# Meta-Analysis of Music Therapy Efficacy as Intervention for Sleep Disorders

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**ABSTRACT**: Sleep is a fundamental biological process critical for cognitive function, emotional regulation, and physical health. Despite its importance, sleep disorders have become increasingly prevalent globally, contributing to reduced quality of life, impaired daily functioning, and elevated risks for chronic illnesses, for example cardiovascular disease and depression. Current treatments, such as pharmacotherapy and cognitive-behavioral therapy, also have limitations such as limited accessibility, side effects, and costs, therefore there is a need for alternative, low-risk, and accessible intervention to improve sleep quality. Music therapy, as a non-invasive and cost-effective approach, appears as a promising candidate, but requires systematic evaluation to establish its efficacy. This meta-analysis investigates the effectiveness of music therapy for individuals experiencing sleep disorders. A systematic review of prior studies was conducted; Egger's regression test confirmed the absence of publication bias ($p > 0.05$). Results demonstrated a large effect size (Hedge's $g = 1.29$), indicating that music therapy substantially enhances sleep quality. Future research should incorporate objective sleep measurements such as electroencephalography (EEG) and actigraphy, alongside subjective self-reports. Utilizing objective sleep monitoring technologies should further our knowledge regarding the mechanisms underlying music's effects on sleep. Overall, this study reinforces viability of music therapy as an accessible and effective tool for managing sleep disorders and emphasizes the need for continued rigorous research.

## INTRODUCTION

Sleep is one of the most vital activities of almost every living being, including us humans. Such is the importance of sleep for the functioning of our brain and body that previous researchers have found links between individual's sleep quality and cognitive ability, memory, and health problems (Deak & Stickgold, 2010; García et al., 2021; Tobaldini et al., 2017). However, with how important sleep is for our functioning, there are still a relatively large number of people in the modern world who are having trouble with sleep, so much so that the Diagnostics and Statistics Manual (American Psychiatric Association, 2013) has a chapter dedicated to the elaboration of sleep-wake disturbances. In this study, the focus is on insomnia, defined as a disorder of quality or quantity of sleep, marked by difficulty initiating sleep (sleep onset), frequent wakefulness, and early rise(American Psychiatric Association, 2013).

A survey cited in Matthew Walker's book (Walker, 2017) shows that the prevalence of insomnia in the US population rose from 8% in 1942, to 25% in 2017, with home lighting and blue light from screens as one of the main causes responsible for disturbed sleep cycle in the modern society. Screens and lighting being responsible allows us to safely assume that this rise in the prevalence of insomnia is widespread worldwide, accounting to the increasingly modernized society around the world. The Centres for Disease Control (CDC) has classified sleep disorders as a public health problem (Ginger Pinholster, 2014), which calls for intervention in the societal level, not just individuals and groups.

As hinted in the previous paragraph, sleep disorders can have an impact on multiple levels, in the individual level, people who are carrying sleep debts will have a higher risk of crashing a motor vehicle (Foundation for Traffic Safety, 2016), a harder time focusing on a task, decrease in working memory performance, and decrease in executive functioning ability (Durmer & Dinges, 2005; García et al., 2021). It has also been found that lack of sleep is correlated with psychological illnesses, such as depression and anxiety (Alfano et al., 2009; Sullivan & Ordiah, 2018). In the physiological landscape, lack of sleep is also associated with a heightened risk of cardiovascular disease (Kohansieh & Makaryus, 2015; Tochikubo et al., 1996).

On the organizational level, researchers in the field of Industrial and Organizational Psychology have found that there is a negative correlation between sleep disturbances of employees and workplace deviance, rate of accidents, and rate of illness (Engle-Friedman et al., 2003; Engle-Friedman & Riela, 2004; Pilcher & Morris, 2020). Some research even recommends employers to adopt organizational policies and interventions that promote sleep in order to increase employee performance, and subsequently the organization's monetary gain (Walker, 2017). Besides the valuable performance gain of the employees, improved sleep can also lower the incidence of sick leaves, and therefore health insurance costs from the organization.

