How Prescribed Music and Preferred Music Influence Sleep Quality in University Students

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Objective: The purpose of this study was to investigate the effect of listening to music on sleep quality in university students and to explore the influence of preferred music on this effect.
Methods: University students identified by the Pittsburgh Sleep Quality Index (PSQI) as 'poor' sleepers (global score > 5) were assigned to three groups (a prescribed music group, preferred music group, and no-music group). During the period of intervention, the prescribed music group and preferred music group listened to their assigned type of music at home every day at bedtime.
Results: Global PSQI scores after the intervention were significantly lower in the prescribed music group and preferred music group, but there was no significant reduction in the no-music group. Between the designated sedative music group and the each subject's preferred music group, both the PSQI score showed significant differences in several items, but variations were found in the results.
Conclusions: This study confirms that listening to music improves sleep quality, even among university students in Japan. Sleep quality was improved in both prescribed and preferred music groups, although the groups gave different responses to specific PSQI components, which suggests that sleep is potentially affected by music type.

Key words: receptive music therapy, sleep quality, preferred music, sedative music, university student

INTRODUCTION

Sleep problems are very common among university students, with studies that use the Pittsburgh Sleep Quality Index [1] (PSQI) to assess sleep reporting 'poor' sleepers (PSQI score > 5) in 79.2% [2], 60.3% [3], and 52.6% [4] of students in Japan, 61.9% [5] and 65.9% [6] of students in the USA, 54.7% in Taiwan [7], 55.8% in Ethiopia [8], 50.1% in Nigeria [9], 37.1% in the Republic of Lebanon [10], and 47.2% in a Chinese meta-analysis [11].

To date, two meta-analyses have examined the effect of music on patients with sleep disorders. A meta-analysis of patients with various sleep disorders was conducted in 2014 [12], a meta-analysis of patients specifically with insomnia was conducted in 2015 [13], and both reported that music improved the sleep quality of patients with sleep disorders. Harmat, Takacs, and Bodizs (2008) and Kavurmaci, Dayapoğlu, and Tan (2019) also reported that receptive music therapy had a beneficial effect on sleep quality in university students [14, 15]. Harmat *et al.* studied 94 university students with 'poor' sleepers (PSQI > 5), comparing listening to music (n = 35), listening to an audiobook (n = 30), and a control group (n = 29), finding that sleep quality improved significantly only in the group that listened to music [14]. Kavurmaci *et al.* (2019) studied 50 nursing students classified as 'poor' sleepers (PSQI > 5), comparing a group of these that listened to music (N = 25) and a control group (N = 25), and found a reduction in PSQI scores following intervention in the music group [15]. The subjects in both of these studies could not choose the music listened to, and neither study considered personal music preference. Despite many studies reporting that personal preference is the most important factor in music efficacy [16, 17], few have investigated the influence of listening to one's preferred music on improvement in sleep quality.

In light of this, we carried out the study described below to reveal the effect of music on sleep quality in university students and to reveal the influence of music type (listening to one's preferred music or listening to sedative music chosen by the authors) on this effect.

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Table 1 List of Prescribed Music

Song No.	Song name	Composer
1	Air ‘on the G string’	J.S.Bach
2	Morning	E.H.Grieg
3	Canon in D	J.Pachelbel
4	Jesu, Joy of Man’s Desiring v	J.S.Bach
5	Gymnopedie No.1	E.Satie
6	Piano Concerto No.21 in C ‘Elvira Madigan’	W.A.Mozart
7	Viens, Mallika (from Lakme)/Leo Delibes	L.Delibes
8	In Paradisum (from Requiem Op.48)	G.U.Fauré
9	Clair de lune	C.A.Debussy
10	Violin Concerto in E minor (Op.64- Ⅱ)	F. Mendelssohn

MATERIALS AND METHODS

Design and Participants

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

This study was conducted as a controlled clinical trial with subjects assigned alternatively to three groups (a prescribed music group, preferred music group, and no-music group) to prevent differences in sex or number of participants between the groups. This study was approved by the Institutional Review Board for Clinical Research of Tokai University. (date approved: August 24, 2017, approval number: 17R097). Participation in the study was invited from October 2017 to September 2019 in some lectures at A and B Universities, and the intervention study was conducted in each subject’s home. Because long vacations may affect sleep habits, we suspended recruitment when the study period overlapped with summer and spring vacations, which were longer than one month. Subjects were informed that participation in the study was voluntary before obtaining their consent in writing. Subjects were also informed they could withdraw consent at any time during the study and there would be no penalty whatsoever for withdrawing consent.

