Efficacy of Wholetones® 2Sleep Music on Sleep and Health Behaviors of Adults with Insomnia Symptoms: A Single Blind, Randomized, Controlled, Crossover Trial

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Keywords: Sleep Quality, Music, Insomnia Symptoms

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Abstract

Objectives: Music may provide a natural alternative to improve sleep quality. The study purpose was to conduct a randomized single-blind placebo-controlled crossover trial on adults with insomnia symptoms to examine the efficacy of Wholetones® 2Sleep Music and Classical Music on sleep quality, anxiety, stress levels, fatigue, productivity, and mood using both self-report and objective measures.

Design: Randomized single-blind placebo-controlled crossover trial.

Setting/location: Nightly sleep objectively assessed in the home sleep environment. Self-report assessments completed electronically at baseline and following each music condition.

Subjects: Following one week of baseline assessments, otherwise healthy adults who reported insomnia symptoms (*N* = 38, *M* age = 46.6 years) were randomized to either the Wholetones® 2Sleep Music or Classical Music condition for 10 days and then the alternative music for 10 days after a 4 day "wash-out".

Outcome Measures: The primary outcome was sleep quality (i.e., Pittsburgh Sleep Quality Index). Secondary outcomes included objective physiological sleep quality as assessed nightly by the EMFIT QS sleep trackers™ as well as self-reported daytime mood, anxiety, perceived stress, productivity, and fatigue that were completed at baseline and following each music condition. Participants also completed a daily sleep diary.

Results: When the participants listened to the Wholetones® 2Sleep and Classical music they had significant improvements from baseline for their sleep quality (i.e., Pittsburgh Sleep Quality Index scores). As well, when the participants listened to the Wholetones® and Classical music they had significant improvements from baseline in their daytime levels of perceived stress, anxiety, fatigue, productivity, and mood, *p*'s < .05. No significant condition or condition x time interactions were evidenced. Participants also had a significant improvement in integrative recovery (i.e., how much recovery people got during their sleep) following listening to the Wholetones® music.

Conclusion: Wholetones®2Sleep and Classical Music may be simple, noninvasive, and non-pharmacological intervention to promote nighttime sleep quality and recovery resulting in improved daytime mood, fatigue levels, productivity, anxiety, and stress. Wholetones® Music outperformed Classical Music for certain self-report and objective measures including integrative sleep recovery.

Introduction

Insomnia is an economic burden and a public health concern that represents one of the most common complaints in medical practice. Insomnia is the most common sleep disorder, and it is characterized by persistent difficulties either initiating or maintaining sleep, including early morning awakening, accompanied by daytime impairments. Representing a major health problem insomnia is associated with decreased quality of life, mood, mental health (e.g., anxiety, depression), and functional and cognitive abilities (Taylor et al., 2001). Between 33 to 50% of adults experience insomnia symptoms (Ancoli-Israel et al., 1999; Ohayon, 2002).

A common intervention to re-establish sleep patterns are over-the-counter and prescribed drugs. No professional sleep organizations have issued either consensus statements or recommendations about either the efficacy or safety of over-the-counter or prescription sleep aids for improving sleep quality in the general adult population. In addition, prescription sleep aids have been criticized regarding their side effects, short- and long-term efficacy, and dependency.

Music, particularly the classical genre, may provide a healthier, safer, and natural alternative to over-the-counter and prescription sleep aids to improve sleep quality and overall health (Jespersen et al., 2018). Systematic and meta-analytic reviews reveal that music listening before nighttime sleep results in improved self-reported sleep outcomes (De Niet et al., 2009; Feng et al., 2018; Jespersen et al., 2015). For example, a recent meta-analysis found that music listening prior to nighttime sleep resulted in improved sleep (as determined by the Pittsburg Sleep Quality Index) compared to usual care (Feng et al., 2018).

Limitation of previous research examining the effects of music on sleep include methodological issues such as baseline and between group differences in the data collection procedure, lack of objective sleep assessments (in particular in the home sleep environment), and lack of assessments on the daytime consequences of the intervention (Chang, Lai, Chen, Hsieh, & Lee, 2012; Jespersen et al., 2015). A recent study found a significant positive effect of music (i.e., classical, jazz, new-age and ambient) on perceived sleep and quality of life, but no changes on the objective sleep measures (Jespersen et al., 2018). In comparison, Huang et al. (2016) found that listening to soothing music at nocturnal sleep improved the rested rating scores, shortened stage 2 sleep, and prolonged REM sleep, but had little effect on sleep quality. In short, music listening at bedtime appears to have a positive impact on sleep quality, but further research is needed to determine its effects on objective sleep parameters, in particular in the home environment (Jesperen et al., 2018) as well as its daytime consequences using crossover designs.

As well, limited studies have directly compared the effects of different types of music. Typical study designs have compared a music condition to other nonmusic conditions (e.g., audiobook control, waitlist control group; Jespersen et al., 2018). Thus, a need exists to compare different types of music to determine the moderating effect of type of music on sleep outcomes as well as daytime mood and productivity.

In particular, research has revealed that listening to classical musical prior to nighttime sleep, compared to other genres (e.g., meditation, heavy metal, New Age, techno), may be the most beneficial for improving quality of life, anxiety levels, and cardiovascular outcomes (Smith & Joyce, 2004; Trapper, 2010). For example, Harmat, Takács, and Bódizs (2008) found that listening to classical music prior to nighttime sleep improved sleep quality and depressive symptoms compared to control and audio conditions. Of importance, classical music is the most common type of music that people will select to listen to prior to sleep (Trahan et al., 2018).

Wholetones® 2Sleep, which is music that is designed to lull the listener into a deep, delta sleep, using frequency-enhanced music and precise tempos, may facilitate restorative sleep, improve mood, and reduce anxiety. Wholetones® differs from other musical genres in that it employs a proprietary method of tuning and layering the music with a unique frequency underlayment. Although Wholetones® offers a relatively inexpensive, nonpharmacologic intervention to improve sleep outcomes, research on its efficacy is lacking.

Thus, to address these shortcomings, the purpose of this trial was to examine the efficacy of different types of music (i.e., Wholetones® 2Sleep and Classical Music) to improve sleep quality (using both self-report and objective measures) as well as the daytime consequences of the intervention in adults with insomnia symptoms. The primary outcome was sleep quality as assessed by the Pittsburg Sleep Quality Index. Secondary outcomes included objective sleep assessments in the home environment (as assessed by the EMFIT Trackers), as well as daytime fatigue, mood, perceived stress, anxiety, and productivity. We hypothesized that both music conditions would result in improved sleep and self-reported health outcomes, with

larger positive effects evidenced for the Wholetones® 2Sleep music condition compared to the Classical music condition.

Methods

Participants

Participants were 38 adults (*n* = 25 women and *n* = 13 men; age range = 29 - 64 years; *M* age = 46.6 years, *SD* = 9.04) who reported experiencing insomnia symptoms (as determined by the Insomnia Severity Index; Bastien et al., 2001). Individuals were excluded if they smoked, were either pregnant or trying to conceive, had health disorders, were taking sleep supplements or medication, or had a BMI greater than 32 (see Figure 1 for the Participant Flow Chart). The participants Insomnia Severity Index Scores reflected moderate insomnia at baseline, with a mean score of 11.00 (*SD* = 4.67). Regarding insomnia issues 71.05% had difficulties falling asleep, 89.47% had difficulty staying asleep, and 81.58% woke up too early.

Procedures and Design

This study received Institutional Review Board approval from both WIRB and Jacksonville University. Using a single-blind crossover design, following completion of one week of baseline assessments the participants were randomized to either the Wholetones® 2Sleep or Classical Music condition for 10 days. Following a 4 day "washout period" the participants listened to the alternative music for 10 days. The participants were blinded to the music condition and they were instructed to listen to the music for 30 minutes prior to bed. The music would continue to play throughout the night unless the participants turned it off.

The participants received a daily reminder to listen to the music each night and they completed a daily diary assessing sleep quality and adherence. They also completed self-report assessments of their mood, daytime fatigue, anxiety, perceived stress, productivity, and sleep quality at baseline and following each of the music conditions. Participants maintained their current lifestyle behaviors for the study duration. A total of 42 adults were enrolled in the trial and 38 participants completed the trial, representing an adherence rate of 86.36%. Three participants dropped out because of difficulties listening to the music and one person had technical difficulties with the sleep tracker.

