n=27) Study room, 30min	(b) Music listening (n=27) Study room, 30min				
Lai* (2013)	60 nurses 21~42 years old (0/60) 25 min, serial arithmetic test	(A) Music(sedating) listening (n=20) Study room, 30min	(B) Music(stimulating) listening (n=20) (C) No treatment (n=20) Study room, 30min	Experimental-selected (sedating, stimulating) 60~80beat/min	(1) MAP (2) Pulse (3) Anxiety(TAI)	(1) A vs B, p=.02; A vs C, NS (2) NS (3) NS	"Music with different tempi had little effect on mean arterial pressure. Any effect of music on immune markers of stress requires further research."
Lee* (2016)	64 university students exp.19.8/cont.19. 4 years old (19/45) 10min, serial arithmetic test and 10 min other methods	(A) Music listening (n=33) Study room, 20min	(B) No treatment (n=31) Study room, 20min	Participant-selected (various styles) None	(1) Perceived stress (VAS-10cm) (2) BP (3) Pulse (4) LF(%) (5) HF(%) (6) SDNN	(1) p<.005 (2) p<.05 (3) p<.001 (4) p<.001 (5) p<.05 (6) p<.005	"These results suggest music therapy as an intervention for stress reduction."

Koelsch* (2016)	143 healthy adults 20~33 years old (72/71) 1 min 30 second, CO_2 stress test	(A) Music listening (n=71) Study room, 41min	(B) No treatment (n=72) Study room, 41min	Experimental-selected (stimulating) 106~132beat/min	(1) Serum cortisol (2) NA (3) ACTH (4) Mood (POMS)	(1) p<.005 (2) p<.005 (3) p<.005 (4) p=.001	"The music intervention was associated with more positive mood, and strongercortisol responses to the acute stressor in the music group…"
Knight* (2001)	87 undergraduate students 18~50(26.3) years old (44/43) None, task stressor	(A) Music listening (n=45) Study room, 23min 12seconds	(B) No treatment (n=44) Study room, 23min 12seconds	Experimental-selected (relaxing) None	(1) Salivary cortisol (2) Salivary Ig A (3) SBP (4) DBP (5) Heart rate (6) Anxiety(STAI)	(1) NS (2) p<.005 (3) p<.005 (4) p<.05 (5) p<.005 (6) p<.001	"Music treatment may provide a simple, safe, and effective method of preventing the potentially harmful physiological concomitants of the stress reactions."
Rapolien e (2016)	140 seamens 25~64 years old (140/0) No experimental stress (VAS≥2)	(A) Balneotherapy (n=55) Home, 15min, 5times/week, 2weeks	(B) Musiclistening (n=35) Home(avoid noise, sitting, closed eyes, earphone), 20min, 5times/week, 2weeks (C) No treatment (n=50)	Experimental-selected (relaxing) None	(1) Perceived stress (VAS-10cm) (2) Stress symptom (GSDS) (3) BP (4) Pulse (5) Mood (Likert's 5-point scale)	(1) A vs B, p=.03; A vs C, p=.05 (2) A vs B, NS; A vs C, p<.001 (3) NS (4) NS (5) A vs B, p=.03; A vs C, p<.001	"The music therapy group, there were significant positive changes in the number of stress symptoms, intensity, mood, pain, and activity with the effect size of 0.4 to 1.1."
Kim (2015)	30 customer service center workers 30.0 years old (0/30) No experimental stress	(A) Imagery with Music listening(n=15) anywhere(avoid noise, sitting, closed eyes, earphone), 10min(music 3min), 5times/week, total 19times	(B) Imagery with rest (n=15) anywhere(avoid noise, sitting, closed eyes, earphone), 10min(rest 3min), 5times/week, total 19times	Experimental-selected (relaxing) None	(1) Stress response (SRI) (2) Anxiety (STAI)	(1) p<.001 (2) p<.001	"The results of the repeated ANOVA test found the significant difference intimes of measurement within the experimental group on both anxiety and stress measure."
Toma** (2013)	57 healthy adults 20~30 years old (0/57) 10 min, serial arithmetic test	(A) Musiclistening (n=19) Study room, 10min	(B) Water sound listening (n=20) Study room, 10min (C) No treatment (n=18) Study room, 10min	Experimental-selected (relaxing) None	(1) Perceived stress (VAS-10cm) (2) Salivary cortisol (3) Salivary α-amylase (4) HR (5) Anxiety (STAI)	(1) NS (2) A vs B, p=.009; A vs C, NS (3) A vs B, p=.026; A vs C, p=.039 (4) NS (5) NS	"Listening tomusic prior to a standardized stressorpredominantly affected the autonomic nervous system (in terms of a fasterrecovery), and to a lesser degree the endocrine and psychological stress response."
Burns* (2002)	60 undergraduate students 21.6 years old (31/29) 6 min, mild mental rotation task test	(A) Music(classical) listening (n=16) (B) Music(Rock) listening (n=13) (C) Music(self-selected) listening (n=18) Study room, 10min	(D) No treatment (n=13) Study room, 10min	Experimental-selected (classical, Rock) Participant-selected (relaxing) None	(1) Relaxation (Likert scale-7) (2) Anxiety (SAI) (3) Heart rate	(1) NS (2) p<.05 (3) p<.05	"The results of the researchsuggest that music may have an effect on the cognitive component of the stress response."
Fukui (2003)	88 college students 18~27 years old	(A) Musiclistening (n=22) (B) Musiclistening with visual stress (n=22) Study room, 30min	(C) Visual stress (n=22) (D) No treatment (n=22) Study room, 30min	Experimental-selected (English folk song) None	(1) Salivary cortisol (2) Mood (POMS)	(1) p<.005 (2) p<.0001	"As for cortisol, no sex-related differences were found under any of the conditions studied. Cortisol decreased with music and increased under otherconditions."