Study subjects were students from University A and University B. The inclusion criteria were: (1) aged between 18 and 30 years, and (2) usual sleep period occurs between 9 pm and 9 am the following day. The exclusion criteria were: (1) receiving treatment at a medical facility for a psychiatric disorder (including disorders involving alcohol, caffeine, or other substances) not part of a sleep disorder, (2) a physical disorder with pain or other physically uncomfortable symptoms, and (3) pregnancy. Students who provided consent were screened for sleep problems using the PSQI, and those with a global PSQI score of 5 or below were considered problem-free and were excluded from the study. Students with a global PSQI score of 6 or above were immediately assigned to one of the above three groups in sequential order, and took part in the intervention for 4 weeks.

Music Intervention

Subjects in the prescribed music group or preferred music groups listened to their assigned music type every day at bedtime while at home, during the intervention period. Subjects in the no-music group were instructed to listen to no music at bedtime during the intervention period. Each subject was allowed to choose their preferred method of listening to music, whether through earphones or speakers. Each subject was also allowed to choose the volume level they considered best for good sleep. Subjects were told they were not required to listen until the music ended, but may fall asleep while the music continued to play. Subjects were also given no specific instructions regarding their bedtime environment or timing, and were told to go to sleep as normal. After the intervention began, all students self-monitored their sleep by completing a sleep journal with information such as sleep onset time, waking time, and daytime napping time.

Prescribed Music

The music prescribed by the authors was the same album used in the study by Harmat, Takacs, and Bodizs (The Most Relaxing Classical) [14]. For this study, we used 40 minutes of music in the order it appeared on the album (Table 1). The music duration was decided based on mean sleep latencies shown in recommendations by the American Academy of Sleep Medicine. According to the American Academy of Sleep Medicine, the mean sleep latency for healthy people is 10 to 20 minutes, and the sleep latency for elderly people, who have a high number of sleep disorders, is reportedly 13 to 35 minutes [18, 19]. Considering this study was performed in university students who were ‘poor’ sleepers, we chose a music listening time of 40 minutes, to account for these reported sleep latencies.

Preferred Music

Each of the subjects was free to select his or her preferred music that he or she considered appropriate for sleep. They were informed there were no specific restrictions on musical types, whether they used an album or several pieces from different albums (even of different artists), and pieces with or without lyrics. However, just as in the prescribed music group, we instructed that sound source should be able to be played continuously for 40 minutes and that they should listen to the same music each night. The musical types listened to for 4 weeks in the preferred music group are shown in Table 2. Some subjects mixed different types in 40 minutes, and the N number is not equal to the number of subjects.

Table 2 Music Genres Chosen in the Preferred Music Group

	Genre	N	%
1	J-pop	18	64
2	Non-Japanese pop	4	14
3	Video game music	3	11
3	Movie soundtrack music	3	11
3	Classical music	3	11
3	Dance music	3	11
7	Jazz	2	7
7	Anime soundtrack music	2	7
7	Other	2	7

Measures

The Japanese version of the Pittsburgh Sleep Quality Index; PSQI-J.

The PSQI questionnaire is standardized for countries throughout the world. The PSQI contains 19 questions on subjective symptoms concerning sleep quality during the previous month and assesses sleep based on the following seven components: subjective sleep quality (C1), sleep latency (C2), sleep duration (C3), sleep efficiency (C4), sleep disturbance (C5), the use of sleep medication (C6), and daytime dysfunction (C7). The higher the global score (0–21), the poorer the quality of sleep, and a cut-off point of 5.5 has been demonstrated to provide high sensitivity and specificity [1]. The PSQI-J was published by Doi *et al.* and has been verified for reliability and appropriateness [20]. All subjects assessed their sleep using the PSQI a total of two times: once before and once after the music intervention.

Statistical Analyses

The Kruskal-Wallis test was used to compare demographic characteristics between the three groups. The Wilcoxon signed-rank test was used to compare PSQI scores in each group before and after the intervention, the Kruskal-Wallis test was used to compare the change in PSQI scores between the three groups, and Scheffe's method was used for post hoc analysis. Statistical significance was determined by a test result of $p < .05$. The analysis software used was IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA).