Music Intervention

The classical music was selected based on the Mayo Clinic and NIH music recommendations for better sleep. More specifically, the classical music consisted of the following six pieces: Beethoven (i.e., Moonlight Sonata, first movement), Marconi Union (i.e., Weightless), Chopin (i.e., Nocturne No.2, Op.9), Ravel (i.e., Piano Concerto in G major, 2nd movement), and J.S. Bach (i.e., Prelude No.1).

Wholetones® 2Sleep is music that is designed to lull the listener into a deep, delta sleep, using frequency-enhanced music and precise tempos. Wholetones® differs from other musical genres in that it employs a proprietary method of tuning and layering the music with a unique frequency underlayment.

Measures

Outcome Summary

The following psychometrically validated self-report measures were completed at Day 0 and following the completion of each music condition:

- Pittsburgh Sleep Quality Index (PSQI) which assesses sleep quality and patterns (Buysse et al., 1989);
- Profile of Mood States (POMS) which assesses the mood states of tension, anger, vigor, fatigue, depression, and confusion (McNair et al., 1971);
- Flinders Fatigue Scale that measures various characteristics of daytime fatigue;
- Trait Anxiety Inventory which assesses trait anxiety levels (Spielberger et al., 1983); and
- Perceived Stress Scale which measures the degree to which situations are appraised as stressful (Cohen et al., 1983).
- Daytime productivity was assessed with a single item assessing satisfaction with ability to complete daily activities (from the Life Satisfaction Scale; Cheung & Lucas, 2014).

The following outcomes were assessed each day:

- EMFIT QS sleep tracker™, which relies on ballistocardiography, was used to objectively assess nighttime sleep in the natural environment. EMFIT trackers are a valid alternative for sleep staging with the advantage of low cost and simplicity (Kortelainen et al., 2010). This sleep tracker is automatic, autonomous, and is installed under the mattress. It measures heart rate, breathing rate, and movement activity data every 4 seconds; and sleep staging every 30 seconds and heart rate variability every 3 minutes. See Appendix A for a detailed list of tracker data obtained;
- Daily diary which assessed adherence, music likeability, and sleep quality.

Self-report Assessments (see Table 2, 6, and 14 for a summary of the self-report results)

Pittsburgh Sleep Quality Index (PSQI): PSQI was used to assess changes in subjective sleep quality. It is a self-report questionnaire with 19 items (scale range = 0 – 21). Higher scores indicate more sleep problems, and a score > 5 separates poor sleepers from good sleepers (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI has good psychometric properties and it is recommended as an essential outcome measures in sleep studies (Buysse, Ancoli-Israel, Edinger, Lichstein, & Morin, 2006).

Flinders Fatigue Scale: The Flinders Fatigue Scale is a 7-item scale that measures various characteristics of fatigue (e.g., frequency, severity) experienced. The items tap into commonly reported themes of how problematic fatigue is, the consequences of fatigue, fatigue frequency, fatigue severity, and perceptions of fatigue's association with sleep. Six items are presented in Likert format, with responses ranging from 0 (not at all) to 4 (extremely). Item 5 measures the time of day when fatigue is experienced and uses a multiple-item checklist. Respondents can indicate more than one response for item 5, and it is scored as the sum of all times of the day indicated by the respondent. One item explicitly asks for respondents' impression of whether they attribute their fatigue to their sleep. Total fatigue is calculated as the sum of all individual items. Total fatigue scores range from 0 to 31, with higher scores indicating greater fatigue. A clear description of the term “fatigue” is provided in the initial instructions to the scale.

Profile of Mood States (POMS): The POMS is a well-established measure of psychological distress derived from factor analysis, and its high levels of reliability and validity have been documented (McNair, 1971; McNair, Loss, & Droppleman, 1992). This questionnaire contains 65 words/adjectives that describe several aspects of mood that are grouped into the following six subscales: tension, depression, anger, vigor, fatigue, and confusion. The vigor subscale refers to a positive state of mind, and the other factors, to a negative state of mind. Each

item is valued following a Likert type format, with five response alternatives: nothing (0), little (1), regular (2), enough (3) or much (4).

Perceived Stress Scale: The Perceived Stress Scale (PSS) is the most widely used psychological instrument for measuring the perception of stress (Cohen et al., 1983). It is a measure of the degree to which situations in one's life are appraised as stressful. Items were designed to tap how unpredictable, uncontrollable, and overloaded respondents find their lives. The scale also includes a number of direct queries about current levels of experienced stress. The PSS was designed for use in community samples with at least a junior high school education. The items are easy to understand, and the response alternatives are simple to grasp. Moreover, the questions are of a general nature and hence are relatively free of content specific to any subpopulation group.

Trait Anxiety Inventory: The Trait Anxiety Inventory is widely used to measure trait anxiety (Spielberger, 2010). The Trait Anxiety Inventory contains 20 four-point Likert scale items. Trait anxiety items assess how subjects generally feel. Total scores range from 20 to 80. Higher scores indicate more severe anxiety levels.

Satisfaction with Productivity: Productivity was measured by the single item "In general, how satisfied are you with your ability to get things done during the day (i.e., how productive do you feel?" with a 4-point scale from 1 (Very Unproductive) to 4 (Very Productive; Cheung & Lucas, 2014). Total scores range from 1 to 4, and higher scores indicate higher levels of productivity (See Table 11).

Daily Diary: Each morning the participants completed the Daily Diary that assessed their music adherence, sleep quality, and music likeability. More specifically, the participants were asked the following questions:

- "How would you rate your sleep quality last night?"
    - Very good, fairly good, neutral, fairly bad, and very bad
- How long (hours/minutes) did you sleep last night?
- How refreshed did you feel when you woke up this morning?
    - Very refreshed, somewhat refreshed, neutral, somewhat tired, very tired
- Did you like listening to the music?
    - Very unlikeable, unlikeable, neutral, likeable, extremely likeable
- How long did it take you to fall asleep last night (in minutes)?
- How many times did you wake up last night?

Data Analysis

The sleep data gathered with the EMFIT tracker were analyzed using RStudio. Data were aggregated and analyzed for missing values and errors. Tukey analysis was used to determine abnormal data by identifying values outside of 2*Interquartile Range and histogram analysis was used to remove errors. Classification and Regression Trees method was used for the missing value replacement utilizing the Multiple Imputation by Chained Equations (MICE) package. Paired sample *t*-tests were used to analyze mean differences between groups delta scores. And 2 (Condition: Wholetones vs Classical Music) x 2 (Time: Baseline vs Music Condition) repeated measures analysis of variance (ANOVAs) were used to examine condition, time, and interaction effects. Fligner-Killeen's test was conducted to determine the difference in condition variances. Chi- squared analysis was used to examine within group

changes. The significance level was set at p's ≤ .05. The self-report data were analyzed using SPSS.

Results

Adherence

Both music conditions had a high music adherence rate of ~85% for listening to the music 30 minutes prior to nighttime sleep. During the Classical Music condition, participants listened to the music throughout the night 61.1% of the time, as compared to the Wholetones® 2Sleep condition where the music was listened to throughout the night 52.9% of the time.

Likeability/Enjoyment

When compared to the Classical music condition, the Wholetones® 2Sleep music condition reported more favorable responses to items regarding enjoyment of the music, sleep quality with music, finding it easier to fall asleep with the music, and feeling more rested in the morning after listening to the music; however, these condition differences were not statistically significant (see Table 12).

On 10-point Likert scale, where 1 represented "Not at all Enjoyable" and 10 represented "Very Enjoyable", 32% of the participants reported scores of 7 or higher for music likeability in the Wholetones® 2Sleep condition as compared to only 24% in the Classical music condition.

