REVIEW PAPER

Music-assisted relaxation to improve sleep quality: meta-analysis

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Abstract
Title. Music-assisted relaxation to improve sleep quality: meta-analysis.
Aim. This paper is a report of a meta-analysis conducted to evaluate the efficacy of music-assisted relaxation for sleep quality in adults and elders with sleep complaints with or without a co-morbid medical condition.
Background. Clinical studies have shown that music can influence treatment outcome in a positive and beneficial way. Music holds the promise of counteracting psychological presleep arousal and thus improving the preconditions for sleep.
Methods. Data were extracted from the included studies using predefined data fields. The researchers independently assessed the quality of the trials using the Delphi list. Only studies with a score of 5 points or higher were included. A pooled analysis was performed based on a fixed effect model.
Results. Five randomized controlled trials with six treatment conditions and a total of 170 participants in intervention groups and 138 controls met our inclusion criteria. Music-assisted relaxation had a moderate effect on the sleep quality of patients with sleep complaints (standardized mean difference, $-0.74$; 95% CI: $-0.96$, $-0.46$). Subgroup analysis revealed no statistically significant contribution of accompanying measures.
Conclusion. Music-assisted relaxation can be used without intensive investment in training and materials and is therefore cheap, easily available and can be used by nurses to promote music-assisted relaxation to improve sleep quality.

Keywords: insomnia, meta-analysis, music, relaxation, sleep complaints, systematic review
Introduction

Music is one of the most-used self-help strategies to promote sleep. Morin et al. (2006a) found that more than a quarter of a randomly-selected sample of community-dwelling participants used music to promote their sleep. A survey among urban people in Finland (Urponen et al. 1988) also showed that music was the second most important factor in promoting sleep. The clinical and systematic use of music as a (complementary) treatment in various medical conditions has been a subject of study in recent decades.

Clinical studies show that music can influence human emotions and treatment outcome in a positive way. A review by Evans (2002) showed that music decreases the level of anxiety during normal care delivery. Studies by Chan et al. (2006) in patients undergoing a C-clamp procedure after percutaneous coronary interventions and Almerud and Peterson (2003) in mechanically-ventilated intensive care patients showed positive and statistically significant changes in physiological variables. Although some researchers report statistically significant influences of sedative music on hormonal levels and the immune system, the precise mechanism by which music may improve human well-being is still unclear.

Because there is evidence that music has the potential to reduce anxiety, it holds the promise for counteracting psychological presleep arousal and thus improving the preconditions for sleep. Moreover, Johnson (2003) has suggested that music can decrease the frustration and dread associated with sleep complaints. Therefore, the use of music could be beneficial for people with sleep (onset) problems. Even in patients with chronic sleep problems, whose frustration about not being able to fall asleep might be a perpetuating factor, music could potentially be beneficial.

Music might be a valuable contribution to the range of non-pharmacological nursing interventions to promote sleep. However, only one report about the actual use of music as a sleep-promoting nursing intervention was found: Gagner-Tjellesen et al. (2001) found that nurses working in acute inpatient settings reported music as the most often-used independent therapeutic nursing intervention to enhance sleep.

Non-pharmacological interventions, in particular cognitive behavioural treatment, have been proven to be effective and to have resulted in stable therapeutic changes over time (Morin et al. 2006b). However, most non-pharmacological interventions require a relatively large investment in training. The systematic application of music interventions does not involve large investments in training or tools. These interventions are ‘relatively inexpensive, readily available, portable, and completely subject controlled’ (Mornhinweg & Voigner 1995, p 252).

The growing interest for non-pharmacological interventions has led to reviews evaluating the efficacy of such strategies. Examples include reviews of psychological and behavioural treatment (Morin et al. 2006b), bright light therapy (Montgomery & Dennis 2002a), and physical exercise (Montgomery & Dennis 2002b). However, we could not find a review about the efficacy of music as a sleep-promoting intervention. A meta-analysis of data from previous research findings might provide or enhance the evidence-base of such an intervention.

The review

Aim

The aim of this meta-analysis was to evaluate the efficacy of music-assisted relaxation (MAR) for sleep quality in adults and elders with sleep complaints with or without a co-morbid medical condition.