RESULTS

Consent was obtained from 239 students, of whom 39 dropped out while completing the PSQI questionnaire and before the music intervention, leaving 200 students who completed the PSQI. Of these, we decided that 120 students were 'poor' sleepers (PSQI > 5) and 80 were 'good' sleepers (PSQI < 6). Using statistical power analysis, the sampling size required for ≥ 80% statistical power was 118 subjects. The 80 students with a PSQI score < 6 were withdrawn from the study at that point. After excluding the 80 students with PSQI score < 6, 1 student who did not meet the inclusion criteria (aged 31 or older), and 24 dropouts who did not complete the post-intervention PSQI questionnaire, 95 subjects in total were included for analysis. Of these 95 subjects, the prescribed music group contained 32 subjects, the preferred music group 33 subjects, and the no-music group 30 subjects. The clinical characteristics of each group are shown in Table 3. There was no significant difference in age, sex, lifestyle habits, music habits, or pre-intervention PSQI score between the three groups (Table 3).

Comparing the PSQI score before and after intervention in each group showed a significant decrease in PSQI score in the prescribed music group ($p < .001$) and the preferred music group ($p < .001$), but no significant change in the no-music group ($p = .095$). The Kruskal-Wallis test revealed the change in PSQI score (pre-intervention score – post-intervention score) was significantly different between the three groups ($p = .014$). Multiple comparisons revealed a significant difference between the no-music group and prescribed music group ($p = .044$) and between the no-music group and preferred music group ($p = .035$), but no significant difference between the prescribed music group and preferred music group ($p = .998$).

Comparing the PSQI component scores before and after intervention in each group revealed: a significant change in C1 ($p < .001$), C2 ($p = .003$), and C7 ($p < .001$) in the prescribed music group; a significant change in C1 ($p = .011$), C3 ($p = .010$), C5 ($p = .016$), and C7 ($p = .006$) in the preferred music group; and a significant change in C2 ($p = .037$) in the no-music group. Comparing PSQI component scores between the three groups revealed the only significant difference was in the C1 component score between the no-music group and prescribed music group ($p = .008$; Table 4).

DISCUSSION

'Poor' sleepers were found in 60% of the 200 students (120/200) who completed the PSQI questionnaire. This is a similar finding to past reports that show sleep problems are common among university students [2–9]. We conducted this study to reveal the effect of music on sleep quality in university students and to reveal the influence of music type (the subject's own preferred music or sedative music prescribed by the authors) on this effect. The findings of this study include: (1) a significant reduction in global PSQI scores after intervention in the prescribed music group and preferred music group, but no significant reduction in global PSQI scores in the no-music group; (2) comparing the change in global PSQI scores between groups revealed no significant difference between the prescribed music group and preferred music group; and (3) comparing the change in PSQI component scores showed a difference between groups, with a significant reduction in C1, C2, and C7 components in the prescribed music group, and C1, C3, C5, and C7 components in the preferred music group.

Table 3 Comparison of Demographic Characteristics between the Three Groups

	Prescribed music group (n = 32)		Preferred music group (n = 33)		No-music group (n = 30)			
	M	*SD*	*M*	*SD*	*M*	*SD*	χ^2	$p^{\dagger}$
Age (y)	19.5	1.2	19.3	1.4	19.7	2.4	0.37	.83
Sex (% males)	40.6	-	48.5	-	46.7	-	0.44	.80
Meal frequency	3	0.5	2.7	0.6	2.7	0.5	4.67	.10
Breakfast	7:12	1:30	6:45	1:41	7:10	0:57	0.14	.93
Lunch	12:31	1:00	12:17	1:30	12:21	0:28	2.39	.30
Evening meal	20:22	1:35	19:52	2:45	20:08	1:11	0.77	.68
Alcohol intake (% at least once/week)	15.6	-	27.3	-	26.7	-	1.02	.60
Caffeine intake (% at least once/week)	50	-	62.5	-	63.3	-	1.12	.57
Exercise (times/week)	1.7	1.7	1.5	1.7	2.6	2.5	2.91	.23
Smokers (%)	9	-	9	-	0	-	2.97	.23
Listen to music daily (%)	90.6	-	93.9	-	86.7	-	2.37	.31
Listen to music at bedtime(%)	34.4	-	36.4	-	33.3	-	0.13	.94
Played at least one musical instrument (%)	56.3	-	63.6		70		1.25	.54
PSQI score (Preintervention)								
global score	8.3	2.5	8.2	2.4	8.3	2.1	0.41	.81
C1 score	1.8	0.6	1.7	0.6	1.8	0.6	1.39	.50
C2 score	1.5	0.9	1.4	1.0	1.6	1.0	0.69	.71
C3 score	1.9	0.9	2.1	0.7	2.1	0.7	0.72	.70
C4 score	0.3	0.7	0.4	0.7	0.3	0.5	0.23	.89
C5 score	0.7	0.6	0.9	0.5	0.8	0.5	2.44	.29
C6 score	0.3	0.8	0.2	0.6	0.1	0.5	1.05	.59
C7 score	1.7	0.9	1.7	0.6	1.7	0.9	0.12	.94