Lastly, the adverse effects of insufficient sleep can also be observed in the societal level. For example, in countries that adopt daylight saving time to accommodate winter season, the number of incidences of heart attacks increases significantly the day after a daylight-saving time is applied in the northern hemisphere, and conversely, it decreases the day after the clock is set back to normal (Walker, 2017). Adverse health effects from insufficient sleep can also be a detriment to the nation's economy, since a considerable amount of otherwise healthy productive individuals will be more likely to be sick and needing to get off work. Not only will bad sleep render workers less productive, it will also incur more public health expenses from healthcare systems (Hafner et al., 2017; Hillman et al., 2006; Streatfeild et al., 2021).

The serious and pervasive effect of sleep deprivation throughout human society warrants an equally serious effort in combatting sleep disorders. The current trend for treating sleep disorders - including insomnia- is by using Cognitive Behavioral Therapy (CBT) (Babson et al., 2010; Ramar & Olson, 2013). However, the implementation of CBT requires the involvement from professional mental health provider, which comes at a cost that may not be accessible to a wide enough portion of the population. This necessitates a less costly, more accessible alternative to CBT, which can serve as a complement to the highly standardized and formal CBT.

When looking for an alternative that can fill this gap, there is a candidate that shows potential, which is music therapy. This alternative fills the accessibility gap left open by CBT by being much easier to apply, not requiring the involvement of qualified professionals, and is easy for the participants to stop if it doesn't bring the expected result. The immense potential accessibility of music therapy is also partly due to the fact that a very large portion of people in the modern world already own devices that may be utilized to administer music therapy.

In the current literature, there has been evidence that music therapy could be beneficial for psychological interventions, including sleep. This sleep-promoting effect of music is explainable by several mechanisms, as detailed in the review by (Dickson & Schubert, 2019). In their review, they

proposed 6 different mechanisms by which music can help people who are experiencing problems with their sleep. The 6 mechanisms will be shortly detailed below:

Table 1 Mechanisms of music therapy as explained by Dickson and Schubert.

| Mechanism | Description |
|---|---|
| Relaxation | The fact that music has a relaxing effect on people has been widely known even amongst laymen. This relaxing effect of music may help people who are experiencing anxiety-related sleep problems, this is also supported by the fact that other known interventions for sleep disorders frequently also have relaxation elements in them. |
| Enjoyment | Music, especially when the individual enjoys the selection of music, can help improve mood, which may in turn reduce sleep onset latency. However, the evidence supporting this mechanism is relatively weak as individuals who perceived the music as pleasant doesn't demonstrate improved sleep quality compared to controls that didn't rate the music as pleasant. |
| Distraction | Music could distract us from thoughts and emotions that may bother us and thus hinder sleep-onset. This distracting effect would be especially helpful towards those who are having sleep problems due to rumination behavior. |
| Entrainment | The term entrainment refers to the synchronization of waves of neural activity in participant's brain with music that contains 2-3hz frequencies. It has been theorized that this exogenous frequency can help the brain to assume a slower neural wave activity that is more suitable for sleep. Although it must be noted that there wasn't any electro-encephalogram used in the experiment, so while there is support for this theory, it hasn't been confirmed with standardized measurements whether the exogenous frequency affected the participants' neural waves or not. |
| Masking | The sound of music can be used to mask environmental noise, which we may unknowingly already be using in our day-to-day lives, for example in the workplace. This noise-masking quality of music can also be used as aid to improve sleep quality, which is supported by the evidence that in places with relatively high level of noise in the bedroom, such as Intensive Care Units of hospitals, music can help patients achieve better sleep. |
| Expectation | It has been well documented that outcome expectation can play a role in the result of an intervention in human subjects, also known as the placebo effect. Dickson proposed that this placebo effect also applies to the use of music therapy, and that subjects who believe music can help their sleep will benefit more from it than those who are indifferent. |

**Study aim**

This meta-analytic study aims to increase the scientific rigor of the existing literature surrounding the use of music therapy as intervention for sleep disorders. The authors hope that this research can help other researchers and practitioners determine whether music therapy is a promising field, provide recommendations, or as evidence base for application in the field of psychotherapy. The authors also wish to add more inputs for the direction that music therapy and sleep research might explore in the future.