Design

A meta-analysis was conducted using data from five randomized controlled trials. We chose sleep quality as the primary outcome measure for the intervention. The reason for this choice was primarily practical: sleep quality can be assessed without medical competences. This means that professionals without medical training, such as nurses, are able to assess it. Sleep quality refers to the multi-dimensionally assessed, subjective experience of sleep. It comprises quantitative aspects of sleep, such as sleep duration, sleep latency, and number of arousals, as well as more purely subjective aspects, such as depth or restfulness of sleep (Buijsse et al. 1989).

Search methods

Keywords, titles and abstracts were searched. The search terms ‘sleep’ or ‘insomnia’ in combination with ‘music’ or ‘music therapy’ were used. After the searches were completed, reference lists from identified studies were examined to find additional studies.

Selection criteria were prespecified. We included published randomized controlled trials performed in an adult (18–60 years) or elderly (60 years or older) population with primary sleep complaints or sleep complaints co-morbid with a medical condition. Studies involving active use of music, such as playing instruments, were excluded. Finally, studies of people suffering neurological or severe cognitive disorders (such as Parkinson or Alzheimer disease) were excluded.

Music-assisted relaxation comprises therapeutic relaxation improving interventions in which music is the key ingredient. We divided these interventions into two groups: (1) those offered without additional measures and (2) those offered with additional measures. Added measures are, for instance, oral or written relaxation instructions. Use of this distinction makes it possible to determine the contribution of these additional relaxation-improving measures.

Music in the context of this meta-analysis was considered to be recorded music, played by CD/DVD player, mp3 player, tape-recorder or video recorder. The music must have been intentionally applied for the promotion of sleep quality in a passive way, that is, listening to music while resting or relaxing.

Music-assisted relaxation in the selected studies was offered with patient preferred or selected music, or with standardized music that had been intentionally composed to relax or promote sleep. Many people experience slow rhythm music, without a heavy beat, as relaxing. However, the effect is strongly dependent on personal preferences.

Search outcome

After removing duplicates, our initial broad search produced a list of 236 references (see Figure 1). After carefully reviewing the titles for relevance, this list was reduced to 27 potentially-relevant papers. Abstracts from all of these were reviewed for usefulness. Seventeen were rejected as obviously unsuitable (e.g. no trial). Ten remaining studies were read in full. Of these ten, five did not meet the inclusion criteria. The main reasons for rejection were non-comparability of data and low methodological quality (lack of control).

Quality appraisal

The methodological quality of each selected study was assessed using the Delphi list for quality assessment of RCTs (Verhagen et al. 1998). This is a 9-item list, assessing randomization of allocation, blinding of allocation, group comparison, inclusion criteria, blinding (assessor, therapist, patient), presentation of estimates and intention-to-treat analysis. Two reviewers (GN and BT) assessed the studies independently. Only studies with a positive score on 5 or more Delphi items (≥55% of the maximum attainable score) were included. Consensus was achieved for all data.

Data abstraction

Pre- and post-test means and standard deviations, demographic data and condition properties were extracted from each included study. To evaluate two studies (Kullich et al. 2003, Harmat et al. 2008), the authors were contacted for additional information.

Synthesis

Review Manager 5.0.12 (The Cochrane Collaboration 2008) was used to calculate the effect sizes of the individual studies and for calculation of the pooled mean difference. Since continuous data from different scales were extracted, the standardized mean difference (SMD) was calculated for effect size based on sample size (Cohen’s d with Hedges adjustment) and 95% confidence intervals for each study, and for the pooled studies using variance analysis. Effect sizes of 0.2
are usually interpreted as small, those of 0·5 as moderate and from 0·8 as large (Cohen 1988).

Potential statistical heterogeneity between the studies was evaluated with a chi-square test. Statistically significant heterogeneity was considered present when the *P*-value was less than 5%. Publication bias was addressed by inspection of the funnel plot (Begg 1994). A funnel plot is a scatter plot of effect sizes against a measure of study size.

**Results**

**Characteristics of included studies**

The characteristics of the five studies that met the inclusion criteria are presented in Table 1. The studies included a total of 170 participants in intervention groups and 138 controls. Mean participant age was 51 years and mean sample size was 69. Three studies involved patients in a hospital setting, one was performed with community-dwelling elders and one was performed with students. With exception of one study (Hernandez-Ruiz 2005), all included studies had explicit inclusion criteria and/or exclusion criteria (i.e. use of hypnotics, psychiatric condition, sleep apnoea).