† Kruskal-Wallis test

Effect of Music on Sleep in University Students

We observed a significant reduction in global PSQI scores after intervention in the prescribed music group and preferred music group, but no significant difference in global PSQI scores in the no-music group. Similar to the findings reported by Harmat *et al.* (2008) and Kavurmaci *et al.* (2019) [14, 15], our results reveal that music also improves sleep quality in Japan's university students.

The global PSQI score decreased below the cut-off for 'poor' sleepers (6 points) after intervention in the prescribed music group, but not in the preferred music group. As touched on later in this discussion, this difference may be influenced by the type of music used, but could also be due to the duration of the music intervention. Shum *et al.* (2014) investigated the effect of music on sleep quality in elderly subjects and reported global PSQI scores were above 6 after 4 weeks of music intervention, but decreased with increasing duration of the intervention, and fell below the cut-off after 6 weeks. Shum *et al.* recommend 6 weeks of music intervention when observing sleep patterns [21]. By contrast, several other studies recommend 3 weeks of music intervention [22, 23]. Harmat *et al.* (2008) used 3 weeks of intervention, but cited 3 weeks as potentially being insufficient as a limitation of the study [14]. Meanwhile, Kavurmaci *et al.* (2019) observed a significant decrease in PSQI scores among university students using an intervention period of just 1 week [15]. This indicates that effects vary depending on the duration of the intervention, and PSQI scores can be reduced by both shorter and longer intervention periods. A 4-week intervention duration was chosen for this study because PSQI is designed to evaluate sleep over the past month. However, a longer intervention period, as mentioned above, may have further reduced global PSQI scores.

Influence of Music Type

Many reports cite personal preference as the most important factor in music effectiveness and show that listening to one's preferred music has a beneficial effect in terms of relaxation, stress, pain, agitation relief, and anxiety relief [16, 17, 24, 25]; however, few studies have examined how music type affects music intervention for sleep quality. Chang, Lai, Chen, Hsieh, and Lee (2012) state that 10 subjects were allowed to listen to their own preferred music and music was prescribed by the authors for another 15 subjects, but did not include an analysis comparing the two music types [26].

Instead of examining the beneficial effect of music in terms of relaxation, stress, pain, or anxiety relief, our study showed that both prescribed music and preferred music improved sleep problems based on global PSQI scores, although this improvement did not differ significantly between the music types.

We did see a difference in between music types upon examining specific PSQI components. In the prescribed music group, there was a significant reduction in C1 (subjective sleep quality), C2 (sleep latency), and C7 (daytime dysfunction) components. In the preferred music group, there was a significant reduction in C1 (subjective sleep quality), C3 (sleep duration), C5 (sleep disturbance), and C7 (daytime dysfunction) components. Although the reason for this difference is unclear, the prescribed music included only sedative music, while the preferred music spanned various genres of music, including many songs that were not

