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Evaluation of an Internet-Based Self-Help Program for Better Quality of Sleep among Japanese Workers: A Randomized Controlled Trial

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Abstract: Evaluation of an Internet-Based Self-Help Program for Better Quality of Sleep among Japanese Workers: A Randomized Controlled Trial: Etsuji SUZUKI, *et al*. Department of Epidemiology, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences—The effectiveness of Internet-based self-help programs for insomnia is still unclear. A randomized controlled trial was conducted to evaluate the effect of an Internet-based self-help program for better quality of sleep among adult workers. Forty-three volunteers were recruited and randomly assigned to either an intervention group (n=21) or a waiting-list group (n=22). The intervention group participated in a two-week Internet-based program, including selecting and daily practicing sleep-related target behaviors and monitoring those behaviors along with sleep quality. At the same time, each participant received automatically generated, personalized messages and reports both daily and weekly. A total of 12 intervention group participants and 18 waiting-list group participants completed questionnaires at baseline, post-intervention, and at a 3-wk follow-up. Subjective sleep quality was measured by a self-reported questionnaire developed for this study. The sleep quality score increased in the intervention group at post-intervention, with a significant interaction effect [F(1,28)=5.19, p=0.031]. Sleep-related behaviors also greatly increased in the intervention group at post-intervention, with a significant interaction effect [F(1,28)=7.14, p=0.012]. Sleep-onset latency reduced in the intervention group at follow-up, with a marginally significant effect [F(1,28)=3.52, p=0.071]. The Internet-based self-help program improves subjective sleep quality and sleep-onset latency among adult workers. *(J Occup Health 2008; 50: 387–399)*

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Insomnia is highly prevalent among the general population in industrial countries including Japan[1–6]. Insomnia also seems to be a common problem among daytime workers[1, 3, 7, 8]. A recent review showed that the impact of insomnia on quality of life (QOL) and on absenteeism is well reported in the literature[3], indicating the necessity for well-designed occupational interventions to ensure good sleep[7].

In a recent systematic review by Morin *et al*.[2], it was shown that psychological and behavioral interventions represent an effective treatment option for the management of persistent insomnia, with benefits which are sustained over time. In order to more efficiently disseminate the available evidence[2], several studies using self-help approaches have been conducted among the general population[9–17]. The treatment modalities include muscle relaxation[14], bedtime restriction and education[11], relaxation and stimulus control[16, 17], cognitive behavioral therapy (CBT) or behavioral therapy (BT) in general[9, 10, 12, 13], and a combination of these modalities[15]. Indeed, sleep hygiene education has been shown to be less effective when used alone[18].

To reach subjects more effectively, the effectiveness

of a variety of mediums has been verified, including audiotapes[16], videotapes[11], television and radio[15], and booklets[10, 13]. In general, the results from these studies have shown significant improvements in several sleep parameters with durable effect.

Another possible treatment medium is the Internet. To our knowledge, only one study has used Internet-based treatment for insomnia to convey CBT approaches, such as sleep restriction, stimulus control, and cognitive restructuring[9]. In that study, the participants underwent a pre-scheduled 5-wk program in which they were provided information on the activities of each week and asked to submit their sleep diary once a week. Although many outcome measures, including sleep quality, improved significantly after the program in the treatment group, the interaction effect was weak and insignificant in general. Another problem of that study was the high attrition rate (44% for the intervention group and 7% for the waiting-list group), which may have attenuated the program's effect. Thus, additional research is needed to address the effectiveness and efficacy of Internet-based self-help approaches for insomnia. The use of both feedback and reinforcement throughout an intervention phase has been found to improve both compliance and outcomes in sleep interventions[13]. Even sleep hygiene, which has been reported to be less effective for improving sleep, might be useful if provided in an attractive format and in a manner that improves its acceptance and compliance rates[18–20]. This could be achieved with Internet technology.