* stress induction : before intervention / ** stress induction : after intervention

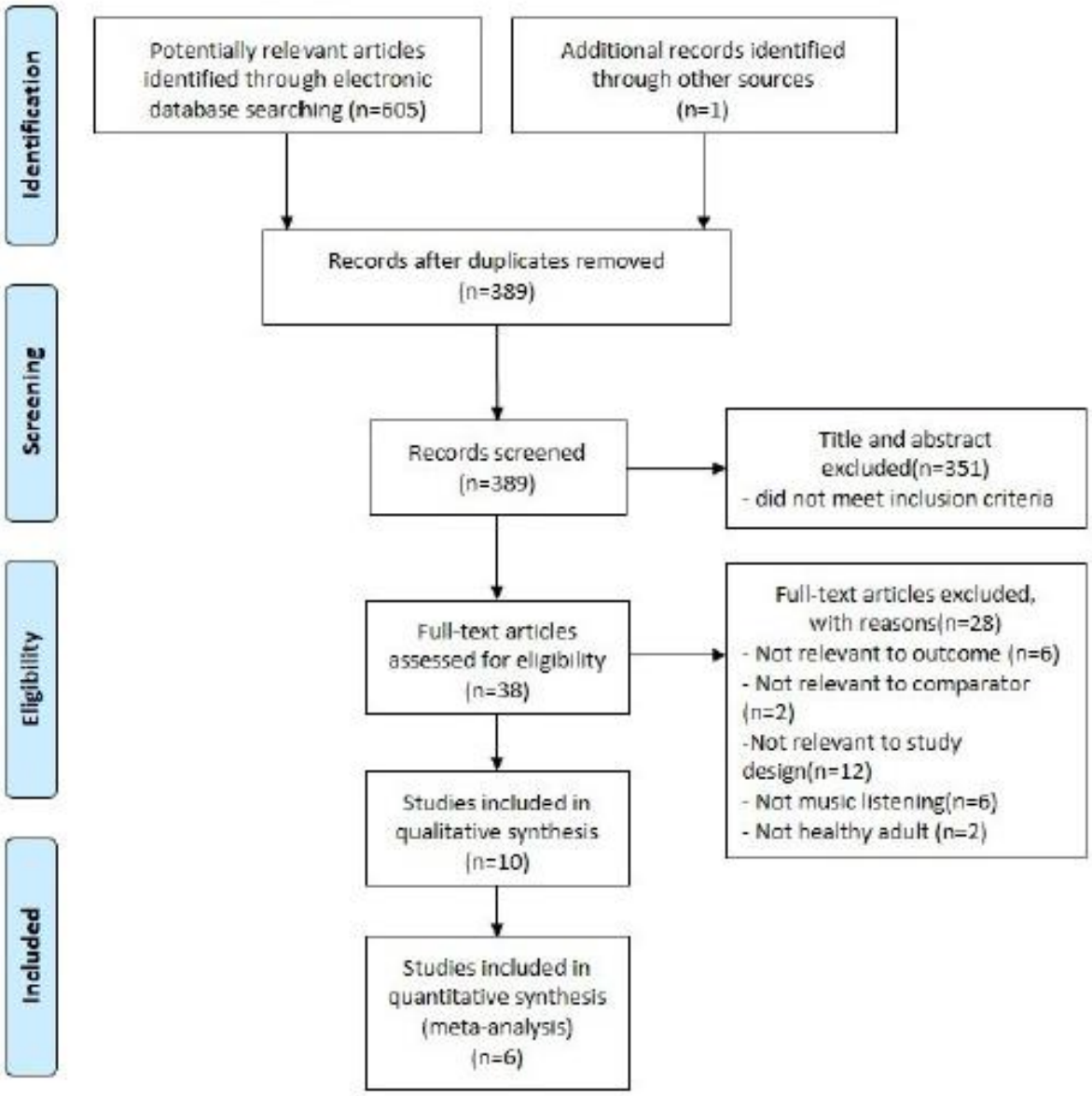
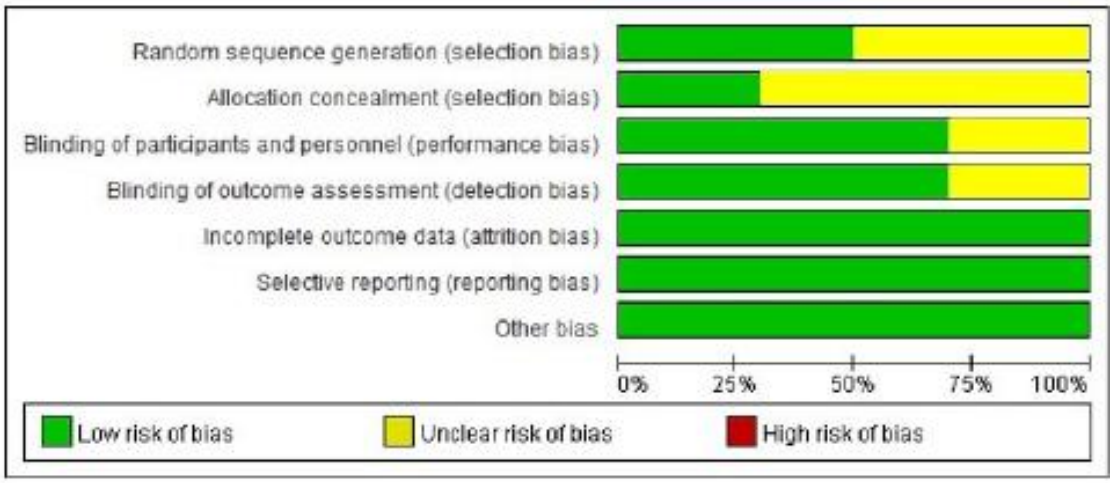