## METHODS

### Design

This study employs a meta-analytic design to analyze the efficacy of music therapy in helping people with sleep disorders. All data are collected from relevant empirical studies that have been conducted previously by other researchers. Collected data from previous studies will be statistically analyzed using the meta-analysis method to enable a quantitative, empirical analysis of the efficacy of music therapy as an intervention for sleep disorders. Additionally, this approach allows the authors to examine whether different types of populations respond to music therapy differently, and to identify which groups may benefit more from the same treatment.

### Statistical method

This research uses Jamovi as the main statistical analysis software, more specifically with the "MAJOR" module plugin that contains specialized tools tailored towards doing meta-analyses. Authors compile the data gathered from the literature search into a spreadsheet, which is then opened via Jamovi to conduct the analysis. The Jamovi analysis used in this research is "Mean Differences (n, M, SD), which includes an Egger's regression analysis for publication biases, and Hedge's g analysis using random-effects model (Viechtbauer, 2010)

### Study selection

The previous studies that were analyzed in this research is collected via Google Scholar, using Boolean search to filter irrelevant studies, and then reviewing each paper to ensure it is suitable to be included in the meta-analysis. Authors searched for papers listed in Google Scholar that fulfils the selection criteria, as follows:

A. Study includes control and experimental groups which are decided randomly
B. The study includes a note of the standard deviation of each group
C. The study notes the mean scores of each group
D. The study uses Pittsburgh Sleep Quality Index to measure subjects sleep quality

The study selection process yielded results presented in Table 2. After the selection process, we gathered 7 different studies that fulfilled selection criteria.

Table 2 Study selection process.

| Process | Description |
|---|---|
| Identification | Preliminary search using the keywords "music therapy for sleep quality"<br>k: 153.000 |
| Screening | Boolean search:<br>"All in title: "music therapy" "sleep quality""<br>k: 69 |
| Inclusion | Selection of journals which fulfils selection criteria<br>k: 7 |

## RESULTS AND DISCUSSION

### Results

Based on the statistical analysis done via Jamovi, the meta-analysis yielded a Hedge's *g* effect size of 1.29, indicating a rather large effect, with a 0.708 lower bound and 1.872 upper bound with 95% confidence interval. To assess the potential for publication bias among the included studies, Egger's regression analysis was conducted, yielding a result of -1.199, and a P-value of 0.231, since P is larger than 0.05, it is concluded that no publication bias was present in the final selection.

Table 3 Analysis using random effects model.

| Estimate | se | Z | P | CI 95% |
|---|---|---|---|---|
| 1.29 | 0.297 | 4.35 | <.001 | 0.708 - 1.872 |

Table 4 Publication bias assessment.

| Test Name | value | p |
|---|---|---|
| Fail-Safe N | 473.000 | <.001 |
| Begg and Mazumdar Rank Correlation | -0.357 | 0.275 |
| Egger's Regression | -1.199 | 0.231 |
| Trim and Fill Number of Studies | 3.000 | . |

Note: Fail-safe N Calculation Using the Rosenthal Approach.

The details of each study included in this meta-analysis will be detailed in a table below:

Table 5 Studies included in the meta-analysis.

| Study ID | Description |
|---|---|
| Gokalp, Kubra, Ekinci & Mine, 2020 | A randomized control trial (RCT) of 60 elderly hematologic cancer patients, the experimental group receives receptive music therapy, and the control receives no intervention. |
| Tang, Haoke, Chen, et al., 2021 | RCT of 100 chemotherapy patients, the control group receives a combination of active and receptive music therapy, and the control receives no intervention. |
| Kavurmaci, Mehtap, et al., 2020 | RCT of 50 nursing students, divided into experimental group which receives receptive music therapy, and a control group which receives no intervention. |
| Naulia, Resi Putri, Allenidekania, et al., 2019 | RCT of 30 children with chronic diseases aged 8-18 years, 15 children in the experimental group receives receptive music therapy, while the other 15 in the control group receives no intervention. |
| Gaewlai, Pailin, Valibhakara, et al., 2018 | RCT study of adults with Major Depressive Disorder, patients are divided into 2 groups, experimental group receives active group music therapy while the control receives standard group psychotherapy. |
| Vinayak, Seema, Dehkoda, et al., 2017 | RCT of 184 adult cancer patients divided into 3 groups, one experimental group receives receptive music therapy, another experimental group receives active music therapy, while the control group receives no intervention. |
| Kumar, Anuj, Merridith, et al., 2019 | RCT of 60 older adults, experimental group receives active music therapy, while the control receives no intervention. |