Pittsburgh Sleep Quality Index (PQSI) (see Table 4, 5, 7, and 13)

- PSQI assesses changes in subjective sleep quality
- Listening to both the Wholetones® 2Sleep and Classical music resulted in significant improvements in the sleep quality items of:
    - feeling too cold at night
    - feeling too hot at night
    - more enthusiasm during the day to get things done
- Listening to the Wholetones® 2Sleep music also resulted in significant improvements in sleep quality items of:
    - being able to fall asleep within 30 minutes of going to bed
    - being less likely to wake up in the middle of the night or early morning
    - having pain
- A total score of "5" or greater on the PSQI is indicative of poor sleep quality. If participants scored "5" or more it is suggested that they discuss their sleep habits with a healthcare provider.
    - Participants had a significant improvement in poor sleep quality following listening to the Wholetones and Classical music

- At baseline 82% of the participants were classified as poor sleepers. Following listening the Wholetones music 42% were classified as poor sleeper. And following listening to the Classical music 47% were classified as poor sleepers

Flinders Fatigue Scale (see Table 1 and Table 7)

- Flinders Fatigue Scale assesses daytime fatigue (i.e., feeling tired, weary, exhausted) [not feelings of sleepiness – that is the likelihood of falling asleep]
- Listening to both the Wholetones and Classical music resulted in significant improvements in daytime fatigue (in other words reductions in daytime fatigue)
- Regarding specific fatigue items, listening to the Wholetones and Classical music resulted in significant improvements in:
    - Fatigue causing problems with everyday tasks

- Regarding specific fatigue items, listening to the Wholetones music resulted in significant improvements in:
    - Fatigue severity experienced
    - The degree that fatigue was caused by poor sleep

Trait Anxiety (see Table 2 and Table 7)

- Listening to the Wholetones and Classical music resulted in significant improvements in trait anxiety
    - Of importance, the Wholetones condition had a larger improvement (that approached significance, $p = .07$) in anxiety scores compared to the Classical condition

Profile of Mood States (POMS) (see Table 2 and Table 7)

- Significant improvements from baseline following listening to the Wholetones and Classical music for total mood as well as the mood subscales of depression, anger, confusion, and tension
    - That is, listening to the music resulted in improvements in daytime levels of depression, anger, anger, fatigue, tension, and overall mood,
- Significant improvements from baseline to following the Wholetones music condition for confusion

Perceived Stress (See Table 2 and Table 7)

- Significant improvements from baseline following listening to the Wholetones and Classical music for perceived stress

EMFIT Tracker (see Table 7, 8, 9, and 10)

The physiological data collect through the EmFit QS system indicated that the participants had marginally better sleep quality when listening to Wholetones compared to baseline and

the Classical Music in some measured variables. Participant scored better in total recovery, integrative recovery, and length spent in deep sleep -- all of which are all strong indicators of sleep quality. Chi-squared analysis revealed a statistically significant proportion of individuals while in the Wholetones condition had a positive change in integrative recovery scores compared to those who had no change or negative score changes. This difference did not translate for the Classical Music Condition. No other statistically significant measures where observed for distributional differences, distribution shape, or proportional changes.

Sleep Dairy (see Table 10)

Sleep Dairy data showed high adherence throughout the study for both music conditions with ~85% adherence throughout the study. During the Classical Music condition participant listened to the music 61.1% throughout the entire night, compared to the Wholetones condition where the music was listened to throughout the entire night 52.9% of the time. The Wholetones condition marginal outperformed that Classical condition on all sleep diary questions, but the differences were not statistically significantly ($p > 0.05$).

Improvement on the Self-report Measures (see Table 13 and 14)

- After listening to the Wholetones® 2Sleep music for 10 days
    - 55% had less depression (e.g., felt less sad, blue, hopeless)
    - 52% were less angry (e.g., felt less angry, peeved, grouchy)
    - 53% had more energy/vigor (e.g., felt more lively, active, energetic)
    - 58% were less confused (e.g., felt less confused, unable to concentrate, muddled)
    - 68% were less tense (e.g., felt less tense, shaky, on edge)
    - 79% improved on their overall mood
    - 50% were less anxious
    - 66% were less stressed
    - 24% were more productivity
    - 61% were less fatigued

Adverse Events

No adverse effects were reported. The music was well-tolerated.

Moderator Analysis

No significant moderator effects were evidenced for gender, music appreciation, and level of baseline insomnia (high or low).

Anecdotal Researcher Feedback

Some participants anecdotally reported trouble keeping the music playing throughout the entire night and five participants reported that the volume control needed a lower setting (i.e., they found the music too loud).

Recommendations – to have an option to listen to the music for 30 minutes prior to sleep (e.g., a sleep timer) and a lower volume setting.

Discussion

The purpose of this trial was examine the efficacy of different types of music (i.e., Wholetones® 2Sleep and Classical music) to improve sleep quality (using both self-report and objective measures) as well as the daytime consequences of the intervention in adults with

insomnia symptoms. Wholetones is frequency based music which is specifically tuned to help people relax, feel a sense of peace and get the sleep they need.

Consistent with the hypothesis, we found that both music conditions resulted in improved sleep and self-reported health outcomes. In partial support of our hypothesis we found larger positive effects for the Wholetones® 2Sleep compared to the Classical music for selected outcomes. Both the objective and self-report data revealed that listening to music 30 minutes prior to nighttime sleep resulting in significant improvements in sleep quality resulting in improved daytime mood, productivity, fatigue, perceived stress, and anxiety levels. These findings are consistent with research showing relationships between insomnia and listening to music (Jespersen et al., 2015).

Future researcher should examine how music longitudinally impacts the physiology and pathways associated with sleep in a variety of populations and environments. In summary, the Wholetones and Classical music were well-tolerated and may be a simple, noninvasive, and non-pharmacological intervention to promote improved sleep quality/quantity, mood, anxiety, fatigue, and stress with adults who experience insomnia symptoms. The Wholetones music condition tended to outperform the Classical music condition (albeit often nonsignificant).

References

Ancoli-Israel S, Roth T. Characteristics of insomnia in the United States: results of the 1991 National Sleep Foundation Survey. I. Sleep. 1999;22:S347–353.

Bastien, C. H., Vallieres, A. and Morin, C. M. Validation of the Insomnia Severity Index as an outcome
measure for insomnia research. *Sleep Med*, 2001, 2: 297-307.

Buysse, D. J., Ancoli-Israel, S., Edinger, J. D., Lichstein, K. L., & Morin, C. M. (2006). Recommendations for a standard research assessment of insomnia. Sleep, 29, 1155–1173. https://doi.org/10.1093/ sleep/29.9.1155

Chang, ET, Lai HL, Chen PW, Hsieh YM, Lee LH. The effects of music on the sleep quality of adults with chronic insomnia using evidence from polysomnographic and self-reported analysis: a randomized control trial. Int J Nurs Stud. 2012 Aug;49(8):921-30. doi: 10.1016/ j.ijnurstu.2012.02.019. Epub 2012 Apr 10.

Cheung F, Lucas RE. Assessing the validity of single-item life satisfaction measures: results from three large samples. Qual Life Res. 2014;23(10):2809–18.

Cohen, S., Kamarck, T., and Mermelstein, R. (1983). A global measure of perceived stress. Journal of Health and Social Behavior, 24, 386-396.

De Niet, G., Tiemens, B., Lendemeijer, B., & Hutschemaekers, G. (2009). Music-assisted relaxation to improve sleep quality: Metaanalysis. Journal of Advanced Nursing, 65, 1356–1364. https://doi. org/10.1111/j.1365-2648.2009.04982.x

Feng F, Zhang Y, Hou J, Cai J, Jiang Q, Li X, Zhao Q, Li BA. Can music improve sleep quality in adults with primary insomnia? A systematic review and network meta-analysis. Int J Nurs Stud. 2018 Jan;77:189-196. doi: 10.1016/j.ijnurstu.2017.10.011.

Harmat, L., Takács, J. & Bódizs, R. (2008). Music improves sleep quality in students. J Adv Nurs. 2008 May;62(3):327-35. doi: 10.1111/j.1365-2648.2008.04602.x.

Huang, C. Y., Chang, E. T., & Lai, H. L. (2016). Comparing the effects of music and exercise with music for older adults with insomnia. Appl Nurs Res. 2016 Nov;32:104-110. doi: 10.1016/ j.apnr.2016.06.009. Epub 2016 Jun 23.

Jespersen, K. V., Koenig, J., Jennum, P., & Vuust, P. (2015). Music for insomnia in adults. Cochrane Database of Systematic Reviews (Online), 8, CD010459.

Jespersen, K. V., Otto, M., Kringelbach, M., Someren, E. V., & Vuust, P. (2018). A randomized controlled trial of bedtime music for insomnia disorder. Journal of Sleep Research.

Kortelainen, J. M., Mendez, M. O., Bianchi, A. M., Matteucci, M. and Cerutti, S. Sleep staging based on
signals acquired through bed sensor. *IEEE Trans Inf Technol Biomed*, 2010, 14: 776-85.

McNair (POMS) McNair DM. Manual profile of mood state. Educ Ind Test Serv. 1971.