In the present study, we develop such a new Internet-based approach. The program of this approach features (1) basic education on sleep and ways to improve sleep, (2) a "sleep e-diary" (a daily self-report of sleep quality and sleep-related behaviors to the online system), (3) daily personalized automatic messages to encourage each participant's behavior changes for better sleep, and (4) weekly self-monitoring of the effects of the participants' behavior changes on sleep quality that incorporate both visual presentation and personalized advice summaries. The aim of the present study is to evaluate this Internet-based self-help program for better quality of sleep among working adults. We hypothesize that the program will improve the subjective quality of sleep with a long duration effect. We also hypothesize that the improvement of the subjective quality of sleep will be accompanied by changes in behavioral patterns and sleep-related parameters.

Methods

Subjects

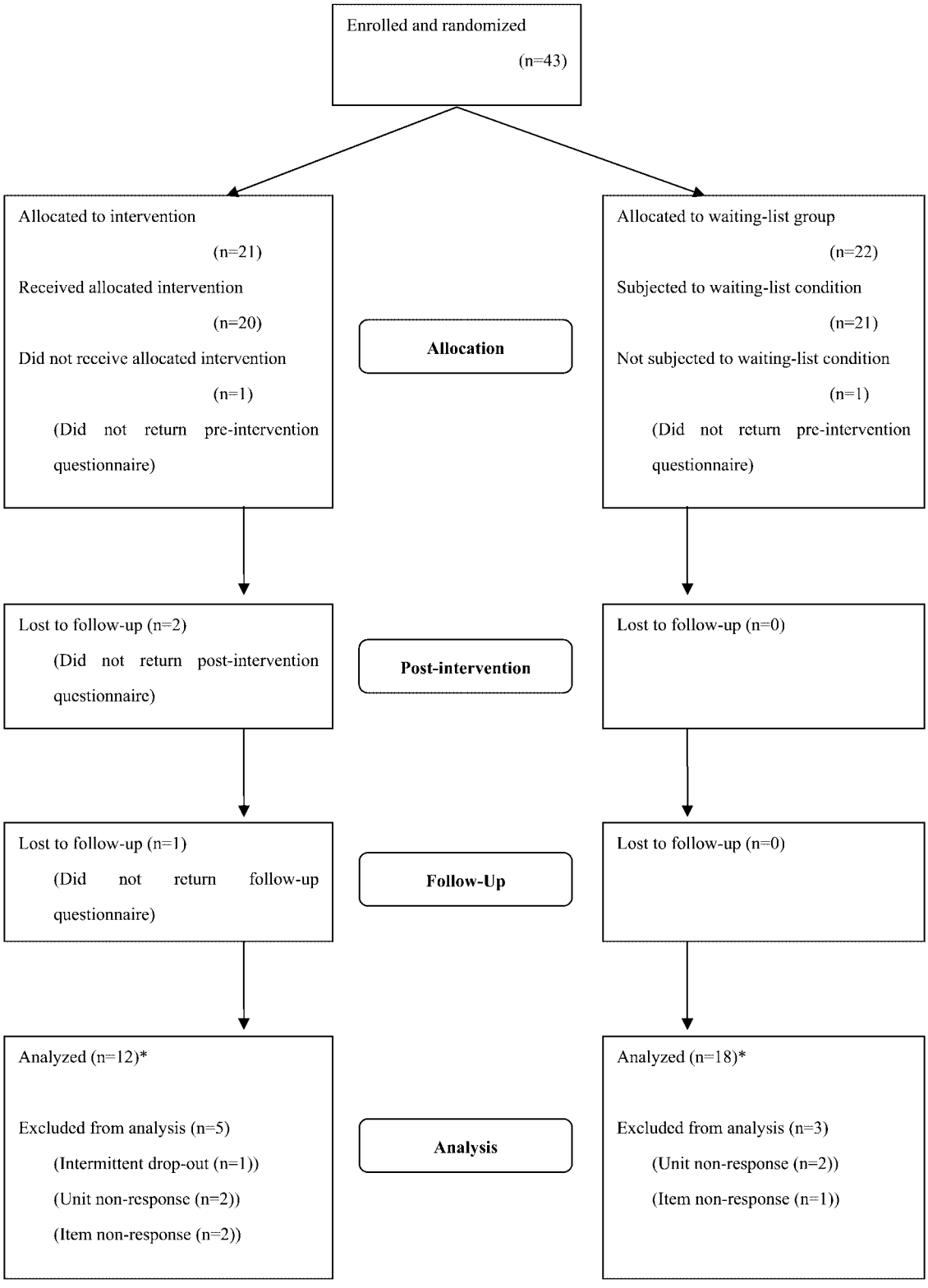
Participants were recruited between December 2005 and January 2006 online through a website of the Department of Hygiene and Preventive Medicine of the Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences. In addition, recruiting advertisements for this program were sent to some companies in Okayama and Shizuoka prefectures so that interested employees could easily participate in the study. These advertisements were also distributed directly by the authors to participants of mental health seminars. On both the website and advertisements, the eligibility criteria were shown. These criteria were (1) being 20 years of age or older, (2) having a desire to improve one's quality of sleep, (3) having either a permanent or part-time job, and (4) having a mobile phone e-mail address. The exclusion criteria, on the other hand, included current involvement in treatment for insomnia and having any problems related to sleep that were being treated at a medical facility. The information was obtained based on self-report. Only those who were both interested in the topic and who met the criteria were asked to register for the program via e-mail. Written informed consent was not obtained, but the participants were fully explained the aims and the procedures of the study beforehand and asked to register to the program of their own free will.

