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A systematic review and meta-analysis of music interventions to improve sleep in adults with mental health problems

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Abstract

Background. Music listening has been used as a sleep intervention among different populations. This systematic review and meta-analysis aimed to explore whether music is an effective sleep aid in adults with mental health problems.

Methods. We searched for studies investigating music interventions for sleep in adults with mental health problems. The primary outcome was subjective sleep quality; secondary outcomes were objective sleep outcomes, quality of life, and other mental health symptoms. Risk of bias assessment (RoB1) and random-effect model were used for the systematic review and meta-analyses.

Results. The initial screening ($n = 1492$) resulted in 15 studies in the systematic review. Further qualified studies led to the meta-analysis of sleep quality ($n = 7$), depression ($n = 5$), and anxiety ($n = 5$). We found that the music listening intervention showed a potential effect on subjective sleep quality improvement compared to treatment-as-usual or no-intervention groups. When excluding an outlier study with an extreme effect, the meta-analysis showed a moderate effect on sleep quality (Hedges' $g = -0.66$, 95% CI [-1.19, -0.13], $t = -3.21$, $p = 0.0236$). The highest risk of bias was the blinding of participants and researchers due to the nature of the music intervention.

Conclusions. Our results suggest that music interventions could have the potential to improve sleep quality among individuals with mental health problems, even though more high-quality studies are needed to establish the effect fully.

Introduction

Sleep is paramount to mental health as poor sleep quality is associated with various mental health problems. Sleep problems are associated with stress and reduced quality of life [1] and are considered a risk factor for mental health problems globally [2]. Sleep difficulties are part of the diagnostic criteria for major depressive disorder (MDD), anxiety disorder, and post-traumatic stress disorder (PTSD) [3]. As such, treatments enhancing sleep quality are key to improving mental health (in this paper, we used the terms mental health problems and mental health conditions interchangeably to cover clinically diagnosed mental disorders and other non-diagnosed mental health problems).

Besides playing an important role in various mental conditions, sleep quality is also strongly associated with general health and well-being. One recent meta-analysis showed that better sleep quality was associated with improvements in composite mental health, depression, anxiety, and rumination [4]. Furthermore, sleep quality also has a positive impact on physical health and well-being. Studies have found that sleep improvements were linked to the improvement of self-reported physical health, work performance, and cognitive abilities [5–7].

Due to the robust benefits of good sleep quality for both mental and physical health, different types of treatments for improving sleep quality have been investigated. Standard treatments for improving sleep problems include medication and cognitive behavioral therapy for insomnia (CBT-I). Medications such as eszopiclone and lemborexant showed effective improvement in sleep quality, but the safety and potential adverse events, such as dependency and daytime drowsiness, should be considered [8]. Moreover, the recent European guidelines for insomnia treatment recommend pharmacotherapy only as a short-term solution [9]. An alternative option is CBT-I, which is recommended as a first-line treatment. Studies have found that CBT-I is an effective treatment for improving sleep quality in different populations [10, 11]. However, the use of CBT-I can be limited by the fact that it is demanding to complete, and not all patients achieve remission [12, 13]. Furthermore, it can be hard to find available treatment in many countries, and it may be expensive [14]. Therefore, it is common to seek other treatment alternatives.

Many people do not seek clinical treatment for their sleep problems but instead engage in various alternative strategies to improve sleep [15]. One common strategy is to use music as a non-pharmacological sleep aid [16–18]. In clinical research, music interventions for sleep have been examined in systematic reviews and meta-analyses showing a beneficial effect of music on sleep quality in different populations such as critically ill patients [19, 20], older adults [21, 22], adults with insomnia [23], and women with pregnancy [24, 25]. Music is increasingly used in healthcare settings [26], and several mechanisms may underlie the impact of music on sleep. For example, music can facilitate psychological/physical relaxation, regulate the emotional state of the listener, distract from negative thoughts, or mask noisy environments [27, 28]. Biologically, studies have shown that music can impact part of the neurochemical system and down-regulate cortisol levels, which can facilitate relaxation and sleep [29, 30]. The advantages of using music to improve sleep are that it is easy and safe to implement in individuals' daily lives. So far, no systematic review has evaluated the evidence of the effect of music on sleep in adults with mental health problems. Therefore, the main objective of this study was to evaluate whether music is effective as a sleep aid in adults with mental health problems, and the secondary aim was to explore the effect on related mental health outcomes.

Methods

Search strategy

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [31], and the review protocol was pre-registered in the Prospero database (registration number: CRD42023421382). We used the following electronic databases to conduct a systematic search: Pubmed, Scopus, Embase, PsycINFO, RILM, Cinahl, ClinicalTrial, Cochrane database, China National Knowledge Infrastructure, OSF database, and WHO trial register database. The search string included terms of music, sleep, and mental health problems. Specifically, search terms related to mental health problems were adapted from a previous systematic review on insomnia and mental disorders [32] (see Supplementary Table S1).

Inclusion and exclusion criteria

For this systematic review, we followed the pre-specified inclusion and exclusion criteria. We included quantitative studies (randomized controlled trials, cohort studies, and case-control studies) investigating the effect of music interventions on sleep in adults (age > 18 years old) with mental health problems. We included studies that employed music listening as an intervention. Other types of music interventions, such as songwriting, improvisation, or rhythmic auditory stimulation (in a non-music context), were excluded. In the case of combined interventions, studies were included when music intervention was the main component. We excluded studies with participants who were diagnosed with neurodegenerative disorders or younger than 18 years old. The primary outcome was subjective sleep quality. The secondary outcomes were objective sleep measurement (e.g., actigraphy and polysomnography sleep parameters) and psychological well-being (e.g., quality of life, mental illnesses symptoms severity).

Data extraction and synthesis

Record selection and data extraction were independently conducted by two researchers (NZ and KVJ) using the online software Covidence [33]. After duplication detection, the two researchers independently screened the titles and abstracts to remove non-relevant reports. The relevant full-text papers were retrieved and evaluated according to the pre-defined exclusion/inclusion criteria. Disagreements were resolved by discussion. For the included studies, the following information was extracted: publication years, study designs, sample size, attrition rate, age, sex distribution, primary/secondary outcomes, and intervention characteristics. The extracted data of the included trials was included in a narrative synthesis for each outcome. When enough studies reported a predefined outcome, we evaluated them and used qualified studies to conduct a meta-analysis. For the meta-analyses, we only included studies that compared the music intervention group with a control group, which was defined either as treatment-as-usual or no intervention. Studies that compared music intervention to an active intervention group (e.g., medication, acupuncture, or meditation) were excluded. Authors were contacted if additional data was needed for meta-analyses.

We used random effect models for both primary and secondary outcome meta-analyses. The outcomes were continuous, and we used standardized mean differences (SMD) when outcomes were measured on different scales. The direction of the scales was checked and reversed in case of discrepancy. To correct for potential small-sample size bias ($n < 20$), we applied Hedges' g [34]. We used a restricted maximum likelihood (REML) estimator in the model due to its robustness for continuous variables and the Knapp–Hartung adjustment to reduce the risk of committing the type I error. We used I^2 statistics tested between-study heterogeneity. A group of outlier diagnostic tests was conducted to detect outliers or influential cases. Quantitatively identified influential cases were further evaluated by their traits, such as study design and intervention characteristics. If a study used multiple scales to measure the same psychophysiological construct (e.g., sleep quality, depression, anxiety), each scale was tested separately in the meta-analysis models.

All analyses were conducted through R version 4.2.0 [35], with "dmetar" [36] and "meta" [37] packages.