McNair D.M., Lorr M., Droppleman L.F. Profile of Mood States Manual. Educational and Industrial Testing Services; San Diego, CA, USA: 1992

Ohayon, M.M., 2002. Epidemiology of insomnia: what we know and what we still need to learn. Sleep Medicine Reviews 6, 97–111.

Smith, J. C., & Joyce, C. A. (2004). Mozart versus new age music: relaxation states, stress, and ABC relaxation theory. J Music Ther. 2004 Fall;41(3):215-24.

Spielberger CD. State-trait anxiety inventory. In: Weiner IB, Craighead WE, editors. The Corsini encyclopedia of psychology. 4th ed. Hoboken: John Wiley & Sons, Inc; 2010.

Taylor DJ, Lichstein KL, Durrence HH. Insomnia as a health risk factor. Behavioral sleep medicine. 2001;1(4):227–247

Trahan, T., Durrant, S. J., Müllensiefen, D., Williamson, V. J. (2018). The music that helps people sleep and the reasons they believe it works: A mixed methods analysis of online survey reports. PLoS One. 2018; 13(11): e0206531.

Trapper, H. J. (2010). The effects of music on the cardiovascular system and cardiovascular health. Heart. 2010 Dec;96(23):1868-71.

Table 1

Item	Baseline M (SD)	Wholetones M (SD)	Statistics	Classical M (SD)	Statistics
Was fatigue a problem for you?	1.53 (1.01)	1.47 (1.05)	t = 0.36, p = . 72	1.49 (1.02)	t = 0.29, p = . 77
*#Did fatigue cause problems with your everyday?	1.53 (1.01)	0.94 (0.98)	t = 4.06, p < . 01	1.00 (0.91)	t = 4.46, p < . 01
Did fatigue cause you stress?	0.95 (1.11)	0.72 (0.98)	t = 1.57, p = . 13	0.78 (0.85)	t = 1.09, p = . 28
How often did you suffer from fatigue?	1.47 (0.98)	1.30 (0.92)	t= 0.97, p = . 34	1.32 (0.88)	t = 0.98 p = . 34
*#At what time(s) of the day did you typically suffer from fatigue?	1.76 (1.08)	1.09 (1.48)	t= 2.62, p = . 01	0.59 (0.72)	t= 5.33, p < . 01
*How severe was the fatigue you experienced?	1.79 (1.04)	1.50 (0.97)	t= 2.36, p = . 02	1.51 (0.96)	t= 1.74, p = . 09
*How much was your fatigue caused by poor sleep?	2.05 (1.14)	1.58 (1.17)	t= 2.25, p = . 03	1.81 (1.20)	t = 1.17, p = . 25
*#Fatigue Total Score	11.08 (5.87)	8.60 (5.46)	t= 3.00, p = . 01	8.51 (4.93)	t= 3.34, p < . 01

Flinder's Fatigue Scale Individual Items by Music Condition

Notes: Higher scores indicate greater fatigue (i.e., feeling tired, weary, exhausted) [not feelings of sleepiness – that is the likelihood of falling asleep]; Statistic = paired sample t-tests, t(37) (baseline vs music)

* = significant improvements in fatigue levels from baseline following listening to the Wholetones music. That is, listening to the Wholetones music resulted in reduction in daytime fatigue levels.

= significant improvements in fatigue levels from baseline following listening to the Classical music. That is, listening to the Classical music resulted in reduction in daytime fatigue levels.

Table 2

Descriptive Statistics for the Self-report Measures of Profile of Mood States, Anxiety, and Stress

Outcome	Baseline	Wholetones Music	Statistic t(37)	Classical Music	Statistics t(37)
	Mean (SD)	Mean (SD)		Mean (SD)	
Trait Anxiety	36.39 (10.06)	33.55 (9.84)	t(37)= 1.86, p=.07	35.24 (8.75)	t(37)= 1.11, p=.27
*#Perceived Stress	13.34 (7.36)	10.39 (6.63)	t(37)= 2.85, p=.01	10.45 (6.37)	t(37)= 3.60, p<.01
*#POMS Total	52.47 (29.28)	38.26 (20.51)	t(37)= 2.93, p=.01	43.13 (21.82)	t(37)= 2.85, p=.01
#*POMS Depression	6.34 (7.49)	3.34 (4.67)	t(37)= 2.49, p=.02	4.11 (5.58)	t(37)= 2.85, p=.01
*#POMS Anger	6.76 (7.20)	3.71 (4.29)	t(37)= 2.64, p=.01	4.32 (4.54)	t(37)= 2.55, p=.02
POMS Vigor	15.95 (6.62)	15.18 (6.35)	t(37)= 0.78, p=.44	16.53 (6.17)	t(37)= -0.80, p=.42
*POMS Confusion	5.89 (3.83)	4.63 (3.57)	t(37)= 2.23, p=.03	5.47 (3.45)	t(37)= 0.97, p=.34
*#POMS Tension	8.76 (5.61)	5.68 (4.37)	t(37)= 3.48, p<.01	6.11 (3.77)	t(37)= 3.98, p<.01
*#POMS Fatigue	8.76 (4.75)	5.71 (3.45)	t(37)= 4.11, p<.01	6.61 (4.23)	t(37)= 3.40, p<.01
*#PSQI Global	6.47 (2.77)	4.52 (2.00)	t(37)= 4.65, p<.01	4.73 (2.04)	t(37)= 4.22, p<.01

Note: Lower scores indicate an improvement (except for Vigor in which higher scores indicate an improvement) POMS = Profile of Mood States; PSQI = Pittsburgh Sleep Quality Index; Statistic = paired sample t-tests, t(37) (baseline vs music)

* = significant improvements from baseline following listening to the Wholetones music for perceived stress, total mood, depression, anger, confusion, tension, fatigue, and sleep quality. That is, listening to the Wholetones music resulted in improvements in daytime levels of perceived stress, depression, anger, confusion, anger, tension, and overall mood, and sleep quality.

= significant improvements from baseline following listening to the Classical music for perceived stress, total mood, depression, anger, tension, fatigue, and sleep quality. That is, listening to the Wholetones music resulted in improvements in daytime levels of perceived stress, depression, anger, tension, anger, and overall mood, and sleep quality.

Table 3

% Improvement from Baseline by Music Condition for the Self-report Measures

Outcome	Wholetones Music (%)	Classical Music (%)
Trait Anxiety	5.60% Increase	1.17% Increase
Perceived Stress	13.69 % Increase	19.65% Increase
POMS Total	16.26% Increase	8.85% Increase
Fatigue Scale	14.30% Increase	11.98% Increase
PSQI	17.19% Increase	16.93% Increase

Table 4

Item	Baseline M (SD)	Wholetones Music M (SD)	Statistic	Classical Music M (SD)	Statistic
When have you usually gone to bed?	10.30 (1.66)	10.65 (0.90)	t(37)= -1.15, p=.26	10.60 (0.99)	t(37)= -0.94, p=.35
How long (in minutes) has it taken you to fall asleep each night?	14.37 (7.63)	13.71 (7.89)	t(37)= 0.57, p=.57	14.16 (10.44)	t(37)= .14, p=. 89
What time have you usually gotten up in the morning?	6.22 (1.00)	6.23 (1.07)	t(37)= -0.22, p=.83	6.21 (0.95)	t(37)= 0.10, p=. 92
How many hours of actual sleep did you get at night?	6.81 (1.02)	6.95 (0.78)	t(37)= -1.40, p=.17	6.95 (0.74)	t(37)= -1.00, p=.32
How many hours were you in bed?	7.62 (1.05)	7.51 (0.94)	t(37)= 1.48, p=.15	7.53 (0.87)	t(37)= 0.70, p=. 49
During the past 14 days, how often have you had trouble sleeping because you…					
*…Cannot get to sleep within 30 minutes	0.89 (0.69)	0.59 (0.59)	t(37)= 3.05, p=.01	0.62 (0.82)	t(37)= 1.82, p=. 07
*…Wake up in the middle of the night or early morning	1.79 (0.87)	1.51 (0.82)	t(37)= 2.10, p=.04	1.54 (1.00)	t(37)= 1.55, p=. 13
…Have to get up to use the bathroom	1.37 (1.05)	1.16 (0.85)	t(37)= 1.66, p=.11	1.24 (0.82)	t(37)= 0.85, p=. 40
…Cannot breathe comfortably	0.08 (0.27)	0.08 (0.36)	t(37)= -0.06, p=.96	0.16 (0.49)	t(37)= -1.04, p=.31
…Cough or snore loudly	0.11 (0.39)	0.13 (0.41)	t(37)= -0.28, p=.78	0.05 (0.23)	t(37)= 0.96, p=. 35
*#…Feel too cold	0.39 (0.64)	0.14 (0.34)	t(37)= 2.22, p=.03	0.16 (0.37)	t(37)= 2.12, p=. 04
*#…Feel too hot	1.00 (1.04)	0.59 (0.68)	t(37)= 3.26, p<.01	0.65 (0.81)	t(37)= 2.62 p=. 01
*#…Have bad dreams	0.47 (0.80)	0.19 (0.46)	t(37)= 2.89, p=.01	0.19 (0.46)	t(37)= 2.09, p=. 04
*…Have pain	0.47 (0.73)	0.24 (0.54)	t(37)= 2.24, p=.03	0.35 (0.67)	t(37)= 1.20, p=. 23