The duration of the intervention varied between 20 and 45 minutes per session and the follow-up period varied between two days to three weeks. With the exception of the study by Harmat et al. (2008) and one condition in the study by Zimmerman et al. (1996), the music in all included studies was offered with an accompanying relaxation technique or instruction. Kullich et al. (2003) used standardized music that was intentionally composed for sleep promotion for every participant. The other researchers used patient-preferred music that could be selected from a list. Types of music used in the four included studies were traditional folk-music (Chinese orchestra), instrumental new age (synthesizer), classical and modern instrumental soothing music (harp, piano, and orchestra) and vocal soothing music.

The study by Harmat et al. (2008) comprised two treatment conditions, music and an audio book, both compared to the same control condition. The audio book intervention comprised use of a CD containing 11 hours of short stories. Since this condition did not involve music, it was not included in the pooled analysis. The study by Zimmerman et al. (1996) also had two treatment conditions, music and music video, also both compared to the same control condition. These two treatment conditions are presented separately in Table 2.

In all included studies the efficacy of the intervention was measured with a subjective, self-rating scale. Four studies used the Pittsburgh Sleep Quality Index (PSQI) (Buijsse et al. 1989); the fifth study used the Richards-Campbell Sleep Questionnaire (RCSQ) (Richards 1987). Five of the six included conditions led to statistically significant improvement of the ‘total score’ for sleep quality. The music condition in the study by Zimmerman et al. (1996) approached statistical significance (*P* = 0·06). None of the researchers reported adverse effects.

**Quality of included studies**

All included studies suffered from some methodological flaws. The Delphi list score was mainly compromised by the requirement for blinding. In high quality RCTs, a double-blind process is used: neither participant nor administer should be aware of whether the participant is in the intervention or control group. However, the nature of the intervention makes binding of participants virtually impossible; when patients are informed about the goal and procedure of the trial, as good ethical practice demands, it is impossible to hide the condition to which they are allocated. Randomization was blinded in all included studies.

**Pooled analysis**

The clinical diversity of the four studies seems rather large (mixed age groups, various medical conditions). However, there is no evidence or theory making a prominent difference in treatment effect between the various populations plausible.

The outcomes of the two different used instruments, the PSQI and the RCSQ, are not directly comparable; a high PSQI value means a lower sleep quality, while a high RCSQ value indicates the opposite. To allow calculation of the effect size and standardized mean difference, RCSQ scores were converted by subtracting the real score from the maximum score.

Table 2 shows the means and calculated effect sizes of the included studies. Since the studies did not show considerable methodological diversity, a pooled analysis was conducted (Figure 2). Because we assumed that the included studies evaluated a common treatment effect, we chose the fixed effect model.

An overall SMD of −0·74 (95% CI: −0·96 to −0·52) was found. The *Z* test for overall effect was statistically significant (*Z* = 6·59, *P* < 0·0001). The chi-square for statistical heterogeneity was not statistically significant (χ² = 7·84, d.f. = 5, *P* = 0·17). The I-square test represents the between-trial difference that cannot be attributed to chance. A value greater than 50% may be considered substantial heterogeneity. In our case, the I-square was 36%. To detect publication
<table>
<thead>
<tr>
<th>Study</th>
<th>Total (n)</th>
<th>Country</th>
<th>Treatment</th>
<th>Additional relaxation measure</th>
<th>Control condition</th>
<th>Intervention duration</th>
<th>Dwelling and population</th>
<th>Measure</th>
<th>Result</th>
<th>Delphi list score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmat et al. 2008</td>
<td>94</td>
<td>Hungary</td>
<td>Standardized classical music, daily 45 minutes at bedtime</td>
<td>None</td>
<td>No intervention</td>
<td>3 weeks</td>
<td>University (students with sleep complaints)</td>
<td>PSQI²</td>
<td>Statistically significant improvement of total sleep quality score and six of seven PSQI components</td>
<td>5</td>
</tr>
<tr>
<td>Hernandez-Ruiz 2005</td>
<td>28</td>
<td>USA</td>
<td>Participant selected music, daily 20-minute sessions at bedtime</td>
<td>Progressive muscle relaxation</td>
<td>Silence</td>
<td>5 days</td>
<td>Shelter (abused women)</td>
<td>PSQI²</td>
<td>Statistically significant effect on sleep quality</td>
<td>5</td>
</tr>
<tr>
<td>Kullich et al. 2003</td>
<td>65</td>
<td>Austria</td>
<td>Standardized music, at least once a day, no specified time</td>
<td>Booklet with relaxation text</td>
<td>Care as usual</td>
<td>3 weeks</td>
<td>Stationary rehabilitation (low back pain patients)</td>
<td>PSQI²</td>
<td>Statistically significant improvement of total sleep quality score and four of seven PSQI components</td>
<td>5</td>
</tr>
<tr>
<td>Lai &amp; Good 2003</td>
<td>60</td>
<td>Taiwan</td>
<td>Patient selected sedative music, daily 45-minute sessions at bedtime</td>
<td>Relaxation instructions</td>
<td>Care as usual/no intervention</td>
<td>3 weeks</td>
<td>Community (elderly)</td>
<td>PSQI²</td>
<td>Statistically significant improvement of total sleep quality score and five of seven PSQI components</td>
<td>6</td>
</tr>
<tr>
<td>Zimmerman et al. 1996*</td>
<td>96</td>
<td>USA</td>
<td>Patient selected soothing music, daily 30-minute sessions in the afternoon or early evening</td>
<td>None</td>
<td>Scheduled rest</td>
<td>2 days</td>
<td>Hospital (postoperative coronary artery bypass graft patients)</td>
<td>RCSQ¹</td>
<td>Almost statistically significant improvement of sleep quality</td>
<td>5</td>
</tr>
<tr>
<td>Zimmerman et al. 1996*</td>
<td>96</td>
<td>USA</td>
<td>Sedative music video, daily 30-minute sessions in the afternoon or early evening</td>
<td>Video with relaxing scenes</td>
<td>Scheduled rest</td>
<td>2 days</td>
<td>Hospital (postoperative coronary artery bypass graft patients)</td>
<td>RCSQ¹</td>
<td>Statistically significant better sleep quality ratings</td>
<td>5</td>
</tr>
</tbody>
</table>