Risk of bias assessment

To evaluate the risk of bias, we used the Cochrane risk-of-bias tool version I (RoB1) [38]. Three researchers independently evaluated the studies (NZ, HNL, KVJ), and disagreements were resolved through discussion. Studies were rated with low, high, or unclear risk in the following domains: random sequence generation, allocation concealment, blinding of participants and researchers, blinding of outcome assessment, incomplete outcome data, selective reporting, and other biases. The unclear risk was given when there was not enough information for the assessment. In addition, we used funnel plots to evaluate publication bias. In case a researcher was the author of an included study, the risk of bias assessment was done by two authors not involved in the specific study.

Results

Search results

We conducted database searches in April 2023. After the duplication detection, we identified 1492 records. In the subsequent title and abstract screening phase, we excluded 1443 records. The remaining 49 records proceeded to the full-text retrieval stage. After the full-text assessment, 15 studies were included in the systematic

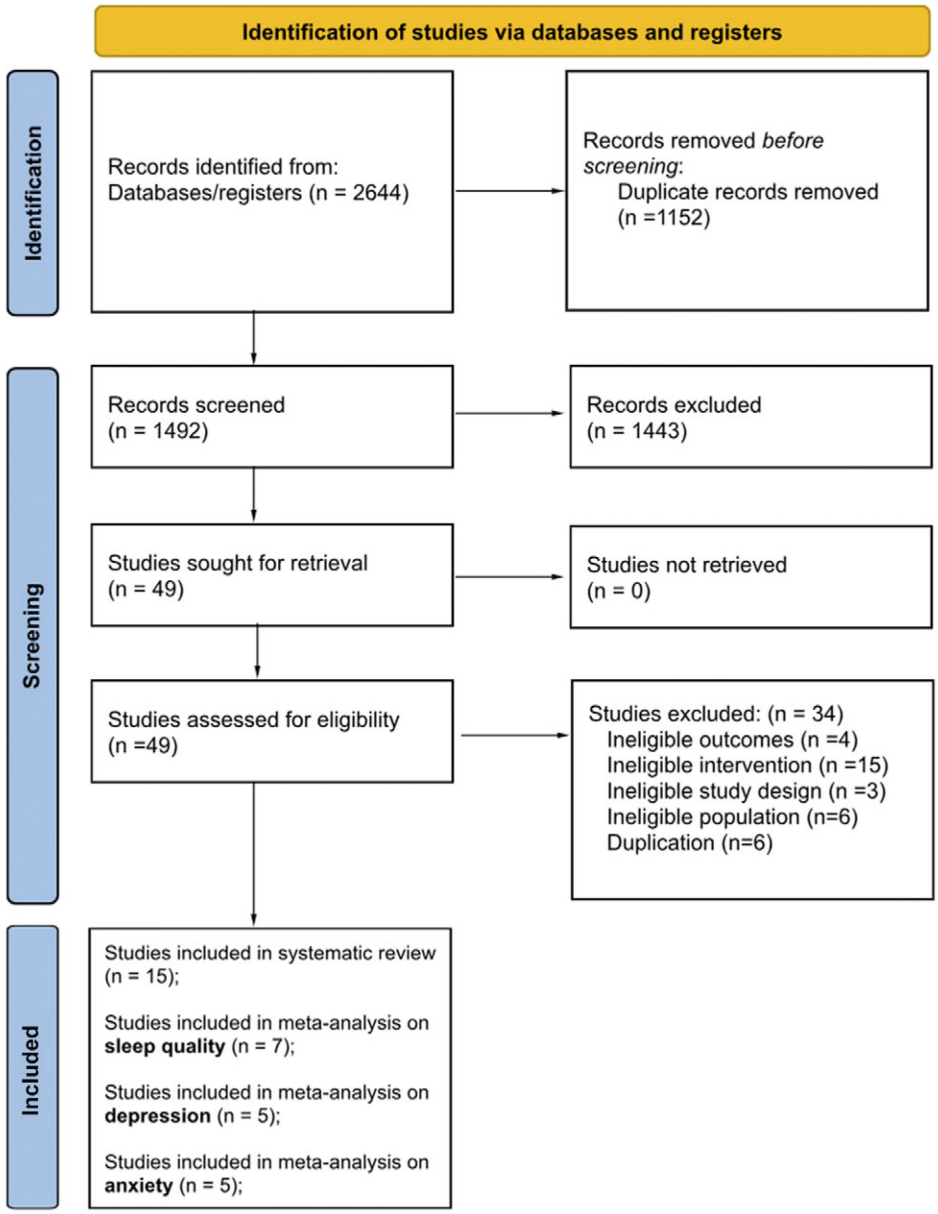

Figure 1. PRISMA flow chart showing the number of studies identified, screened, excluded, and included.

review. Of these 15 studies, seven studies could be included in the meta-analysis for the primary outcome “subjective sleep quality”, five studies for a meta-analysis of the secondary outcome “depression”, and five studies for a meta-analysis of the secondary outcome “anxiety” (see Figure 1).

Characteristics of included studies

The characteristics of the included studies are presented in Table 1. The publication year of the 15 included studies ranged from 2005 to 2022. The majority of the studies were conducted in China [39–41], Denmark [42, 43], Israel [44, 45], and the US [46, 47]; the other six studies were conducted in different countries [48–53]. Nine of the included studies were randomized control trials [39–41, 43, 44, 47, 49, 50, 52], and four studies were pre-registered before they conducted the experiments [43, 49, 50, 53].

The included studies had a total of 1,120 participants. The average sample size was 75 and the sample size of the single study ranged from 13 to 280 participants.

The majority of the studies ($n = 7$) focused on participants with depression [39–41, 43, 47, 52, 53]. Other mental problems included trauma and PTSD [42, 44, 46], Schizophrenia [45, 48], alcohol use disorder [49] and stress [50]. Most of the studies used music described as soft and slow. Some studies used culturally unique music from specific countries [39–41, 48, 52]. The duration of the music intervention sessions ranged from 20 to 60 min with an average of 40 min across all studies. The intervention period ranged from 5 to 42 days. Five studies compared the music intervention group with other active intervention groups (e.g., acupuncture, medication, and cognitive behavioral therapy) [47, 49, 50–52], and others compared with passive control or treatment-as-usual groups.

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Table 1. Characteristics of the included studies

Study name	N	Country	Participants	Comparison group	Study type	Mean age	Music duration	Intervention period	Timing of intervention	Who chose the music	Sleep measure	Mental health measure
Ahlberg 2016	280	Sweden	AUD	Two acupuncture groups	RCT	44.5	40 min	28 days	NA	Researchers	ISI	BAI
Blanaru 2012[a,b,c]	13	Israel	PTSD	No intervention + muscle relaxation	RCT	45.7	40 min	7 days	Bedtime	Researchers	MSQ, TSQ, Actigraphy	BDI, HAMD, STAI
Bloch 2010	32	Israel	Schizophrenia	No control group	Quasi-experiment	45.7	40 min	7 days	Bedtime	Researchers	MSQ, TSQ, Actigraphy	BDI, STAI
Braun Janzen 2019	20	Canada	Depression	No control group	Quasi-experiment	47.8	30 min	35 days	NA	Researchers	PSQI	MADRS
Deshmukh 2009	50	India	Depression	Medication, Benzodiazepines	RCT	33	60 min	28 days	Bedtime	Researchers	PSQI	MADRS
Hernandez-Ruiz 2005[a,c]	28	USA	PTSD	No intervention	Quasi-experiment	35.4	20 min	5 days	Bedtime and daytime	Participants	PSQI	STAI
Jespersen 2012[a]	19	Denmark	PTSD	No intervention	Quasi-experiment	37	60 min	21 days	Bedtime	Researchers	PSQI	NA
Lee 2022	80	South Korea	Stress	ASMR sounds	RCT	46.1	15 min (day); 30 min (night)	21 days	Bedtime and daytime	Participants*	PSQI, ISI	BDI, STAI
Liu 2022[b,c]	80	China	Depression	TAU	RCT	34.3	30 min	14 days	Bedtime	Researchers	Actigraphy	HAMA, HAMD
Lu 2020[b,c]	80	China	Depression	TAU	RCT	53.2	60 min	28 days	Bedtime and daytime	Researchers	Objective sleep measure	SAS, SDS
Lu 2022[a]	66	Taiwan	Schizophrenia	TAU	Quasi-experiment	53	60 min	28 days	Bedtime	Researchers	PSQI	NA
Lund 2022[a,b]	112	Denmark	Depression	Waitlist	RCT	33.7	At least 30 min	28 days	Bedtime and daytime	Participants*	PSQI, Actigraphy	HAMD
Niet 2010[a]	171	Netherlands	Psychotic, mood, anxiety disorders	CBT, No treatment	Quasi-experiment	NA	NA	14 days	Bedtime	Participants*	RCSQ	NA
Wahbeh 2019	29	USA	Depression	Meditation	RCT	66	At least 20 min	42 days	Anytime	Participants	PSQI	CESD
Yang 2021[a,b,c]	60	China	Depression	TAU	RCT	40	30 min	14 days	Bedtime	Researchers	PSQI	HAMA, HAMD