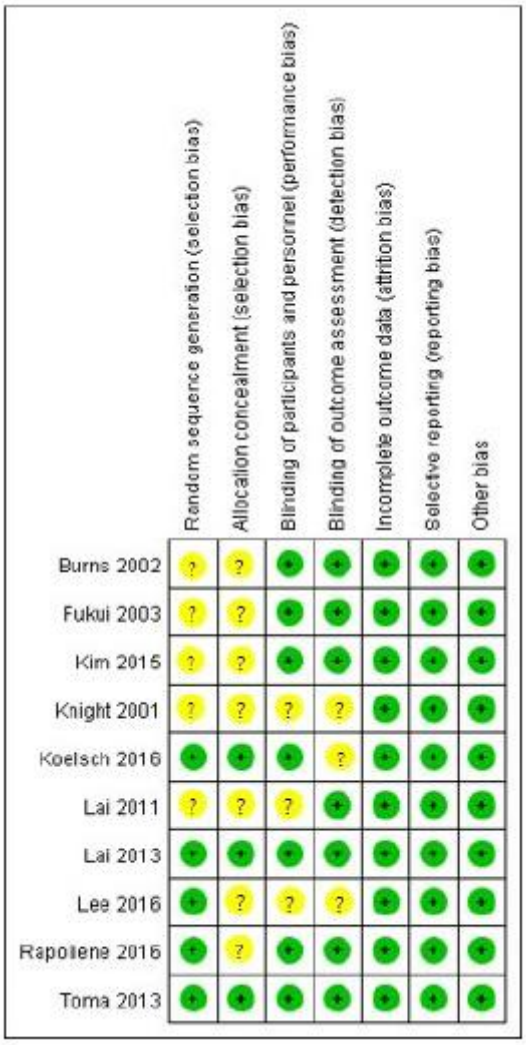
Figure 1.Study flow diagram

3.2. Literature Quality Assessment

Figure 2 illustrates the outcomes obtained from processing literature quality assessment results with RevMan according to assessment standards.