Figure 1 illustrates the participant flow in the study protocol. A total of 43 participants were randomly allocated either to an Internet-based intervention group (n=21) or to a waiting-list group (n=22). A questionnaire was mailed to the 43 subjects, and a pre-intervention assessment was conducted. Finally, 17 and 21 responders were left, and the response rates were 81.0% and 95.5% for the intervention and waiting-list groups, respectively (overall response rate; 88.4%).

Analyses were conducted for only those participants who had completed and returned all the questionnaires. After excluding those who had missing values, analyses were conducted on a total of 30 participants (12 in the intervention group and 18 in the waiting-list group), resulting in completion rates of 57.1% and 81.8%, respectively (overall completion rate; 69.8%).

Procedures

The self-help program used in the present research was a 2-wk, Internet-based program to improve subjective sleep quality. The questionnaires for the pre-intervention assessment were mailed to both groups (Week 0), with instructions to return the completed questionnaires within five days. The questionnaires contained questions on age, gender, marital status, occupation (full-time/part-time, shift work/non-shift work), smoking status, frequency of alcohol consumption, physical activities, and menstruation. Detailed information regarding education and occupation were not obtained with the intention of fostering more responses. In addition, for the intervention group, a letter was also included that indicated the URL of the program website along with an ID number and password for entering and starting the program. These participants were instructed to start the program within a



* Only those who responded to all the questions in the Current Sleep Quality Index (CSQI) and the Sleep-related Behaviors Index (SBI) were included in the analysis since these outcome variables are hypothesized to be closely interrelated.

Fig. 1. Trial profile including recruitment, randomization, intervention and analysis: Japan, 2006.

week. The participants in the waiting-list group were sent a similar letter that informed them that they had been allocated to the waiting-list group and that they would have access to the program approximately two months later. No other instructions were given to the waiting-list group; they were told merely to wait until the start of the program although they were not explicitly told to avoid seeking any other treatment.

The second set of questionnaires was mailed to both groups four weeks after the baseline questionnaires had been sent to the participants (Week 4). These questionnaires were used for post-intervention assessment. Finally, the last set of questionnaires was mailed to both groups three weeks after the second questionnaire had been sent (Week 7). These questionnaires were used for the 3-wk follow-up assessment. All participants who completed the three questionnaires were thanked with a gift certificate.

The design and procedure of the study were reviewed and approved by the Ethics Committee on Epidemiologic Research of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences in December 2005.

Internet-based self-help program

An interactive, Internet-based program was developed based on cognitive-behavioral approaches. The program was accessible via PC or mobile phone. In actuality, 9 participants used a PC and 11 used a mobile phone in the intervention group.