Abbreviations: AUD: Alcohol use disorder, BAI: Beck Anxiety Inventory, BDI: Beck Depression Inventory, CESD: Center for Epidemiologic Studies Depression Scale, HAMA: Hamilton Anxiety Scale, HAMD: Hamilton Depression Rating Scale, MADRS: Montgomery Asberg Depression Rating Scale, MSQ: mini-sleep questionnaire, PSQI: Pittsburgh Sleep Quality Index, PTSD: Post-traumatic stress disorder, RCSQ: Richards-Campbell Sleep Questionnaire, RCT: Randomized controlled trial, SAS: Zung Self-Rating Anxiety Scale, SDS: Zung Self-Rating Depression Scale, STAI: State-Trait Anxiety Inventory, TAU: Treatment as usual, *: Participants' choice among pre-selected playlists.

[a]Studies qualified for sleep quality outcome meta-analysis.

[b]Studies qualified for depression outcome meta-analysis.

[c]Studies qualified for anxiety outcome meta-analysis.

Outcomes

Twelve studies reported the primary outcome of subjective sleep quality using self-report questionnaires [41–48, 50–53]. Among them, nine studies used The Pittsburgh Sleep Quality Index (PSQI) [41–43, 46–48, 50, 52, 53]. The PSQI consists of 19 items with a total score ranging from 0 to 21 and higher scores indicating a more severe sleep problem [54]. Two studies used the mini-sleep questionnaire (MSQ). This scale consists of 10 items. Each item ranges from 1 (never) to 7 (always), and higher scores indicate more severe sleep problems [55]. One study applied the Richards-Campbell Sleep Questionnaire (RCSQ) [51, 56]. This scale consists of five items, with a higher score indicating better sleep quality.

The secondary outcomes included additional sleep and mental health measures. Five studies measured objective sleep parameters such as sleep efficiency, sleep latency, and total sleep time [39, 40, 43–45]. In addition, two studies measured insomnia severity with the insomnia severity index (ISI) [49, 50, 57]. ISI is a seven-item questionnaire with higher scores indicating more severe insomnia symptoms.

Regarding mental health outcomes, nine studies reported measurement of depression symptoms [39–41, 43–45, 47, 52, 53], and the following measurements were employed: the Montgomery Asberg Depression Rating Scale (MADRS) [58], the Beck Depression Inventory (BDI) [59], the Zung Self-Rating Depression Scale (SDS) [60], the Center for Epidemiologic Studies Depression Scale (CES-D) [61], and Hamilton Depression Rating Scale (HAM-D) [62]. Eight studies measured anxiety symptoms [39–41, 44–46, 49, 50]. The following anxiety scales were used: the Beck Anxiety Inventory (BAI) [63], the State-Trait Anxiety Inventory (STAI) [64], the Zung Self-Rating Anxiety Scale (SAS) [65], and the Hamilton Anxiety Scale (HAMA) [66].

Risk of bias

We evaluated the risk of bias for all 15 studies using the Cochrane Risk of Bias assessment tool (RoB version I) (see Figure 2). The highest level of risk was in the domain of blinding of participants and researchers (see Supplementary Figure S1). Given the fact that music interventions are difficult to implement without the awareness of the participants, 14 out of 15 studies were rated as high risk of bias as they did not design any procedures for double-blinding. One study reported the use of a double-blind method without providing additional details and was rated as an unclear risk of bias [50]. The second highest level of risk was the domain of blinding of outcome assessment. Eleven studies did not provide information from this domain and were rated as unclear risk of bias. One study was rated as high risk of bias because only one researcher conducted the intervention; therefore, it was unlikely that the assessor was blinded [42]. Three studies used blinding procedures for the outcome examiner and were evaluated as low risk of bias [41, 47, 52].

The results of the selective reporting domain were mostly unclear due to the low study pre-registration rate. Specifically, 10 studies did not pre-register their experiments. Four studies that had pre-registration were rated as low risk of bias after we compared their reported and pre-registration outcomes [43, 49, 50, 53]. One study was rated at a high risk of bias due to the multiple comparisons on sub-items from the sleep quality questionnaire [45].

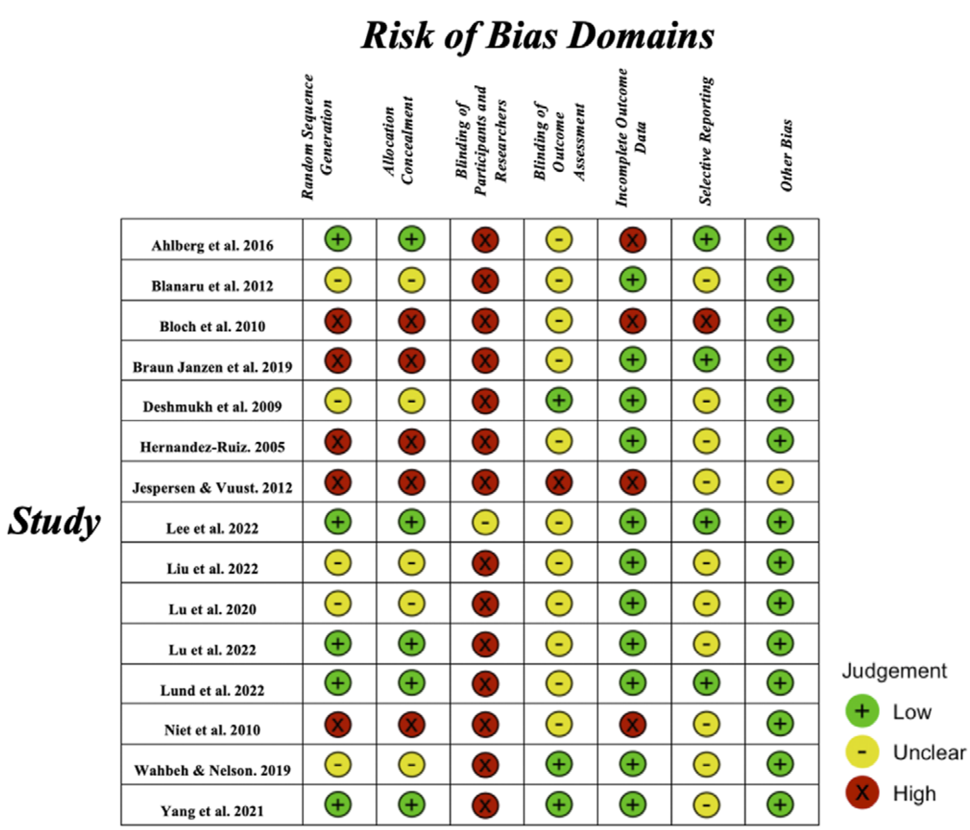

Figure 2. Risk of bias assessment of each individual study on each of the seven risk of bias domains. Green indicates low risk of bias, yellow indicates unclear risk of bias and red indicates high risk of bias.