*This study comprised two treatment conditions: music and music video. The two treatment conditions are presented separately.

¹Richards-Campbell Sleep Questionnaire (Richards 1987).
²Pittsburgh Sleep Quality Index (Buysse et al. 1989).
Music-assisted relaxation to improve sleep quality

Table 2 Effect of music interventions on sleep quality

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Weight</th>
<th>Std. Mean Difference IV, Fixed, 95% CI</th>
<th>Std. Mean Difference IV, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.2 MAR with added relaxation measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lai and Good 2003</td>
<td>16.8%</td>
<td>-0.97 [-1.51, -0.44]</td>
<td></td>
</tr>
<tr>
<td>Zimmerman 1996 - m. video</td>
<td>19.0%</td>
<td>-0.69 [-1.20, -0.19]</td>
<td></td>
</tr>
<tr>
<td>Kullich 2003</td>
<td>19.6%</td>
<td>-0.58 [-1.08, -0.08]</td>
<td></td>
</tr>
<tr>
<td>Hernandez 2005</td>
<td>8.7%</td>
<td>-0.29 [-1.03, 0.46]</td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>64.1%</td>
<td>-0.68 [-0.95, -0.40]</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Chi² = 3.37, df = 3 (P = 0.50); I² = 0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 4.83 (P &lt; 0.00001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.3 MAR without added relaxation measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmat 2008</td>
<td>16.3%</td>
<td>-1.31 [-1.85, -0.76]</td>
<td></td>
</tr>
<tr>
<td>Zimmerman 1996 - music</td>
<td>19.6%</td>
<td>-0.47 [-0.97, 0.02]</td>
<td></td>
</tr>
<tr>
<td>Subtotal (95%)</td>
<td>35.9%</td>
<td>-0.85 [-1.22, -0.49]</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Chi² = 4.91, df = 1 (P = 0.03); I² = 80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 4.55 (P &lt; 0.00001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>100.0%</td>
<td>-0.74 [-0.96, -0.52]</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Chi² = 7.84, df = 5 (P = 0.17); I² = 36%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 6.59 (P &lt; 0.00001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for subgroup differences: Chi² = 0.56, df = 1 (P = 0.45), I² = 0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: MAR = Music-assisted relaxation

Figure 2 Forest plot.

bias, the funnel plot was inspected and found to be roughly symmetrical.