During the past 14 days, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?	0.34 (0.58)	0.16 (0.37)	t(37)= 1.71, p=.09	0.19 (0.46)	t(37)= 1.92, p=.06
*#During the past 14 days, how much of a problem has it been for you to keep up enthusiasm to get things done?	1.05 (0.84)	0.65 (0.78)	t(37)= 2.89, p=.01	0.65 (0.67)	t(37)= 3.61, p<.01
During the past 14 days, how would you rate your sleep quality overall?	1.50 (0.60)	1.30 (0.56)	t(37)= 1.55, p=.13	1.40 (0.54)	t(37)= .79, p=.44
*#Total	6.47 (2.77)	4.52 (2.00)	t(37)= 4.65, <=.01	4.73 (2.04)	t(37)= 4.21, p<.01

Pittsburgh Sleep Quality Index Individual Items by Music Condition

* = significant improvements in sleep quality from baseline following listening to the Wholetones music. That is, listening to the Wholetones music resulted in improvements in:

- being able to fall asleep within 30 minutes of going to bed
- being less likely to wake up in the middle of the night or early morning
- feeling too cold at night
- feeling too hot at night
- having pain
- more enthusiasm during the day to get things done.

= significant improvements in sleep quality from baseline following listening to the Classical music. That is, listening to the Classical music resulted in improvements in:

- feeling too cold at night
- feeling too hot at night
- more enthusiasm during the day to get things done.

Table 5

Number of Participants Who Had Poor Sleep Quality

Time Point	PSQI Sleep Score < 5	PSQI Sleep Score ≥5	Statistic: Chi Square
	Good Sleeper	Poor Sleeper	
Baseline	7 (18.42%)	31 (81.58%)	
Wholetones Music	22 (57.89%)	16 (42.11%)	$p < .01$ (Baseline to Wholetones)
Classical Music	20 (52.63%)	18 (47.37%)	$p < .01$ (Baseline to Classical)
Wholetones to Classical	7 (18.42%)	31 (81.58%)	$p = 0.41$ (Wholetones to Classical)

Note: A total score of “5” or greater on the Pittsburgh Sleep Quality Index Total Score (PSQI) is indicative of poor sleep quality. If participants scored “5” or more it is suggested that they discuss their sleep habits with a healthcare provider.

- Significant improvement in poor sleep quality following listening to the music
- At baseline 82% of the participants were classified as poor sleepers. Following listening the Wholetones music 42% were classified as poor sleeper. And following listening to the Classical music 47% were classified as poor sleepers

Table 6

Outcome	Main Effect for Time	Interaction	Main Effect for Condition
*Trait Anxiety	F(1,74)= 4.66, p=0.03	F(1,74)= 0.68, p=0.41	F(1,74)= 0.18, p=0.67
*Perceived Stress	F(1,74)= 19.89, p, 0.01	F(1,74)= 0.00, p=0.97	F(1,74)= 0.00, p=0.99
*POMS Total	F(1,74)= 16.28, p<0.01	F(1,74)= 0.64, p=0.43	F(1,74)= 0.24, p=0.63
*POMS Depression	F(1,74)= 13.27, p<0.01	F(1,74)= 0.27, p=0.61	F(1,74)= 0.09, p=0.77
*POMS Anger	F(1,74)= 13.37, p<0.01	F(1,74)= 0.16, p=0.69	F(1,74)= 0.70, p=0.79
POMS Vigor	F(1,74)= 0.02, p=0.88	F(1,74)= 0.85, p=0.36	F(1,74)= 0.27, p=0.60
*POMS Confusion	F(1,74)= 5.55, p=0.02	F(1,74)= 1.30, p=0.26	F(1,74)= 0.31, p=0.58
*POMS Tension	F(1,74)= 26.76, p<0.01	F(1,74)= 0.14, p=0.71	F(1,74)= 0.05, p=0.83
*POMS Fatigue	F(1,74)= 28.42, p<0.01	F(1,74)= 0.79, p=0.38	F(1,74)= 0.27, p=0.60
*PSQI Global	F(1,74)= 39.36, p<0.01	F(1,74)= 0.13, p=0.72	F(1,74)= 0.05, p=0.82
*Flinder's Fatigue Scale	F(1,74)= 18.97, p<0.01	F(1,74)= 0.00, p=0.98	F(1,74)= 0.00, p=0.99
*Productivity	F(1,74) = 4.66, p=0.03	F(1,74)= 0.00, p=1.00	F(1,74)= 0.00, p=1.00

Repeated Measures Analysis of Variance (ANOVA) Results for the Self-report assessments

Statistic = 2 (Condition: Wholetones vs Classical) x 2 (Time: Baseline vs Music) repeated measures ANOVA

- No significant Condition effects
- No significant Interactions
- *Significant main effect of time for anxiety, stress, mood total, depression, anger, vigor, confusion, tension, fatigue, sleep quality, productivity, and fatigue.

- In other words, listening the music (regardless of whether it was the Classical or Wholetones music) resulted in significant improvements from baseline in anxiety, stress, mood total, depression, anger, vigor, confusion, tension, productivity, sleep quality, and fatigue

GROUP	BASELINE		WHOLETONES		CLASSICAL	
STAT	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
SLEEP SCORE	80.0	19.5	79.8	19.7	79.4	20.0
TIME SPENT ASLEEP (MIN)	446.2	117.7	440.5	117.5	439.7	117.4
TIME SPENT IN REM PHASE (MIN)	115.2	36.1	111.7	36.2	109.6	36.9
TIME SPENT IN LIGHT PHASE (MIN)	254.3	70.0	248.8	70.4	252.9	69.4
TIME SPENT IN DEEP PHASE (MIN)	76.3	28.2	82.4	50.8	79.6	28.6
% TIME SPENT IN REM PHASE	26.2	5.0	25.5	5.2	25.0	5.0
% TIME SPENT IN LIGHT PHASE	56.8	3.9	56.5	4.1	57.0	4.8
% TIME SPENT IN DEEP PHASE	17.2	4.6	18.2	4.6	18.0	4.5
HRV RMSSDM MORNING	30.8	11.5	39.4	102.0	32.9	12.1
HRV RMSSD EVENING	28.2	11.6	29.6	12.0	30.1	15.3
TOTAL RECOVERY	2.4	13.2	4.0	16.5	3.1	13.9
INTEGRATIVE RECOVERY	206.9	91.0	218.6	100.3	216.5	145.1
ANS LOW FREQUENCY	50.1	9.0	49.4	9.5	49.2	9.3
ANS HIGH FREQUENCY	50.2	9.1	50.8	9.5	50.8	9.2
HIGHEST RECORDED HR	102.5	16.5	104.1	18.1	99.4	18.3
AVERAGE RECORDED HR	65.7	7.0	64.1	6.6	63.9	6.5
LOWEST RECORDED HR	48.4	4.6	48.1	3.6	47.7	4.1
HIGHEST RECORDED BR	23.5	3.5	23.9	9.3	23.9	2.8
AVERAGE RECORDED BR	13.9	2.7	13.8	2.2	14.6	6.1
LOWEST RECORDED BR	6.0	1.8	5.8	1.6	6.0	1.7
TOSS & TURN	81.6	70.4	78.7	78.3	80.2	75.7
AVERAGE ACTIVITY	115.2	114.9	114.6	125.4	108.4	106.5