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For the random sequence generation domain, five studies did not use the randomized controlled method and were rated as high risk of bias [42, 45, 46, 51, 53]. Five studies had randomized procedures, but the method was not further explained and therefore, was rated as an unclear risk of bias [40, 44, 47, 48, 52]. Five studies used a randomized controlled method with a clear explanation of their method and were rated as low risk of bias [41, 43, 48–50]. These ratings were the same for the allocation concealment domain.

Most of the studies ($n = 11$) showed a low attrition rate and were rated as low risk of bias. Four studies were rated as high risk of bias in the domain of incomplete outcome data due to their high dropout rate [42, 45, 49, 51]. For the other bias domain, one study was found not to report other treatments of adults with PTSD during the intervention, therefore, it was rated as an unclear risk [42]. Other studies were rated as low risk of bias in this domain.

We used funnel plots to examine the risk of publication bias. After the visual inspection, asymmetrical patterns from the funnel plots were spotted. After the removal of the outliers in all meta-analyses, the data points became more symmetrical compared to the original model (see Supplementary Figures S2.1, S2.2, S2.3). However, due to the small sample size ($n < 10$) and high heterogeneity ($I^2 > 75\%$), the results could be biased.

Primary outcome

A meta-analysis was conducted on the subjective sleep quality outcome ($n = 7$). As mentioned above, this outcome was reported by 12 studies. Three studies were excluded from the meta-analysis due to comparing with active intervention groups [47, 50, 52], and two were excluded because there was no control group [45, 53].

The results of the meta-analysis showed a large but statistically non-significant effect on subjective sleep quality between the music intervention and control groups in individuals with mental health problems ($g = -1.09$, 95% CI [−2.37, 0.19], $t = -2.09$, $p = 0.0814$). The model showed high heterogeneity ($I^2 = 90.5\%$), further supporting a random effect model. We ran multiple diagnostic tests and identified Lu et al. (2022) [48] as an outlier (see Supplementary Figure S3.1). The 95% CI of the outlier case did not overlap with the pooled effects. After a re-run of the meta-analysis without the outlier, we found a moderate statistically significant difference in the effect of the music intervention on sleep quality ($g = -0.66$, 95% CI [−1.19, −0.13], $t = -3.21$, $p = 0.0236$) (see Figure 3). We examined the qualitative characteristics of the outlier case, but the study design elements (e.g., intervention duration and music selection) and sample size did not stand out from others. Similarly, the study did not stand out regarding the Risk of Bias assessment.

Similar to the results of the meta-analysis, four out of the five studies not included in the meta-analysis showed subjective sleep quality improvement within the music intervention group [45, 50, 52, 53]; one study found no effect within the music group [47]. Music intervention groups were found to have no significant differences in sleep outcomes from other active intervention groups such as ASMR listening or medication [50, 52].

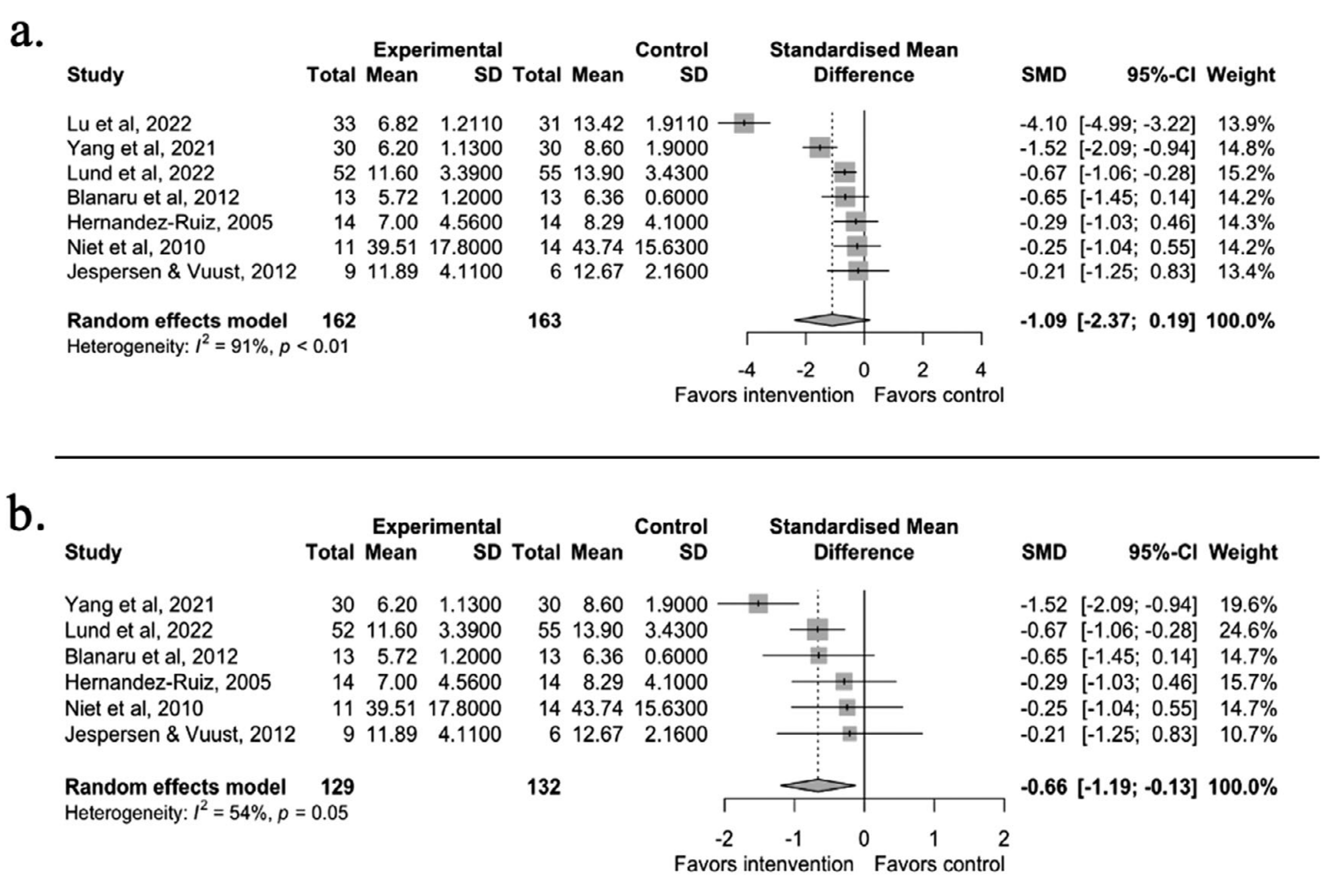

Figure 3. Panel a shows the meta-analysis results from the seven studies included in the sleep quality meta-analysis. Panel b shows the results without the outlier study [48]. A negative effect value indicates a reduction in sleep problems and thereby improved sleep quality. The effect size is Hedges' *g*.