(1) Risk of bias graph: review authors' judgements about each risk of bias as percentages across all included studies.



(2) Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

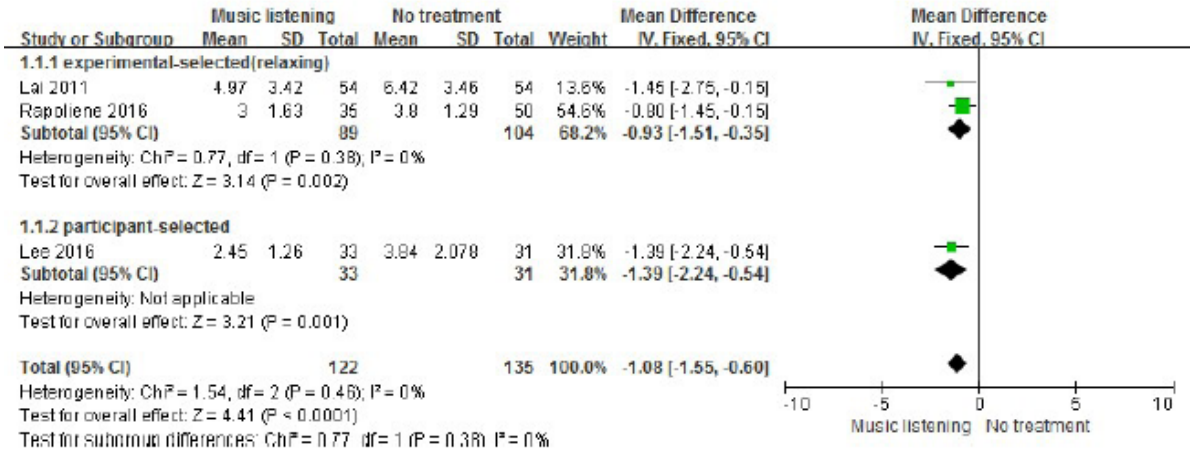
Figure 2. Risk of bias for included study

3.3. Effects Size Estimation

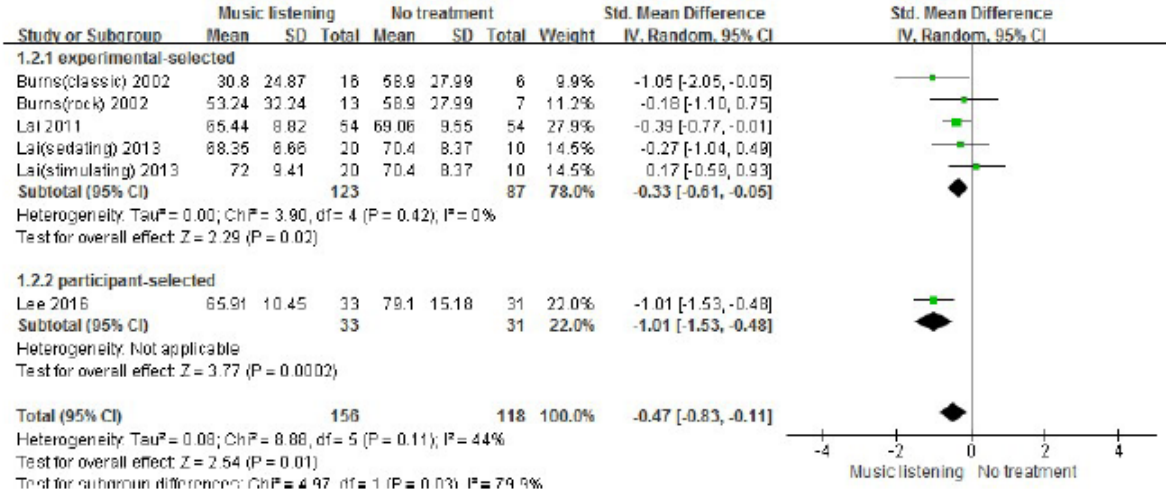
We performed a meta-analysis of six studies that recorded the mean and standard deviation to determine the effect size of music listening on participants' stress [Figure 3]. Further, in three studies the effect size of subjective stress could be analyzed [18-20], and we confirmed homogeneity among them (Higgins I2 = 0%). Consequently, we used the fixed-effect model to analyze the effect size. A comparison with the control group, who did not receive any treatment, revealed a significant decrease in subjective stress (MD = -1.08; 95% CI = -1.55 to -0.60; Z = 4.41, p < .00001).