Table 7: Descriptive Statistics for the EMFIT Tracker

Table 8: EmFit Data Paired two-sample t-test

GROUP COMPARISON	BASELINE VS. WHOLETONES		BASELINE VS. CLASSICAL		WHOLETONES VS. CLASSICAL	
STAT	t statistic	p value	t statistic	p value	t statistic	p value
SLEEP SCORE	0.798	0.432	0.252	0.803	-0.506	0.617
TIME SPENT ASLEEP (MIN)	0.021	0.983	-0.615	0.544	-0.704	0.487
TIME SPENT IN REM PHASE (MIN)	0.838	0.409	0.258	0.798	-0.589	0.561
TIME SPENT IN LIGHT PHASE (MIN)	1.427	0.165	1.558	0.131	0.087	0.931
TIME SPENT IN DEEP PHASE (MIN)	0.814	0.423	-0.359	0.723	-1.377	0.179
% TIME SPENT IN REM PHASE	-1.754	0.090	-1.377	0.179	0.710	0.483
% TIME SPENT IN LIGHT PHASE	1.400	0.172	2.001	0.055	0.926	0.362
% TIME SPENT IN DEEP PHASE	-0.265	0.793	-0.761	0.453	-0.549	0.587
HRV RMSSDM MORNING	-1.627	0.115	-1.311	0.200	0.076	0.940
HRV RMSSD EVENING	-1.494	0.146	-0.818	0.420	1.276	0.212
TOTAL RECOVERY	-1.953	0.061	-1.306	0.202	-0.066	0.948
INTEGRATIVE RECOVERY	-0.732	0.470	0.350	0.729	1.184	0.246
ANS LOW FREQUENCY	-1.677	0.105	-1.001	0.325	0.306	0.762
ANS HIGH FREQUENCY	1.928	0.064	0.897	0.377	-1.579	0.126
HIGHEST RECORDED HR	-1.892	0.069	-0.580	0.566	1.971	0.059
AVERAGE RECORDED HR	0.251	0.804	1.756	0.090	1.712	0.098
LOWEST RECORDED HR	2.385	0.024*	2.791	0.009*	0.069	0.946
HIGHEST RECORDED BR	1.013	0.320	1.610	0.119	0.692	0.495
AVERAGE RECORDED BR	-1.083	0.288	-1.166	0.253	0.313	0.756
LOWEST RECORDED BR	-0.534	0.598	-1.796	0.083	-1.547	0.133
TOSS & TURN	0.479	0.636	-0.254	0.801	-0.929	0.361
AVERAGE ACTIVITY	-0.382	0.706	-1.026	0.314	-0.942	0.354

* = significant difference in distributions

Table 9: EmFit Improvement Scores

VARIBLE	WHOLETONES			CLASSICAL		
STAT	Number of people who improved	Number of people who did not improved	% of people who improved	Number of people who improved	Number of people who did not improved	% of people who improved
SLEEP SCORE	13	16	44.8%	14	14	50.0%
TIME SPENT ASLEEP (MIN)	11	18	37.9%	14	15	48.3%
TIME SPENT IN REM PHASE (MIN)	13	16	44.8%	14	15	48.3%
TIME SPENT IN LIGHT PHASE (MIN)	12	17	41.4%	12	17	41.4%
TIME SPENT IN DEEP PHASE (MIN)	14	15	48.3%	18	11	62.1%
% TIME SPENT IN REM PHASE	14	15	48.3%	15	14	51.7%
% TIME SPENT IN LIGHT PHASE	13	16	44.8%	12	17	41.4%
% TIME SPENT IN DEEP PHASE	16	13	55.2%*	14	15	48.3%
HRV RMSSDM MORNING	17	12	58.6%	13	16	44.8%
HRV RMSSD EVENING	19	10	65.5%	18	11	62.1%
TOTAL RECOVERY	16	13	55.2%*	11	18	37.9%
INTEGRATIVE RECOVERY	20	9	69.0%*	14	15	48.3%

ANS LOW FREQUENCY	12	17	41.4%	16	13	55.2%
ANS HIGH FREQUENCY	16	13	55.2%	11	18	37.9%
HIGHEST RECORDED HR	15	13	53.6%	12	17	41.4%
AVERAGE RECORDED HR	9	20	31.0%	9	20	31.0%
LOWEST RECORDED HR	14	14	50.0%	10	18	35.7%
HIGHEST RECORDED BR	14	13	51.9%	15	14	51.7%
AVERAGE RECORDED BR	15	14	51.7%	18	11	62.1%
LOWEST RECORDED BR	15	13	53.6%	16	12	57.1%
TOSS & TURN	17	12	58.6%	17	12	58.6%
AVERAGE ACTIVITY	17	12	58.6%	20	9	69.0%

* = significant difference in distributions

Table 10: Chi-Square Test Baseline vs. Treatment

GROUP COMPARISON	BASELINE VS. WHOLETONES		BASELINE VS. CLASSICAL	
STAT	x^2 value	p value	x^2 value	p value
SLEEP SCORE	0.310	0.577	0.000	1.000
TIME SPENT ASLEEP (MIN)	1.690	0.194	0.034	0.853
TIME SPENT IN REM PHASE (MIN)	0.310	0.577	0.034	0.853
TIME SPENT IN LIGHT PHASE (MIN)	0.862	0.353	0.862	0.353
TIME SPENT IN DEEP PHASE (MIN)	0.034	0.853	1.690	0.194
% TIME SPENT IN REM PHASE	0.034	0.853	0.034	0.853
% TIME SPENT IN LIGHT PHASE	0.310	0.577	0.862	0.353
% TIME SPENT IN DEEP PHASE	0.310	0.577	0.034	0.853
HRV RMSSDM MORNING	0.862	0.353	0.310	0.577
HRV RMSSD EVENING	2.793	0.095	1.690	0.194
TOTAL RECOVERY	0.310	0.577	1.690	0.194
INTEGRATIVE RECOVERY	4.172	0.041*	0.034	0.853
ANS LOW FREQUENCY	0.862	0.353	0.310	0.577
ANS HIGH FREQUENCY	0.310	0.577	1.690	0.194
HIGHEST RECORDED HR	0.143	0.705	0.862	0.353
AVERAGE RECORDED HR	4.172	0.041	4.172	0.041
LOWEST RECORDED HR	0.000	1.000	2.286	0.131
HIGHEST RECORDED BR	0.037	0.847	0.034	0.853
AVERAGE RECORDED BR	0.034	0.853	1.690	0.194
LOWEST RECORDED BR	0.143	0.705	0.571	0.450
TOSS & TURN	0.862	0.353	0.862	0.353
AVERAGE ACTIVITY	0.862	0.353	4.172	0.041

* = significant difference in proportions

These proportions examine delta scores between baseline and treatment. Positive delta scores where compared to negative delta scores within treatments to examine the proportion of people who improved.

Summary: Participants had a significant improvement in integrative recovery following listening to the Wholetones music. No significant effect was found when listening to the classical music. Integrative recovery is an indicator for how much recovery you've gotten during sleep. For example, some people may start to recover very nicely in the first hours of the night, after they go to bed and fall asleep. But towards the morning hours they may start

to become anxious (for example because of work stress) and their RMSSD starts to decline. As a result, the morning RMSSD may be quite low when compared to the evening RMSSD, thus indicating poor recovery, even though there has been some good recovery during the night. This is where integrated recovery steps in, as it takes this good recovery from earlier in the night into account.

Table 11: Sleep Diary Descriptive Statistics

QUESTION	METRIC	TREATMENT	
		Wholetones	Classical
DID YOU LISTEN TO THE MUSIC BEFORE SLEEPING LAST NIGHT?	No	33	44
	Yes	291	269
	N/A	15	6
DID YOU LISTEN TO THE MUSIC THROUGHOUT THE ENTIRE NIGHT?	No	114	117
	Yes	210	195
	N/A	15	7
DID YOU LIKE LISTENING TO THE MUSIC?	Extremely Likable:	16	13
	Likeable:	97	82
	Neutral:	103	96
	Unlikable:	41	48
	Very Unlikable:	55	54
	N/A:	18	18
	Median answer:	3	3
	Mean answer:	2.916	2.693
	STDev	1.66	1.69
HOW LONG DID IT TAKE YOU TO FALL ASLEEP?	Min	0	0
	1st Qu.	5	5
	Median	10	10
	Mean	15.12	16.33
	STDev	14.52	15.34
	3rd Qu.	20	20
	Max	120	120
HOW MANY TIMES DID YOU WAKE UP LAST NIGHT?	Min	0	0
	1st Qu.	1	1
	Median	2	2
	Mean	2.1	2.09
	STDev	1.41	1.91
	3rd Qu.	3	4
	Max	11	16