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Secondary Outcomes

Depression

The second meta-analysis was conducted on depression symptoms (n = 5). Depression symptoms were reported in nine studies. Following the same exclusion/inclusion criteria as the sleep quality meta-analysis, four studies were excluded due to comparison with active intervention groups or no control group [45, 50, 52, 53]. The results showed a large but statistically non-significant effect on depression symptoms between the music intervention and control groups ($g = -1.01$, 95% CI [−2.64, 0.63], $t = -1.71$, $p = 0.1633$). The random-effect model showed high heterogeneity (I^2 = 93.7%). We then ran the diagnostic analyses and identified Yang et al. (2021) [41] as an influential case (see Supplementary Figure S3.2). After we re-ran the model without the outlier, the effect was moderate and still statistically non-significant ($g = -0.46$, 95% CI [−1.36, 0.43], $t = -1.64$, $p = 0.1991$) (see Figure 4). When examining the characteristics of the outlier study [41], we found that the baseline depression symptoms of the participants were high (HAMD = 23). However, this single trait was not strong enough to explain the large intervention effect of the study. Therefore, the cause of the large effect size was still unclear.

All four studies that were not included in the meta-analysis showed improvement in depression symptoms within the music group [45, 50, 52, 53]. Furthermore, the music groups had no statistically significant differences compared with other active intervention groups, including medication and ASMR sounds [50, 52].

Anxiety

The third meta-analysis was conducted on anxiety symptoms (n = 5). Eight of the included studies reported anxiety symptoms. Two were excluded due to comparisons of the active intervention groups [49, 50], and one was excluded due to no control group [45]. The results showed a large but statistically non-significant effect on anxiety symptoms between the music intervention and control groups ($g = -1.97$, 95% CI [−4.59, 0.65], $t = -2.09$, $p = 0.1052$). After running the diagnostic analyses (see Supplementary Figure S3.3), the same influential case from the depression meta-analysis, Yang et al. (2021) [41] was identified. After running the model without the outlier, the effect was still large and statistically non-significant ($g = -1.12$, 95% CI [−2.25, 0.01], $t = -3.15$, $p = 0.0512$) (see Figure 5).

Another sensitivity analysis was conducted because one of the included studies [44] measured anxiety twice with two different scales in one experiment (STAI and HAMA). HAMA was used for the final analysis since there were no statistically significant differences between the two scales.

The studies not included in the meta-analysis showed mixed results on the anxiety outcomes. Two studies found improvement in anxiety symptoms within the music groups [49, 50], but one did not [45]. In addition, no differences were found between the music group and other active intervention groups, including acupuncture and ASMR sounds [49, 50].

Other sleep outcomes

Five studies reported objective sleep outcomes. Four studies used actigraphy as an objective sleep measure [39, 43–45], and one did not specify the method for objective measurement of sleep [40]. Within-group or between-group sleep improvement with the music intervention was found in sleep outcomes such as sleep efficiency [39, 40, 44, 45], sleep latency [40, 44, 45], and wake after sleep onset [39, 40, 44]. Two studies reported total sleep time with mixed results [40, 45]. One additional study found no improvement or differences in all actigraphy sleep measures, possibly due to insufficient sleep log data [43].

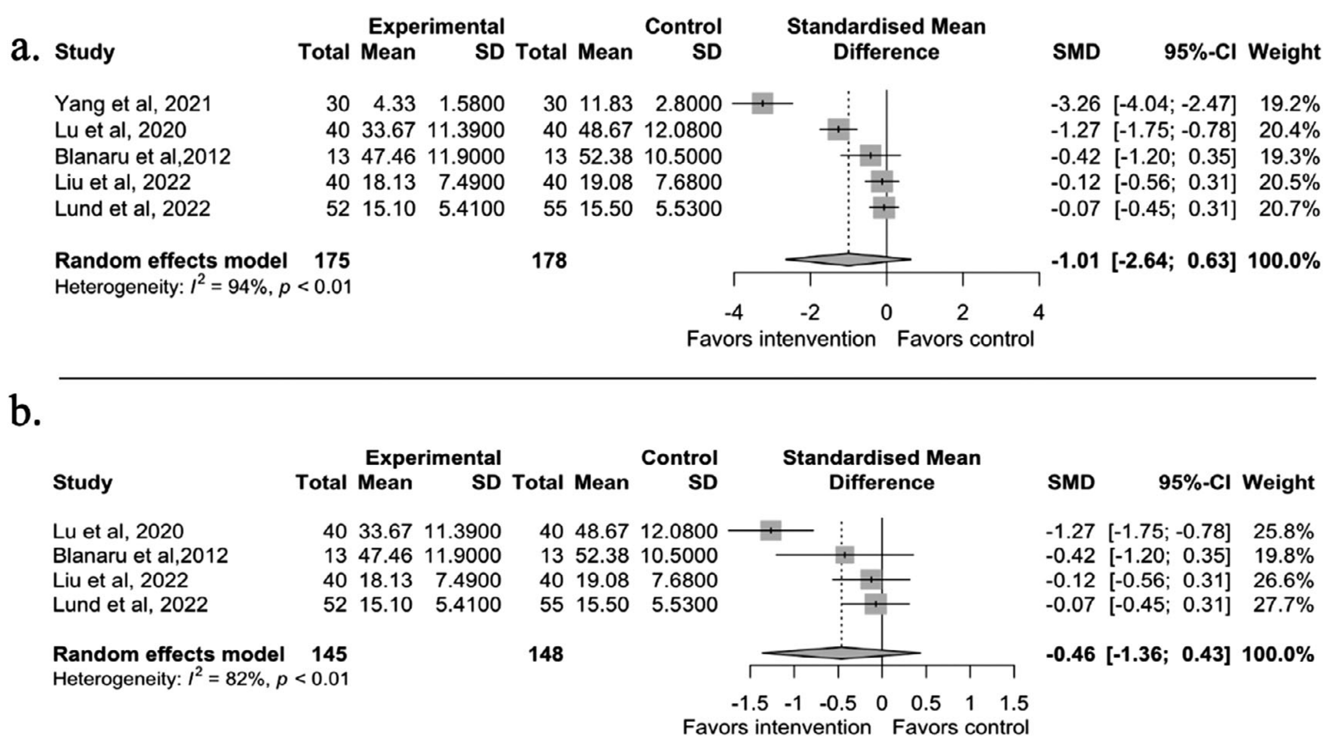

Figure 4. Panel a shows the depression meta-analysis results with all five available studies. Panel b shows the results without the outlier study [41]. A negative effect value indicates a decrease in depression symptoms. The effect size is Hedges' *g*.