1) Registration and basic education phase

A website was created for the intervention program. The program was accessible only by using the ID and password included in the letter to the participants. When participants registered for the program on-line, they were first asked to choose a nickname and new password to remain anonymous. Next, participants were asked to do a baseline assessment of their sleep quality over the previous week, filling out a six-item scale. Participants were then asked to study brief descriptions and explanations of sleep, sleep problems, and health behaviors which could deteriorate or improve sleep quality, and ways to improve sleep quality as well as several sleep disorders. The website provided a list of four groups of ways to improve sleep quality based on sleep hygiene and other modalities[21]: Establishment of a diurnal rhythm (four sample items, such as waking up at the same time everyday), relaxation before sleep (six items, such as avoiding caffeine, alcohol, and nicotine), changing a belief about sleep (three items, such as not minding one's sleep hours), reinforcement of the sleep-bed relationship (three items, such as going to bed only when sleepy). To increase the acceptance and compliance rates among participants, we allowed them to choose their favorite behaviors. Each participant was requested to choose up to three behavior items to conduct daily to improve sleep quality; a participant could also add other behaviors that they thought might be useful. Participants were also asked to fill in what reward they would give themselves, such as playing golf, shopping, singing karaoke, or eating a big cake, when they practiced the selected behaviors a certain number of times. These rewards were calculated using "virtual tokens" (points) that were given if participants performed each behavior in one day.

2) Daily monitoring and feedback

Once registered, the computer program sent an e-mail to each participant's mobile phone or PC at a time designated by the participant. This e-mail prompted the participants to login to the program website and report (1) whether they had conducted each of the targeted behaviors during the previous day, (2) their sleep quality of the previous night on a five-point scale, (3) their total sleep hours of the previous night, and (4) their mood that morning on a five-point scale. The information was stored online in a "sleep e-diary" of the program, and from this the participants could see how their sleep hours and sleep quality changed during each week. At the same time, participants also received personalized messages that were automatically generated by the website to provide positive encouragement if sleep quality improved or if the selected behavior items had been performed; otherwise the messages encouraged participants to continue working on the behaviors. The participants received positive encouragement like: "You are doing well. You practice the behaviors for better sleep. Keep up the good work." or "You now have less difficulty in waking up. You keep this up, and you are going to have better sleep." Participants also received encouragement through learning how many tokens remained to reach their designated bonus. These feedbacks were given once a day immediately after the participants completed the everyday "sleep e-diary"; in addition, they also had Internet access to their own e-diary whenever they wanted. If the total number of tokens reached the set goal, the program sent a message of congratulations and allowed the participant to receive a bonus.

3) Weekly summary and advice

Every week, the online computer program asked each participant to make a weekly assessment of their sleep quality using a six-item scale. The program then generated a weekly report on each participant's sleep quality over the previous week based on their daily sleep e-diaries and assessments, with a personalized message that summarized the one-week trends of their selected behaviors and sleep quality. The computer program also analyzed the associations between the participants' selected behaviors and sleep quality, and provided advice about which specific behaviors might be most effective

for better sleep for each participant.

Measures

1) Sleep quality

In the present study, insomnia was defined as dissatisfaction with sleep quality or quantity[22]. As there is no available standardized scale to measure sleep quality within a short (one- or two-week) interval, sleep quality at baseline (Week 0) and at the follow-ups (Weeks 4 and 7) was measured by a new instrument called the Current Sleep Quality Index (CSQI), which was developed specifically for this program by the authors. It adopts items from previous similar measures[19, 23]. The CSQI is composed of eight, 10-point Likert scale (from '0'=not at all to '100'=extremely in 10 intervals) items on how a respondent "currently" thinks (See Appendix A). For our current study, a composite score (0–800) was obtained by summing the eight item scores so that higher scores indicated higher subjective quality of sleep. The overall Cronbach's alpha for the CSQI was 0.80 at the pre-intervention assessment of all the analyzed participants.

We also used the Pittsburgh Sleep Quality Index (PSQI), a standardized measure of sleep quality that has been widely used for clinical and epidemiological research[24]. The Japanese version of the PSQI was used for the present study[6, 25]. This measure has satisfactory levels of internal consistency and validity in Japanese populations[1, 6]. The PSQI was not used at Week 4 because it requires a one-month recall period.

Sleep parameters such as sleep-onset latency, total sleep time and sleep efficiency (ratio of total time spent asleep to the actual time spent in bed and multiplied by 100) were measured by items adopted from the PSQI. For those whose calculated sleep efficiency exceeded 100%, the results were set to 100%, the maximum.