Table 4 Comparison of PSQI Scores

	Prescribed music group (n = 32)				Preferred music group (n = 33)				No-music group (n = 30)			
	Pre-intervention a)	Post-intervention b)	a) vs b)		Pre-intervention c)	Post-intervention d)	c) vs d)		Pre-intervention e)	Post-intervention f)	e) vs f)	
	M (*SD*)	*M*(*SD*)	*Z*	$p^{\dagger}$	*M* (*SD*)	*M* (*SD*)	*Z*	$p^{\dagger}$	*M* (*SD*)	*M* (*SD*)	*Z*	$p^{\dagger}$
PSQI global	8.3 (2.5)	5.8 (2.2)	4.04	.001**	8.2 (2.4)	6.0 (3.0)	4.02	.001**	8.3 (2.1)	7.6 (2.4)	1.67	.095
C1	1.8 (0.6)	1.2 (0.6)	3.39	.001**	1.7 (0.6)	1.2 (0.7)	2.56	.011*	1.8 (0.6)	1.7 (0.6)	0.30	.767
C2	1.5 (0.9)	0.9 (0.8)	3.02	.003**	1.4 (1.0)	1.0 (0.9)	1.72	.086	1.6 (1.0)	1.2 (1.0)	2.08	.037*
C3	1.9 (0.9)	1.8 (0.9)	0.80	.423	2.1 (0.7)	1.5 (1.0)	2.58	.010*	2.1 (0.7)	1.9 (0.5)	1.18	.239
C4	0.3 (0.7)	0.3 (0.6)	0.04	.969	0.4 (0.7)	0.3 (0.7)	0.98	.328	0.3 (0.5)	0.6 (1.0)	1.41	.158
C5	0.7 (0.6)	0.5 (0.5)	1.48	.139	0.9 (0.5)	0.6 (0.5)	2.40	.016*	0.8(0.5)	0.7 (0.5)	0.71	.480
C6	0.3(0.8)	0.0(0.0)	1.83	.068	0.2(0.6)	0.1(0.5)	1.00	.317	0.1(0.5)	0.0 (0.2)	1.34	.180
C7	1.7 (0.9)	1.0 (0.9)	3.41	.001**	1.7 (0.6)	1.2 (0.9)	2.74	.006*	1.7 (0.9)	1.5 (1.0)	1.28	.201

	a)-b) vs c)-d) vs e)-f)		Prescribed vs Preferred		Prescribed vs No music		Preferred vs No music	
	χ^2	$p^{\dagger\dagger}$	χ^2	$p^{\dagger\dagger\dagger}$	χ^2	$p^{\dagger\dagger\dagger}$	χ^2	$p^{\dagger\dagger\dagger}$
PSQI global	8.54	.014*	0.01	.998	6.27	.044*	6.71	.035*
C1	9.93	.007*	1.19	.553	9.66	.008*	4.25	.120
C2	1.02	.601	0.84	.658	0.68	.711	0.01	.998
C3	2.42	.299	2.33	.311	0.26	.878	0.98	.614
C4	2.14	.344	0.73	.695	0.37	.831	2.11	.349
C5	1.71	.425	0.70	.705	0.21	.901	1.65	.438
C6	2.31	.315	2.27	.321	0.85	.653	0.30	.859
C7	3.53	.171	0.62	.733	3.51	.173	1.24	.539

* $p < .05$; ** $p < .005$
† Wilcoxon signed-rank test
†† Kruskal-Wallis test
††† Scheffe

sedative (Table 2). Furthermore, given that global PSQI scores fell below the cut-off (6 points) after intervention in the prescribed music group, but not in the preferred music group, the findings of this study show a potential influence of music type. Nevertheless, to our knowledge, no reports have examined the influence of music type on sleep quality. Music pieces that improve sleep quality have recently been analyzed in a study, revealing that music pieces separate into several clusters based on 1) scaling exponent of the spectrum of melody's zero-crossings, 2) redundancy of note values, 3) density of notes, and 4) tempo [27]. Analyzing the music pieces selected by the subjects in this study may provide further information on the influence of music type on sleep.

Music Intervention as a Bedtime Routine

Music's effect on sleep also potentially stems from the beneficial effect of introducing a nightly bedtime routine, as reported elsewhere. Mindell, Telofski, Wiegand, and Kurtz (2009) introduced a bedtime routine (bathing, massage, and quiet activities within 30 minutes prior to lights out) for 2 weeks and reported a reduction in sleep onset latency, reduction in the number of night awakenings, and a lengthened period of continuous sleep [28]. Bedtime routines are thought to improve behavior and result in better sleep [29]. The music intervention introduced in this study may be classified as a bedtime routine according to the definition of Mindell [30], and the routine activity of listening to music and recording one's sleep may itself potentially establish a regular sleep-wake rhythm that improves sleep quality. Although the findings of this study suggest that music is effective at improving sleep quality, this result may be partially achieved based on non-music factors. By combining sleep evaluation and self-monitoring with sleep hygiene advice, which has been identified as important for sleep quality [31, 32], we may be able to establish treatments for sleep disorders.

LIMITATIONS

Four limitations of this study were as follows: 1) although subjects were instructed on music listening methods before starting the intervention, because interventions were carried out by subjects at home, we do not know if the same music listening methods were used by all subjects; 2) we do not have a complete understanding of which daily activities affect sleep, and factors other than music may have affected sleep in this study; 3) we did not examine psychological characteristics that could influence sleep; and 4) the subjects of this study had little experience participating in routine research, and the Hawthorne effect may have impacted our findings.

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