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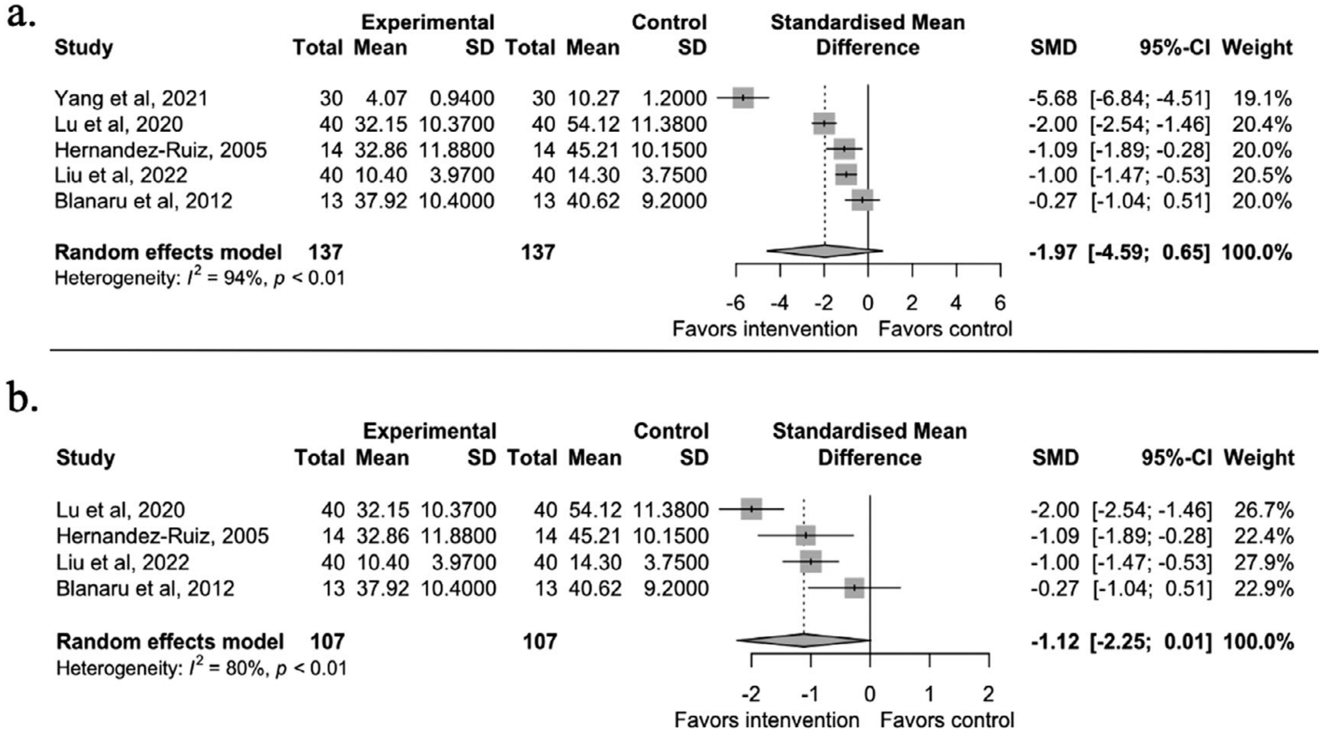

Figure 5. Panel a shows the anxiety meta-analysis results, including all five available studies. Panel b shows the results without the outlier study [41]. A negative effect value indicates a decrease in anxiety symptoms. The effect size is Hedges' *g*.

Insomnia severity was reported by two studies, and they both found improvement within the music group [49, 50]; regarding the between-group comparison, neither acupuncture [49] nor the ASMR intervention group [50] had statistically significant differences compared to the music groups.

Discussion

The results of this systematic review (n = 1,120 participants) and meta-analysis showed that listening to music can have a beneficial effect on sleep quality in individuals with mental health problems. Few studies reported other sleep outcomes, and there was no clear effect on depressive symptoms and anxiety. The quality of the studies was limited by the difficulty of blinding participants to the intervention and by the unclear blinding of the outcome assessors. Seven of the included studies could be pooled in a meta-analysis. One study was identified as an influential case with a much larger effect than the others. When excluding this case, the meta-analysis showed a moderate reduction in sleep problems with the music intervention compared to treatment as usual or no-intervention control groups.

Our results align with reviews of music and sleep in other populations. Recently, a number of reviews have been published showing the beneficial effects of music on sleep quality in people with poor sleep related to age [22], hospitalization [19, 20], and insomnia [23]. These meta-analyses have found moderate to large positive effects of music on sleep quality. Our meta-analysis showed a moderate effect size, and the size of the effect in the included studies varied substantially, reflecting high heterogeneity. This could indicate that the effect may not be stable among the studies. However, heterogeneity was substantially reduced when excluding one outlier study with an extreme effect [48]. We could not identify any study design elements or intervention characteristics explaining why the sleep quality effect size was about four times larger than in the other studies. All participants from the outlier study were selected from the same center, and one possible explanation could be that there were unknown confounders that amplified the effect. Still, it remains unclear what may have caused this distinguishable larger effect, therefore, we presented the pooled results with and without the outlier for transparency and completeness purposes.

The characteristics of the music intervention vary among the studies. Specifically, most of the studies used music playlists that were pre-selected by the researchers, and only a few studies allowed the participants to choose. Previous reviews have found no evidence that participants' influence on the choice of music is crucial for the effect of music on sleep [23], but music preference has been found essential in other domains, such as the analgesic effects of music [67]. The role of the specific music selection for sleep has not yet been investigated in different populations. It could be that for sleep problems in adults with mental health problems, the effect of music on sleep is facilitated particularly by distraction and emotion regulation, making music preference more important. The intervention music was generally described as soothing and relaxing, and culturally unique music was also implemented by some researchers.

Still, no study reported how well the participants liked the intervention music, and only two studies [46, 47] allowed participants to completely select their own music. Another feature that varied substantially was the total intervention exposure, ranging from less than 5 h to up to 30 h. Interestingly, the differences in the intervention time did not always align well with the effect size of the studies. For instance, after we compared different units of music intervention durations (e.g., duration per session, intervention period (days), and total intervention exposure (time per session × days) with both single study effect size and within-group PSQI improvement, we found that

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longer intervention time was not always associated with a larger effect on sleep improvement (see Supplementary Figures S4.1, S4.2). This is in contrast to previous research indicating a dose–response relationship between music and sleep improvement [68]. A next step for future research would, therefore, be to explore the role of music preference and whether there should be a gold standard when designing music intervention for sleep in individuals with mental health problems. Based on the results of this systematic review, the recommendations for a music sleep intervention in adults with mental health problems would be 30–60 min of listening to soothing music every night at bedtime for a minimum of 5 days. In addition, the severity of mental health problems should be considered in relation to the intervention period.

One limitation of this study was the inclusion of both RCT and non-RCT studies in our meta-analyses. The reason for including both types of studies was to provide a general overview of this topic since we anticipated at the pre-registration stage that there would be limited numbers of qualified studies. Indeed, this was true, and as such, we were not able to quantitatively explore subgroup differences related to the type or severity of mental health problems, the intervention duration, or identify other confounders such as treatment-as-usual medication doses. Another limitation was the possibility that the small sample size could bias the results of the meta-analysis. To further test the robustness of the results, a follow-up Bayesian sensitivity meta-analysis was conducted. The results of the Bayesian approach were consistent with the frequentist approach and thereby support the results of the meta-analysis (see Supplementary Figure S5).

Conclusion

This systematic review and meta-analysis suggest that music interventions could have the potential to improve sleep quality among individuals with mental health problems, even though more high-quality studies are needed to fully establish the effect. Sleep problems are highly prevalent among people with mental health problems and should be addressed independently. In this regard, music may serve as a safe, low-cost, and easily accessible intervention option.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1192/j.eurpsy.2024.1773.

Data availability statement. The data that support the findings of this study are openly available in: https://github.com/Tuesday1234567/music_meta.

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Author contribution. NZ: Investigation, Data curation, Formal analysis, Visualization, Interpretation, Writing – original draft. HNL: Formal analysis, Interpretation, Writing – review and editing. KVJ: Conceptualization, Methodology, Investigation, Project administration, Supervision, Interpretation, Writing – review and editing.

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References

[1] Riemann D, Nissen C, Palagini L, Otte A, Perlis ML, Spiegelhalder K. The neurobiology, investigation, and treatment of chronic insomnia. Lancet Neurol. 2015;14:547–58. https://doi.org/10.1016/S1474-4422(15)00021-6.

[2] WHO Team. World mental health report: transforming mental health for all. Geneva: World Health Organization; 2022.

[3] American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5). Washington, D.C.: American Psychiatric Publishing; 2013.

[4] Scott AJ, Webb TL, Martyn-St James M, Rowse G, Weich S. Improving sleep quality leads to better mental health: a meta-analysis of randomised controlled trials. Sleep Med Rev. 2021;60:101556. https://doi.org/10.1016/j.smrv.2021.101556.