To determine the possible contribution of the accompanying relaxation measures, a subgroup analysis was performed. The first group – MAR without added relaxation measures – included two conditions in which music was the sole component. The second group comprised four conditions in which music was accompanied by an additional relaxation measure. For the first group we found a SMD of -0.85 (95% CI: -1.22 to -0.49), and for the second group a SMD of -0.68 (95% CI: -0.95 to -0.40) was found. The test for subgroup differences was not statistically significant (χ² = 0.56, df = 1, P = 0.45). However, this outcome must be interpreted with some caution because the statistical
heterogeneity for the first group was statistically significant ($\chi^2 = 4.91, \text{d.f.} = 1, P = 0.03$).

We explored the influence of follow-up length on the effect size by performing a regression analysis with effect size as the dependent variable and follow-up length as the independent variable. The result was not statistically significant ($F = 3.13, \text{d.f.} = 1, P = 0.15$).

**Discussion**

**Weaknesses and strengths**

The included studies all suffered from some methodological weaknesses. The most important was the lack of double-blinding. However, as stated previously, the nature of this intervention makes blinding virtually impossible. Another limitation of the included studies was the lack of a good definition of the sleep problem. As poor perceived sleep quality can have different causes (for instance physical, neurological, psychological or hormonal) and some sleep problems are unlikely to be influenced by music-assisted relaxation (i.e. restless legs of sleep apnoea).

The main limitation of this review was a general limitation of all reviews: it is liable to publication bias. The number of included studies and the sample sizes in these studies were small. Inspection of the funnel plot showed rough symmetry. However, this is only a rough indication of the absence of publication bias, and as only six conditions were included, this is not a very reliable test.

The clinical diversity of the included studies was large. The question might arise whether pooling the data was appropriate. However, the findings are very consistent. This could mean that the effect of the intervention is independent of the patient’s condition and thus that the generalizability of the findings is potentially large.

Regrettably, none of the studies we included gave follow-up data to evaluate long-term effectiveness. However, follow-up length might be an important factor. At first glance our data suggest that studies with a short implementation resulted in lower effect sizes than those with longer implementation periods. The studies by Kullich et al. (2003), Lai and Good (2003) and Harmat et al. (2008) showed a cumulative dose effect and reached no ‘plateau’ after three weeks. However, a regression analysis revealed that follow-up length was not a statistically significant predictor of effect size.

To evaluate the clinical relevance, we compared this result with the results of two other meta-analyses. Like our meta-analysis, they both used randomized controlled trials and sleep quality as outcome measures. However, both included studies that enrolled participants with a diagnosis of primary insomnia. The first, by Nowell et al. (1997), evaluated the efficacy of benzodiazepines and zolpidem in adult patients (18–65 years). Based on five studies, they found a standardized mean difference of 0.62 (95% CI: 0.45–0.79) for sleep quality. The second, by Irwin et al. (2006), included a meta-analysis to evaluate the efficacy of behavioural interventions for insomnia among middle aged and older adults. For the outcome sleep quality, seven studies were included. A standardized mean difference of 0.79 (95% CI: 0.46–1.1) was found.

**Conclusion**

The results of this review, based on five relatively small studies, show that music-assisted relaxation is an effective aid for improving sleep quality in patients with various conditions. It also gave an indication that the contribution of added relaxation-improving measures such as oral or written instructions to the improvement of sleep quality is limited. Since the amount of included studies was small, this is not a conclusive statement.

Music is already one of the most commonly-used self-help strategies to promote sleep. We found scientific support for the effectiveness of the systematic use of music-assisted relaxation to promote sleep quality. Since no adverse effects
are reported, nurses can use these findings in their practice to promote music-assisted relaxation. It is a safe and cheap intervention which may be used to treat sleep problems in various populations. The use of MAR is quick and easy to learn, and it might also be an effective element in a multifaceted intervention combining cognitive-behavioural and/or educational elements. However, this requires further exploration.

Determining the most effective form (duration of exposure, timing of exposure) of music intervention and type for different populations (e.g. adolescents, elders) are interesting topics for future study. Since objective and subjective outcome measures reflect different dimensions of sleep, researchers should preferably assess both. Strict inclusion criteria based on a good definition of the sleep problem is highly recommended for future research.

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Conflict of interest

No conflict of interest has been declared by the authors.

Author contributions

GN, BT & GH were responsible for the study conception and design. GN performed the data collection. GN & BT performed the data analysis. GN & BT were responsible for the drafting of the manuscript. BL & GH made critical revisions to the paper for important intellectual content.

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Montgomery P. & Dennis J. (2002b) Physical exercise for sleep problems in adults aged 60+. Cochrane Database of Systematic Reviews 4, CD003404.


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