We used four studies to calculate the effect size of objective stress measured through participants' pulse rate [18, 19, 21, 22], where the control group did not receive any treatment. The studies were not homogeneous (Higgins I2 = 44%). We thus opted for the random-effect model and used a standardized mean for the analysis because of distinct measurement methods in each of the studies. The results showed a decrease in objective stress (SMD = -0.47; 95% CI = -0.83 to -0.11), and the difference between the experimental and control groups was significant (Z = 2.54, p = .01). A subgroup analysis was performed to identify the cause of heterogeneity. Our analysis of the four papers showed that three of them used stimulating and sedative music selected by the researcher [18, 21, 22], and one used participants' preferred type of music [19]. The subgroup analysis results showed a negligible increase (SMD = 0.03; 95% CI = -0.56 to 0.62) in objective stress in the studies that used stimulating music selected by the researcher. There was no significant difference in the effect size between the experimental and control groups, and no heterogeneity was detected (Higgins I2 = 0%). In the studies that used sedative music selected by the researcher, there was a decrease in objective stress (SMD = -0.44; 95% CI = -0.76 to -0.12), and a significant difference in the effect size between the experimental and control groups (Z = 2.67, p = .008), and no heterogeneity was identified. The study that used the music of participants' choice reported a decrease in objective stress (SMD = -0.47; 95% CI = -0.83 to -0.11), and a significant difference in the effect size between the experimental and control groups (Z = 2.54, p = .01).

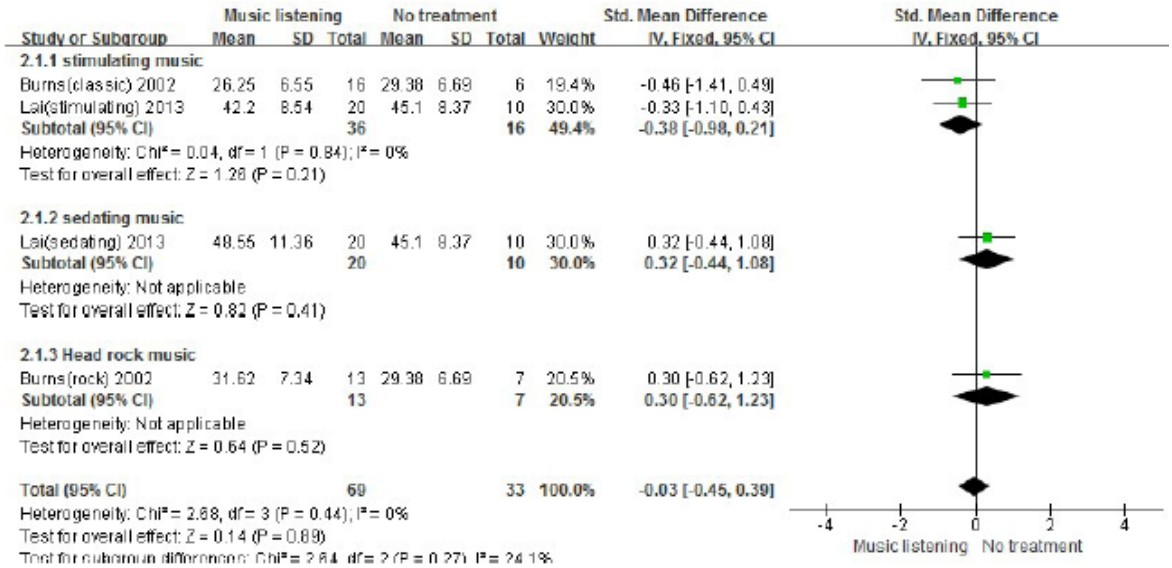
In three studies, the effect size of anxiety could be analyzed, as the control groups either did not receive any treatment or were administered placebos [21-23]. The studies were not homogeneous (Higgins I2 = 65%); therefore, we used the random-effect model to examine the effect size and used a standardized average for the analysis because of distinct measurement tools employed in each of the studies. The results showed a decrease in anxiety (SMD = -0.47; 95% CI = -0.83 to -0.11), and there was no significant difference in the effect size between the experimental and control groups. A subgroup analysis was performed to identify the cause of heterogeneity. We noticed a difference in the intervention period between the three studies: an intervention was performed once in two studies [21, 22], whereas, in one study, the intervention lasted for four weeks [23]. The subgroup analysis results showed a negligible decrease (SMD = -0.03; 95% CI = -0.45 to 0.39) in anxiety in the studies that performed the intervention once. There was no significant difference in effect size between the experimental and control groups, and no heterogeneity was detected (Higgins I2 = 0%). Further, there was a decrease in anxiety (SMD = 1.42; 95% CI = -2.23 to -0.61) in the study that involved a four-week intervention, and the effect size significantly differed between the experimental and control groups (Z = 3.42, p = .0006).