HOW LONG DID YOU SLEEP (MINUTES)?	Min	121	105
	1st Qu.	361	360
	Median	421	420
	Mean	416.4	457
	STDev	76.03	71.59
	3rd Qu.	481	457
	Max	691	690
HOW WOULD YOU RATE YOUR SLEEP QUALITY LAST NIGHT?	Very Bad	10	14
	Fairly Bad	51	59
	Neutral	83	77
	Fairly Good	151	132
	Very Good	35	29
	N/A	0	0
	Median answer:	2	2
	Mean answer:	2.611	2.637
	STDev	0.99	1
HOW REFRESHED DID YOU FEEL WHEN YOU WOKE UP THIS MORNING?	Very Tired	21	29
	Somewhat Tired	59	86
	Neutral	75	69
	Somewhat Refreshed	131	104
	Very Refreshed	44	23
	N/A	0	0
	Median answer:	3	3
	Mean answer:	2.79	2.853
	STDev	1.12	1.17

Table 12: Music Likeability by Music Condition

	Wholetones Mean (S/D)	Classical Mean (S/D)
Was the music enjoyable?	4.63 (3.17)	4.10 (3.02)
Sleep quality compared to no music	4.44 (2.81)	3.86 (2.30)
Easier to fall asleep with music?	4.94 (3.14)	4.41 (2.95)
Feeling rested in morning after music	4.89 (2.41)	4.52 (2.62)

*Music enjoyment was assessed on a 10-point Likert scale with 1 representing very unenjoyable and 10 very enjoyable

*Sleep quality with music as compared to without music was assessed on a 10-point Likert scale with 1 representing less sleep quality improvement and 10 the most sleep quality improvement

*Falling asleep more easily with music as compared to without music was assessed using a 10-point Likert scale with 1 representing not helpful settling down and 10 very helpful for settling down

*Feeling rested after listening to music was assessed on a 10-point Likert scale with 1 representing less rested/more tired and 10 feeling most rested

Table 13: Number and Percentage of Participants who had an Improvement in a Pittsburgh Sleep Quality Index (PSQI) item After Listening to the Wholetones Music

PSQI Item		Number of Participants (%)
PSQI-1	When have you usually gone to bed?	8 (21.05%)
PSQI-2	How long (in minutes) has it taken you to fall asleep each night?	16 (42.11%)
PSQI-3	What time have you usually gotten up in the morning?	8 (21.05%)
PSQI-4a	How many hours of actual sleep did you get at night?	23 (60.53%)
PSQI-4b	How many hours were you in bed?	19 (50%)
PSQI-5a	*…Cannot get to sleep within 30 minutes	13 (34.21)
PSQI-5b	*…Wake up in the middle of the night or early morning	16 (42.11%)
PSQI-5c	…Have to get up to use the bathroom	10 (26.32%)
PSQI-5d	…Cannot breathe comfortably	0 (0%)
PSQI-5e	…Cough or snore loudly	2 (5.26%)
PSQI-5f	*#…Feel too cold	10 (26.32%)
PSQI-5g	*#…Feel too hot	0 (0%)
PSQI-5h	*#…Have bad dreams	10 (26.32%)
PSQI-5i	*…Have pain	7 (18.42%)
PSQI-7	During the past 14 days, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?	8 (21.05%)
PSQI-8	*#During the past 14 days, how much of a problem has it been for you to keep up enthusiasm to get things done?	8 (21.05%)
PSQI-9	During the past 14 days, how would you rate your sleep quality overall?	16 (42.11%)
PSQI-Total	*#Total	12 (31.58%)

*When analyzing improvements from baseline to following the Wholetones Condition, all (100%) of the participants improved on at least one of the sleep quality items from the PSQI. In other words, 100% of the participants had an improvement in at least one aspect of their sleep quality following listening to the Wholetones Music. (although there were no improvements noted in the areas of “Cannot breathe comfortably” and “Felt too hot”, each participant indicated improvements in at least one of the other sleep quality variables).

Table 14: Number and Percent of Participants Who Reported an Improvement in their Mood, Anxiety, Perceived Stress, Productivity, and Fatigue After Listening to the Wholetones® Music

Scale/Item	Number of Participants (%)
POMS-Depression	21 (55.26%)
POMS-Anger	20 (52.63%)
POMS-Vigor	20 (52.63%)
POMS-Confuse	22 (57.89%)
POMS-Tension	26 (68.42%)
POMS-Fatigue	24 (63.16%)
POMS-Total	30 (78.95%)
Anxiety	19 (50%)
Perceived Stress	25 (65.79%)
Productivity	9 (23.68%)
Fatigue	23 (60.53%)

Note: POMS = Profile of Mood States.

Table 15

Change Scores (Baseline – Wholetones Music Condition) for the Self-report Measures

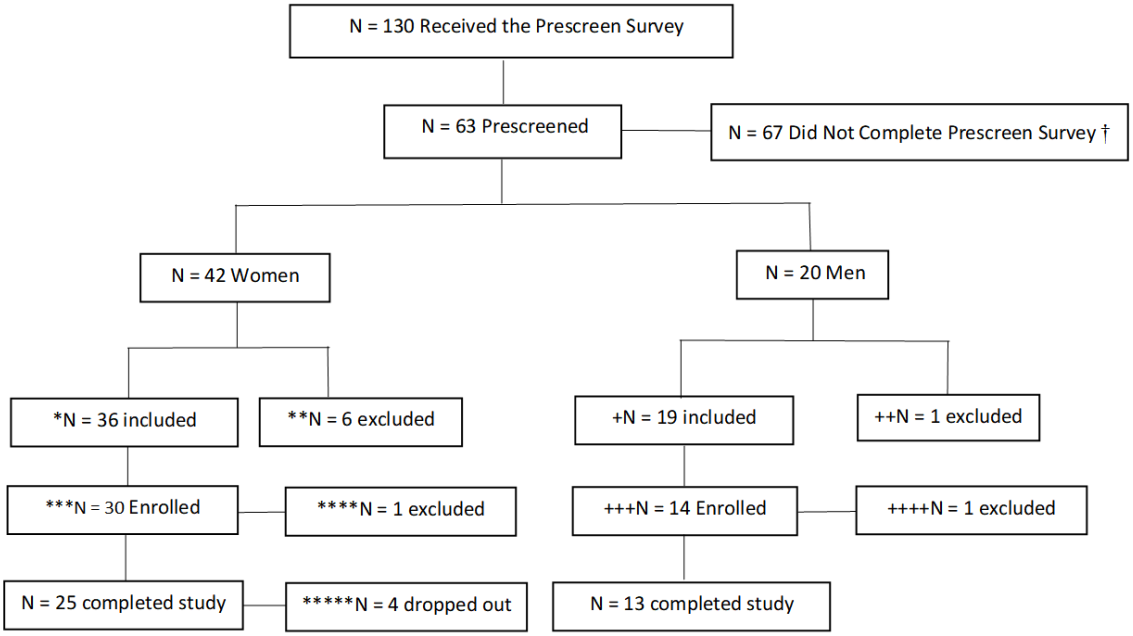
Outcome	Baseline	Wholetones Music	Change Score	Interpretation
	Mean (SD)	Mean (SD)	Mean (SD)	Following listening to the Wholetones Music:
Trait Anxiety	36.39 (10.06)	33.55 (9.84)	-2.85 (9.44)	Anxiety significantly improved (e.g., people were less anxious, tense, worried)
Perceived Stress	13.34 (7.36)	10.39 (6.63)	-2.97 (6.36)	Stress levels significantly decreased
POMS Total	52.47 (29.28)	38.26 (20.51)	-14.21 (29.81)	Overall mood significantly improved (e.g., people were in a better mood)
POMS Depression	6.34 (7.49)	3.34 (4.67)	-3.00 (7.42)	Depression significantly decreased (i.e., people felt less sad, blue, hopeless)
POMS Anger	6.76 (7.20)	3.71 (4.29)	-3.05 (7.14)	Anger significantly decreased
POMS Vigor	15.95 (6.62)	15.18 (6.35)	-0.76 (6.02)	Vigor increased (i.e., people felt more lively, active, energetic)
POMS Confusion	5.89 (3.83)	4.63 (3.57)	-1.26 (3.49)	Confusion significantly decreased (i.e., people felt less confused, unable to concentrate, muddled)
POMS Tension	8.76 (5.61)	5.68 (4.37)	-3.08 (5.46)	Tension significantly decreased (i.e., felt less tense, shaky, on edge)
POMS Fatigue	8.76 (4.75)	5.71 (3.45)	-3.05 (4.58)	Fatigue significantly decreased
PSQI Global	6.47 (2.77)	4.52 (2.00)	-1.96 (2.59)	Sleep quality significantly improved
Productivity	3.00 (0.66)	3.16 (0.72)	0.17 (0.64)	Productivity significantly improved (i.e., people were better able to get things done during the day)
Flinders Fatigue	11.08 (5.87)	8.60 (5.46)	-2.48 (5.08)	Fatigue levels significantly improved (i.e., people felt less tired, weary, exhausted)

Note: POMS = Profile of Mood States, PSQI = sleep quality. Negative score for Anxiety, Stress, Fatigue, PSQI, and POMS Anger, Confusion, Tension, and Depression indicates an improvement from Baseline to Following Listening to the music. In other words, listening to the Wholetones

Music resulted in statistically significant improvement in these outcomes. Significance level = $p \leq .05$.