[5] Afolalu EF, Ramlee F, Tang NKY. Effects of sleep changes on pain-related health outcomes in the general population: a systematic review of longitudinal studies with exploratory meta-analysis. Sleep Med Rev. 2018;39:82–97. https://doi.org/10.1016/j.smrv.2017.08.001.

[6] Henderson AA, Horan KA. A meta-analysis of sleep and work performance: an examination of moderators and mediators. J Organ Behav. 2021;42:1–19. https://doi.org/10.1002/job.2486.

[7] Lim J, Dinges DF. A meta-analysis of the impact of short-term sleep deprivation on cognitive variables. Psychol Bull. 2010;136:375–89. https://doi.org/10.1037/a0018883.

[8] De Crescenzo F, D'Alò GL, Ostinelli EG, Ciabattini M, Di Franco V, Watanabe N, et al. Comparative effects of pharmacological interventions for the acute and long-term management of insomnia disorder in adults: a systematic review and network meta-analysis. Lancet. 2022;400:170–84. https://doi.org/10.1016/S0140-6736(22)00878-9.

[9] Riemann D, Espie CA, Altena E, Arnardottir ES, Baglioni C, Bassetti CLA, et al. The European Insomnia Guideline: an update on the diagnosis and treatment of insomnia 2023. J Sleep Res. 2023;32:e14035. https://doi.org/10.1111/jsr.14035.

[10] Ma Y, Hall DL, Ngo LH, Liu Q, Bain PA, Yeh GY. Efficacy of cognitive behavioral therapy for insomnia in breast cancer: a meta-analysis. Sleep Med Rev. 2021;55:101376. https://doi.org/10.1016/j.smrv.2020.101376.

[11] Reynolds AC, Sweetman A, Crowther ME, Paterson JL, Scott H, Lechat B, et al. Is cognitive behavioral therapy for insomnia (CBTi) efficacious for treating insomnia symptoms in shift workers? A systematic review and meta-analysis. Sleep Med Rev. 2023;67:101716. https://doi.org/10.1016/j.smrv.2022.101716.

[12] Krystal AD. The changing perspective on chronic insomnia management. J Clin Psychiatry. 2004;65(Suppl 8):20–5.

[13] Sateia MJ, Buysse DJ, Krystal AD, Neubauer DN, Heald JL. Clinical practice guideline for the pharmacologic treatment of chronic insomnia in adults: an American Academy of Sleep Medicine Clinical Practice Guideline. J Clin Sleep Med. 2017;13:307–49. https://doi.org/10.5664/jcsm.6470.

[14] Wilson S, Anderson K, Baldwin D, Dijk D-J, Espie A, Espie C, et al. British Association for Psychopharmacology consensus statement on evidence-based treatment of insomnia, parasomnias and circadian rhythm disorders: an update. J Psychopharmacol. 2019;33:923–47. https://doi.org/10.1177/0269881119855343.

[15] Léger D, Poursain B, Neubauer D, Uchiyama M. An international survey of sleeping problems in the general population. Curr Med Res Opin. 2008;24:307–17. https://doi.org/10.1185/030079907x253771.

[16] Morin CM, LeBlanc M, Daley M, Gregoire JP, Mérette C. Epidemiology of insomnia: prevalence, self-help treatments, consultations, and determinants of help-seeking behaviors. Sleep Med. 2006;7:123–30. https://doi.org/10.1016/j.sleep.2005.08.008.

[17] Bjorvatn B, Waage S, Pallesen S, Buysse DJ, Saxvig IW. The association between different sleep health dimensions and sex, age, education, circadian preference, and chronic insomnia: a representative population-based study. Sleep Adv. 2023;4:zpad041. https://doi.org/10.1093/sleepadvances/zpad041.

[18] Brown CA, Qin P, Esmail S. "Sleep? Maybe Later…" A cross-campus survey of university students and sleep practices. Educ Sci. 2017;7:66. https://doi.org/10.3390/educsci7030066.

[19] Kakar E, Billar RJ, van Rosmalen J, Klimek M, Takkenberg JJM, Jeekel J. Music intervention to relieve anxiety and pain in adults undergoing cardiac surgery: a systematic review and meta-analysis. Open Heart. 2021;8. https://doi.org/10.1136/openhrt-2020-001474.

[20] Jespersen KV, Hansen MH, Vuust P. The effect of music on sleep in hospitalized patients: A systematic review and meta-analysis. Sleep Health. 2023;9:441–8. https://doi.org/10.1016/j.sleh.2023.03.004.

[21] Sella E, Toffalini E, Canini L, Borella E. Non-pharmacological interventions targeting sleep quality in older adults: a systematic review and meta-analysis. Aging Ment Health. 2023;27:847–61. https://doi.org/10.1080/13607863.2022.2056879.

[22] Wang C, Li G, Zheng L, Meng X, Meng Q, Wang S, et al. Effects of music intervention on sleep quality of older adults: a systematic review and meta-analysis. Complement Ther Med. 2021;59:102719. https://doi.org/10.1016/j.ctim.2021.102719.

[23] Jespersen KV, Pando-Naude V, Koenig J, Jennum P, Vuust P. Listening to music for insomnia in adults. Cochrane Database Syst Rev. 2022;8: CD010459. https://doi.org/10.1002/14651858.CD010459.pub3.

[24] Paulino DSM, Borrelli CB, Faria-Schützer DB, Brito LGO, Surita FG. Non-pharmacological interventions for improving sleep quality during pregnancy: a systematic review and meta-analysis. Rev Bras Ginecol Obstet. 2022;44:776–84. https://doi.org/10.1055/s-0042-1746200.

[25] Høgholt NF, Kraenge CE, Vuust P, Kringelbach ML, Jespersen KV. Music and sleep hygiene interventions for pregnancy-related insomnia: an online randomized controlled trial. JMWH. 2024. https://doi.org/10.1111/jmwh.13699.

[26] Jespersen KV, Gebauer L, Vuust P. Music Interventions in Health Care: White paper. 2022

[27] Dickson GT, Schubert E. How does music aid sleep? literature review. Sleep Med. 2019;63:142–50. https://doi.org/10.1016/j.sleep.2019.05.016.

[28] Jespersen KV. A lullaby to the brain: the use of music as a sleep aid. In: The Musical Neurons, Cham: Springer International Publishing; 2022, pp. 53–63. https://doi.org/10.1007/978-3-031-08132-3_5.

[29] Chanda ML, Levitin DJ. The neurochemistry of music. Trends Cogn Sci. 2013;17:179–93. https://doi.org/10.1016/j.tics.2013.02.007.

[30] Nilsson U. The effect of music intervention in stress response to cardiac surgery in a randomized clinical trial. Heart Lung. 2009;38:201–7. https://doi.org/10.1016/j.hrtlng.2008.07.008.

[31] Page MJ, Moher D, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. BMJ. 2021;372:n160. https://doi.org/10.1136/bmj.n160.

[32] Hertenstein E, Feige B, Gmeiner T, Kienzler C, Spiegelhalder K, Johann A, et al. Insomnia as a predictor of mental disorders: a systematic review and meta-analysis. Sleep Med Rev. 2019;43:96–105. https://doi.org/10.1016/j.smrv.2018.10.006.

[33] Covidence. Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org.

[34] Hedges LV. Distribution theory for glass's estimator of effect size and related estimators. J Educ Behav Stat. 1981;6:107–28. https://doi.org/10.3102/10769986006002107.

[35] R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria; 2021. Available at https://www.R-project.org/.

[36] Harrer M, Cuijpers P, Furukawa T, Ebert DD. Dmetar: companion R package for the guide Doing meta-analysis in R: R Package Version 00; n.d.

[37] Balduzzi S, Rücker G, Schwarzer G. How to perform a meta-analysis with R: a practical tutorial. Evid Based Ment Health. 2019;22:153–60. https://doi.org/10.1136/ebmental-2019-300117.