(1) Forest plot of the effects of music therapy for perceived stress in healthy adults



(2) Forest plot of the effects of music therapy for physical stress (pulse) in healthy adults



(3) Forest plot of the effects of music therapy for anxiety in healthy adults.

Figure 3. Forest plot of the effects of music therapy for stress and anxiety in healthy adults

3.4. Discussion

This systematic review examined the effects of music listening on stress in healthy adults. Our review covered 10 papers that were published since 2000 and were selected per the inclusion and exclusion criteria. After a systematic review of the intervention method and results of the 10 selected experimental studies, we performed a meta-analysis of their effects.

We examined subjective stress using three of the RCT studies that recorded the outcome variables through mean and standard deviation (the RCT studies all used the VAS method to measure subjective stress).

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The results showed a significant decrease in subjective stress in the experimental group that received treatment through music listening compared to the control group that received no treatment. The types of music that were used included sedative music and participants' preferred music, and both types of music demonstrated a significant effect in reducing subjective stress. Further, the meta-analysis results showed that music listening was also effective in decreasing pulse rate. Of the types of music used in the experiment, using participants' preferred type of music was most effective. Classical and sedative music was also effective at decreasing pulse rate; however, stimulating music was found to increase pulse rate.

These findings indicate that classical and sedative music are effective at reducing stress, and individuals' preferred type of music is most effective at alleviating stress. However, the comparative studies that examined the stress levels of the experimental group, who listened to sedative music, and the control group, who received no treatment, found no significant difference in stress relief between the two groups [24, 25]. A study that used stimulating music reported a decrease in cortisol levels, an objective outcome variable that is an indicator of stress [26]. These findings are congruent with those of recent studies that reported reduced anxiety, better relaxation, and more efficient treatment when participants were given a choice of music [27, 28]. However, extant literature falls largely short of validating the most appropriate method of application. This warrants a more rigorous research endeavor concerning the effects of music listening on stress relief per genre.

The music interventions were implemented in a soundproof space using earphones, the intervention duration varied from 10 minutes to 41 minutes, and the intervention period was one session in eight papers and two and four weeks in the remaining two papers, respectively. We found that the intervention period had a greater effect on anxiety than on stress. In the studies that provided one session of intervention, the decrease in anxiety was negligible, and no significant difference was noted between the experimental and control groups. However, there was a significant decrease in anxiety between groups in the study that offered a 4-week intervention. This result is consistent with that of a study that reported no significant difference in anxiety levels between experimental and control groups, both comprising healthy adults, the former of which received one session of music intervention and the latter of which received no treatment [25] and another study that applied a music intervention for two weeks with pregnant women, which found a significant difference between experimental and control groups [29]. However, the studies that offered one session of music intervention, each to pregnant women during testing and to patients before an operation, reported a significant difference in anxiety reduction between the two groups, which suggests that the test and operation may have heightened anxiety [30, 31]. Therefore, long-term music listening is effective in decreasing anxiety, and temporary music listening is also effective at reducing anxiety in a stress-inducing environment.

IV. CONCLUSION

The significance of this study lies in a more integrated and scientific validation of the results of RCT studies that report the effects of music listening on stress and anxiety in healthy adults. However, this study also has some limitations given the insufficient number of studies used in the meta-analysis, which warrants a more stringent experimental study in the future. Moreover, previous studies implemented music interventions in diverse ways—they used diverse genres of music over distinct durations and periods. Such an unstandardized intervention protocol may compromise the positive effects of music intervention reported in many studies and hinder its effective application as a nursing intervention method in clinical settings.

In this light, we call for further research endeavors that examine the effects of the music intervention in further detail (e.g., genre, duration, and period through repeated interventions) while controlling for exogenous factors and experiment design, to formulate a standardized protocol. Future studies that use this protocol should validate the evidence concerning the effects of music therapy.

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