Figure 1

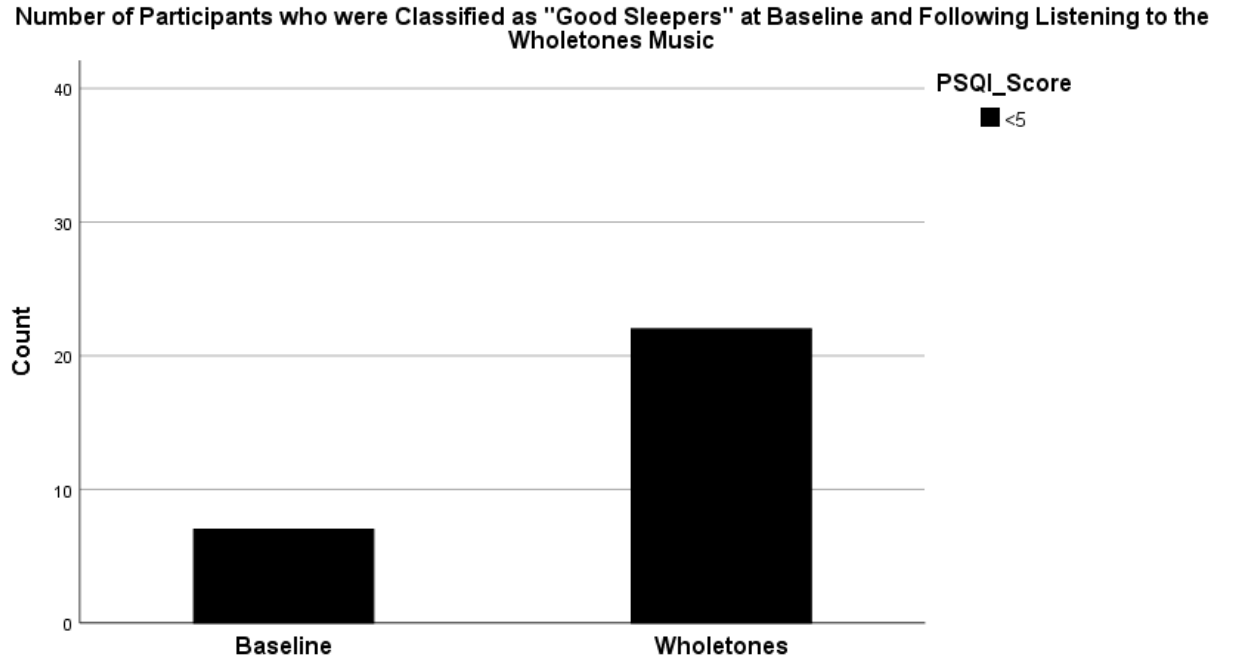
Flow Chart of the Participant Recruitment



Note: † = 37 women and 30 men did not complete the prescreening survey
*N = 6 excluded (N = 2 excluded for not responding after the prescreening survey, N = 1 excluded for international travel during the study, N = 2 lived out of state so could not participate, N = 1 excluded for submitting prescreen after fully enrolled for women)
**N = 6 excluded because they did not meet the inclusion criteria (N = 1 excluded due to high BMI and scoring too low on insomnia index, N = 2 excluded for scoring too low on insomnia index, N = 1 excluded for being under 25 years old, N = 2 excluded because would not be able to tolerate music while sleeping)
*** N = 4 women enrolled with concerns about ability to listen to music throughout the night
****N = 1 excluded due to EMFIT tracker issues which led to a withdraw from the study
*****N = 4 women dropped out (N= 2 due to inability to listen to music throughout the night, N = 1 had to withdraw due to issues with the tracker, N = 1 forgot to keep listening to music halfway through the study)
+N = 5 excluded (N = 3 excluded for not responding after prescreening survey, N = 2 lived out of state so could not participate)
++N = 1 excluded because would not be able to tolerate listening to music throughout the night
+++ N = 3 concerned about ability to tolerate music while sleeping
++++N = 1 excluded due to EMFIT tracker issues which led to a withdraw from the study

Figure 2

Bar Chart of "Good Sleepers" at Baseline and Following Listening to the Wholetones Music



These counts are based on the number of participants that scored <5 on the Pittsburg Sleep Quality Index (PSQI). A score of <5 is indicative of "Good Sleep" and scores ≥5 are indicative of "Poor Sleep Qulaity".

Appendix A

EMFIT Tracker Variables Description

Variable	Description
Sleep Score	Sleep score tells the overall sleep quality and quantity in one number. To calculate the sleep score, a combination of total hours in sleep, durations of REM and deep cycles, hours awake and awakenings are used. The more you sleep, the more REM and deep sleep you get - the better your sleep score is. On the flip side, the more awakenings there are and the longer you lie awake in the bed struggling to doze off, the worse the score is. The maximum value is 100, and values above 80 can be regarded as good. Displays a calculated score indicating the quality of sleep an individual got during that sleep period. Formula: (total_duration_of_sleep + duration_of_REM_sleep * 0.5 + duration_of_DEEP_sleep * 1.5) - (sleep_class_awake_duration / 3600 * 0.5 + number_of_wakenings / 15) * 8.5 = Sleep Score.
REM	The total amount of time (in minutes) an individual spends in REM sleep
Light Sleep	The total amount of time an individual spends in light sleep
Deep Sleep	The total amount of time an individual spends in deep sleep
Heart rate variability (HRV)	HRV is commonly used to measure recovery. HRV gives insight into how well the parasympathetic nervous system (PNS) works. PNS is one part of the autonomic nervous system (ANS). It stimulates the “rest-and-digest” and “feed and breed” activities that happen when the body is at rest. It is complementary to the sympathetic nervous system (SNS), the other part of ANS. The SNS is responsible for stimulating activities associated with the fight-or-flight response. Four measures to provide an understanding of personal recovery and readiness for strain and stress are: HRV RMSSD, total recovery, integrated recovery, and autonomic nervous system balance (described below)
HRV RMSSD M	The RMSSD score in the morning after the recorded sleep period (###). "Root Mean Square of Successive Differences", is one of the most widely used time domain heart rate variability values. Mathematically, it is the square root of the mean of the squares of the successive differences between adjacent heart’s beat-to-beat intervals. Generally, higher values indicate better health, better recovery, lower stress, fitness, etc. In short term RMSSD indicates readiness for the day, and in long term, for example along with training, RMSSD values tend to climb up. Long term decrease in RMSSD may be indication of approaching over training condition.
HRV_RMSSD_E	The RMSSD score in the evening before the recorded sleep period (###).

Total Recovery	Recovery is simply difference between morning and evening RMSSD values. Usually it should be positive, indicating that there has been efficient recovery and resting during the night. Of course, this should be analyzed with regard to activities of previous day: if previous day was very light (no stress, no heavy exercise) and evening RMSSD is relatively high, it is not reasonable to expect high Recovery number, because there is no load to recover from. Values of Recovery are highly individual, and you should inspect them against your own baseline values, and also in comparison to Evening RMSSD values (###).
Integrative recovery	It is an indicator for how much recovery you've gotten during sleep. For example, some people may start to recover very nicely in the first hours of the night, after they go to bed and fall asleep. But towards the morning hours they may start to become anxious (for example because of work stress) and their RMSSD starts to decline. As a result, the morning RMSSD may be quite low when compared to the evening RMSSD, thus indicating poor recovery, even though there has been some good recovery during the night. This is where integrated recovery steps in, as it takes this good recovery from earlier in the night into account.