[38] Higgins JPT, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ. 2011;343:d5928. https://doi.org/10.1136/bmj.d5928.

[39] Liu LD, Yang ZX, Wan AL, Tian YL, Wu GJ, Xu MX, Zhang JZ. Clinical study on the effects of five elements music therapy on sleep quality and cognitive function in patients with depression. China J Trad Chinese Med Pharm. 2022; 37: 1201–1204. 刘利丹,杨 肇 熙,万爱兰,田 洋 丽,吴 国 江,徐 梦 霞,张 剑 昭. 五行音乐对抑郁症患者睡眠质量和认知功能 影响的临床研究. 中华中医药杂志, 2022;37:1201–1204.

[40] Lu YR, Nie ZY, Chen Y. Effect of paroxetine combined with music relaxation therapy on psychology and sleep state of patients with depression. Chinese Nurs Res. 2020; 15. 鲁玉荣,聂智勇,陈钰. 帕罗西汀联合音乐放松疗法对抑郁 症病人心理及睡眠状态的影响[J]. 护理研究, 2020;34(20):3625–3628.

[41] Yang JL, Li YH, Zhao LP. Effects of melodic intonation therapy on psychological state and quality of life in patients with depression and insomnia. Hainan Med J. 2021;32:949–952. 杨菊丽,李玉华,赵黎萍. 角调音乐疗法对抑郁症失眠患者心理状态及生活质量的影响. 海南医学, 2021;32(7):949–952.

[42] Jespersen KV, Vuust P. The Effect of Relaxation Music Listening on Sleep Quality in Traumatized Refugees: A Pilot Study. J Music Ther. 2012;49: 205–29. https://doi.org/10.1093/jmt/49.2.205.

[43] Lund HN, Pedersen IN, Heymann-Szlachcinska AM, Tuszewska M, Bizik G, Larsen JI, et al. Music to improve sleep quality in adults with depression-related insomnia (MUSTAFI): randomized controlled trial. Nord J Psychiatry. 2023;77:188–97. https://doi.org/10.1080/08039488.2022.2080254.

[44] Blanaru M, Bloch B, Vadas L, Arnon Z, Ziv N, Kremer I, et al. The effects of music relaxation and muscle relaxation techniques on sleep quality and emotional measures among individuals with posttraumatic stress disorder. Ment Illn. 2012;4:e13. https://doi.org/10.4081/mi.2012.e13.

[45] Bloch B, Reshef A, Vadas L, Haliba Y, Ziv N, Kremer I, et al. The effects of music relaxation on sleep quality and emotional measures in people living with schizophrenia. J Music Ther. 2010;47:27–52. https://doi.org/10.1093/jmt/47.1.27.

[46] Hernández-Ruiz E. Effect of music therapy on the anxiety levels and sleep patterns of abused women in shelters. J Music Ther. 2005;42:140–58. https://doi.org/10.1093/jmt/42.2.140.

[47] Wahbeh H, Nelson M. iRest Meditation for Older Adults with Depression Symptoms: A Pilot Study. Int J Yoga Therap. 2019;29:9–17. https://doi.org/10.17761/2019-00036.

[48] Lu M-J, Chen W-Y, Li D-J. Efficacy of music therapy and predictors of sleep disturbance among patients with chronic schizophrenia: A prospective study. Arch Psychiatr Nurs. 2022;40:1–7. https://doi.org/10.1016/j.apnu.2022.04.001.

[49] Ahlberg R, Skårberg K, Brus O, Kjellin L. Auricular acupuncture for substance use: a randomized controlled trial of effects on anxiety, sleep, drug use and use of addiction treatment services. Subst Abuse Treat Prev Policy. 2016;11:24. https://doi.org/10.1186/s13011-016-0068-z.

[50] Lee M, Lee HJ, Ahn J, Hong JK, Yoon I-Y. Comparison of autonomous sensory meridian response and binaural auditory beats effects on stress reduction: a pilot study. Sci Rep. 2022;12:19521. https://doi.org/10.1038/s41598-022-24120-w.

[51] de Niet G, Tiemens B, Hutschemaekers G. Can mental healthcare nurses improve sleep quality for inpatients? Br J Nurs. 2010;19:1100–5. https://doi.org/10.12968/bjon.2010.19.17.78558.

[52] Deshmukh AD, Sarvaiya AA, Seethalakshmi R, Nayak AS. Effect of Indian classical music on quality of sleep in depressed patients: A randomized controlled trial. Nordic J Music Therap. 2009;18:70–8. https://doi.org/10.1080/08098130802697269.

[53] Braun Janzen T, Al Shirawi MI, Rotzinger S, Kennedy SH, Bartel L. A Pilot Study Investigating the Effect of Music-Based Intervention on Depression and Anhedonia. Front Psychol. 2019;10:1038. https://doi.org/10.3389/fpsyg.2019.01038.

[54] Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28:193–213. https://doi.org/10.1016/0165-1781(89)90047-4.

[55] Zomer J. Peled R, Rubin A-H, Lavie P. Mini Sleep Questionnaire (mSQ) for screening large populations for EDS complaints. In: Koella Wp, Ruther E, Schulz H, eds. Sleep '84. Stuttgart: Gustav Fischer Verlag, 1985;467–70.

[56] Richards KC, O'Sullivan PS, Phillips RL. Measurement of sleep in critically ill patients. J Nurs Meas. 2000;8:131–44.

[57] Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. Sleep Med. 2001;2: 297–307. https://doi.org/10.1016/s1389-9457(00)00065-4.

[58] Montgomery SA, Asberg M. A new depression scale designed to be sensitive to change. Br J Psychiatry. 1979;134:382–9. https://doi.org/10.1192/bjp.134.4.382.

[59] Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. Arch Gen Psychiatry. 1961;4:561–71. https://doi.org/10.1001/archpsyc.1961.01710120031004.
[60] Zung WW. A self-rating depression scale. Arch Gen Psychiatry. 1965;12:63–70. https://doi.org/10.1001/archpsyc.1965.01720310065008.
[61] Eaton WW, Muntaner C, Smith C, Tien A, Ybarra M. Center for epidemiologic studies depression scale: Review and revision. In: Maruish ME Ed., The use of psychological testing for treatment planning and outcomes assessment. New York: Lawrence Erlbaum Associates Publisher; 2004, pp. 363–77.
[62] Hamilton M. A rating scale for depression. J Neurol Neurosurg Psychiatry. 1960;23:56–62. https://doi.org/10.1136/jnnp.23.1.56.
[63] Beck AT, Epstein N, Brown G, Steer R. Beck anxiety inventory. PsycTESTS Dataset. 2012. https://doi.org/10.1037/t02025-000.
[64] Spielberger CD, Gonzalez-Reigosa F, Martinez-Urrutia A, Natalicio LFS, Natalicio DS. The State-Trait Anxiety Inventory. RIP/IJP 1971;5. https://doi.org/10.30849/rip/ijp.v5i3&4.620.
[65] Zung WW. A rating instrument for anxiety disorders. Psychosomatics. 1971;12:371–9. https://doi.org/10.1016/S0033-3182(71)71479-0.
[66] Hamilton M. Hamilton anxiety scale. Group. 1959;1:10–37.
[67] Valevicius D, Lépine Lopez A, Diushekeeva A, Lee AC, Roy M. Emotional responses to favorite and relaxing music predict music-induced hypoalgesia. Front Pain Res (Lausanne). 2023;4:1210572. https://doi.org/10.3389/fpain.2023.1210572.
[68] Dickson GT, Schubert E. Musical features that aid sleep. Music Sci. 2022;26:497–515. https://doi.org/10.1177/1029864920972161.