Overall, the findings of this meta-analysis support the conclusion that music therapy is a highly effective, non-invasive intervention that is feasible for improving sleep quality, demonstrating a

substantial effect size and statistically significant effect across the analyzed studies. To provide a visual graph, a forest plot is provided below:

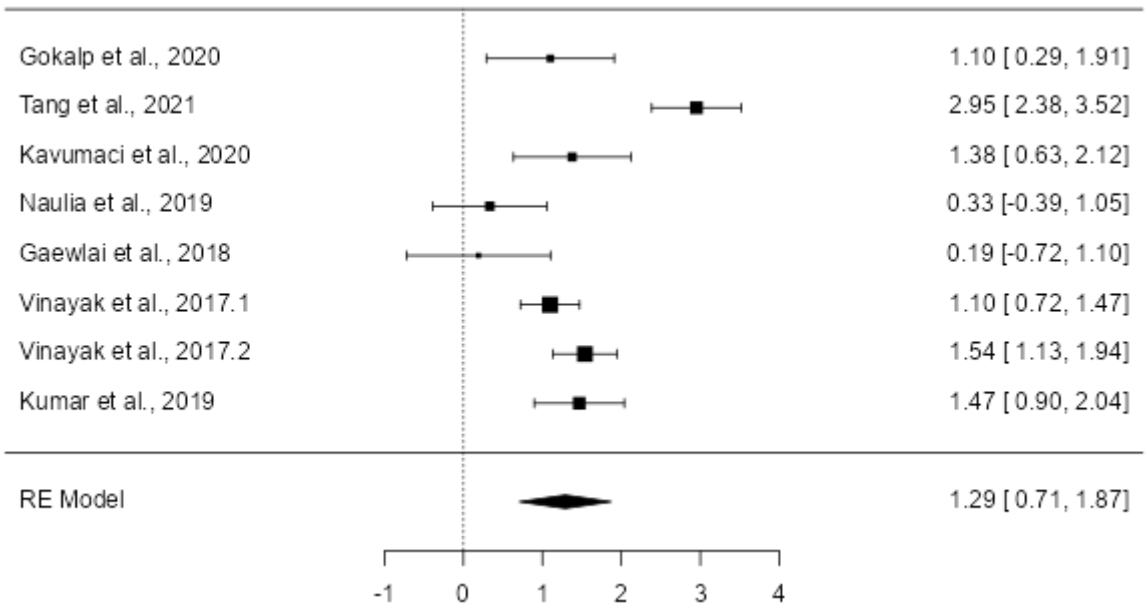


Figure 1 Forest plot.

**Discussion**

Among the studies included in the meta-analysis, some showed relatively small effect sizes. The first is a study by Naulia et al. (2019), which involved children as participants. This age group may contribute to the smaller observed effect size, potentially due to children generally experiencing fewer sleep disturbances. As a result, the difference between the experimental and control groups was minimal, possibly because the baseline level of sleep problems was not severe enough to allow for a large measurable improvement.

Another study reporting a low effect size is by Gaewlai et al. (2018), which yielded a standardized mean difference of 0.19, with confidence intervals extending into the negative range. One possible explanation for this is the nature of the control group, which consisted of individuals receiving standard group psychological therapy. This type of intervention can independently improve sleep quality by addressing underlying psychological stressors, such as worry or anxiety. Therefore, while the study appears to show a limited effect of music therapy, the benefits of the control condition may have reduced the observed difference, without necessarily discounting the therapeutic potential of music interventions.

Conversely, the study by Tang et al. (2021) reported the largest effect size in the dataset. This can be attributed to the characteristics of the sample cancer patients undergoing chemotherapy. As discussed in earlier sections, this population may benefit substantially from music therapy due to several mechanisms: masking ambient hospital noise, alleviating ruminative thoughts, and promoting relaxation. Furthermore, these patients may have had lower baseline sleep quality, which could magnify the observed effects of the intervention. Another possible explanation lies in the combination of receptive and active modalities of music therapy employed in Tang's study, which may work synergistically and yield a larger effect size on sleep.

A particularly noteworthy study is by Vinayak et al. (2017), which included both receptive and active music therapy groups, as opposed to other papers that did not directly compare the different modalities of music therapy. The findings indicate that while both approaches improved sleep quality as measured by the Pittsburgh Sleep Quality Index (PSQI), the active music therapy group showed a greater effect size. Although the mechanisms of active music therapy in relation to sleep

remain underexplored, this result highlights a promising direction for future research, suggesting that the mode of delivery may influence the effectiveness of the intervention.

**Implications**

The findings of this meta-analysis have several important implications, both for clinical practice and future research. Firstly, the overall large effect size suggests that music therapy is an effective intervention for improving sleep quality across a variety of populations. This reinforces music therapy's potential as a complementary treatment, especially in settings where more formal approaches are unsuitable, for example on individuals who have limited access to professional mental health providers.

Secondly, the variation in effect sizes across studies also highlights the importance of considering population characteristics when implementing music therapy. For example, populations with more severe baseline sleep disturbances, such as patients undergoing hospitalization, may receive a greater benefit, likely due to their heightened need for relaxation and environmental noise-masking. In contrast, populations with fewer initial sleep problems such as children may show less noticeable improvements, due to there being less room for measurable change.

Lastly, the finding about studies involving active music therapy points us to the need for more exploration into different modalities of music therapy. While receptive music therapy is easier and more commonly used, active engagement in music therapy may yield stronger therapeutic outcomes and should be studied more systematically, as it may provide another form of intervention suitable for a certain population.

**Limitations and Further Research**

While the findings are promising, there are several important limitations that should be noted. One of the key limitations is that all the studies relied on self-reported measures such as the Pittsburgh Sleep Quality Index (PSQI), which while widely used and psychometrically sound, can still introduce subjective biases. Future studies would benefit from incorporating more objective tools to assess sleep quality and patterns, such as an electroencephalogram (EEG) recording or standardized actigraphy devices. These tools could provide deeper insights into the changes that occur in response to music therapy, and help clarify its underlying mechanisms, all the while also allowing more objective measurement of change.

There is also a need for more investigations into what makes music therapy effective. Future research should explore variables of music such as genre, tempo (slow vs fast BPM), content (lyrical vs instrumental), individual preferences, and the modality of delivery (active vs receptive). Understanding these nuances could help tailor music therapy more effectively to suit individual needs and contexts, thus providing larger benefits for the patients.

**CONCLUSION**

From the result of the analysis, it can be concluded that music therapy shows strong potential in alleviating sleep disturbances across various demographic groups. The intervention appears to be especially effective for individuals in clinical settings, likely due to their lower baseline levels of sleep quality, which emphasizes the therapeutic effects of music therapy. Additionally, patients in clinical environments may benefit more from music's relaxing qualities and its ability to mask ambient noise and distract from distressing thoughts.

Given its non-invasive nature and relatively low cost, music therapy is a relatively promising option as public health intervention. It can be implemented in both clinical and non-clinical settings to support better sleep (and in turn, supports overall well-being). Clinicians may consider using music therapy as first-line intervention for sleep-related disorders, or as a complementary approach to use alongside other, more formal treatments such as CBT or psychopharmacology.

Psychoeducation about the potential therapeutic effects of music can also help clients make informed decisions about integrating music into their sleep habits.

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**AUTHOR CONTRIBUTIONS STATEMENT**

Both authors contributed fairly to the research process, and both approved of the final version of the paper.

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