2) Sleep-related behaviors

Changes in behaviors related to sleep quality were measured by a checklist of 21 predetermined behaviors, the Sleep-related Behaviors Index (SBI) developed by the authors (See Appendix B). Participants were asked to answer whether they had conducted each of the listed behaviors during the past two weeks on a five-point Likert scale ('0'=never, '4'=always). A composite score (0–54) was obtained by summing the 21 item scores after some items were reverse-scored, with a greater score indicative of more behaviors practiced. The SBI was measured at baseline, post-intervention (Week 4) and at the three-week follow-up (Week 7). The overall Cronbach's alpha for the SBI was 0.60 at the pre-intervention assessment of all the analyzed participants.

3) Mental health outcome ratings

There is a strong association reported between insomnia and depressive and anxiety symptoms[26]. The K6 is a recently developed scale that has been shown to be a sensitive screen for DSM-IV disorders in surveys carried out in the US[27]; it was used as a collateral measure of intervention effects. The Japanese version was used in this study[28, 29]. It contains 6 items rating the frequency of depressive symptoms experienced during the past 30 days on a 5-point Likert scale (0 to 4). The K6 was scored by the unweighted summative scoring approach, ranging from 0 to 24, with a higher score suggesting depression and anxiety symptoms. The K6 was measured only at baseline and the three-week follow-up (Week 7) because the K6 also requires a one-month recall period.

Statistical analyses

To evaluate the pre-intervention group's equivalency of demographic characteristics, a chi-square test was conducted. For each dependent measure with three assessments, 2 (group: intervention, waiting-list) × 3 (time: pre-intervention, post-intervention, and 3-wk follow-up) repeated analyses of variance (ANOVA) were conducted. Consequently, to test the research hypothesis further, separate analyses were also conducted for the pre- to post-intervention phase and the pre-intervention to 3-wk follow-up phase, and effect sizes were calculated for each contrast[30]. Regarding each dependent measure with the two assessments (at baseline and Week 7), ANOVAs with repeated measures [2 (group) × 2 (time: pre-intervention vs. 3-wk follow-up)] were conducted. If Mauchly's test indicates that the assumption of sphericity is violated, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity. Due to missing data from two participants in the intervention group, the PSQI was analyzed for the 28 participants for whom data were available (10 in the intervention group and 18 in the waiting-list group).

Two-tailed p values less than 0.05 were considered significant. To obtain a measure of effect size, Pearson's correlation coefficient r was calculated by taking the square root of the fraction with the F-ratio as the numerator and the sum of the F-ratio and the residual degrees of freedom as the denominator[30]. Typical cut-off points for small, medium, and large effects are 0.10, 0.30, and 0.50, respectively[30]. For each dependent measure, effect sizes were calculated for the interaction effects of the two contrasts: from pre- to post-intervention and from pre-intervention to 3-wk follow-up. All analyses were run using SPSS version 14.0J.

Results

Demographic characteristics of the sample

Table 1 summarizes the descriptive data of the demographics and other relevant characteristics for the intervention and waiting-list control groups. Most participants were married, and all were full-time workers. The chi-squared test analysis showed no significant

Table 1. Demographic characteristics of participants after randomization: Japan, 2006

Characteristics	Intervention n=20	Waiting-list n=21	Total n=41
Age, y (mean, (SD))	40.5 (8.1)	38.7 (8.4)	39.6 (8.2)
Sex			
Female	7 (35.0)	9 (42.9)	16 (39.0)
Male	13 (65.0)	12 (57.1)	25 (61.0)
Marital status			
Married	12 (60.0)	14 (66.7)	26 (63.4)
Unmarried	8 (40.0)	6 (28.6)	14 (34.1)
Other	0 (0.0)	1 (4.7)	1 (2.5)
Occupation			
Full-time	20 (100.0)	19 (90.5)	39 (95.1)
Part-time	0 (0.0)	2 (9.5)	2 (4.9)
Shift working			
Non-shift worker	20 (100.0)	21 (100.0)	41 (100.0)
Shift worker	0 (0.0)	0 (0.0)	0 (0.0)
Smoking status			
Non-smoker	12 (60.0)	15 (71.4)	27 (65.9)
Ex-smoker	3 (15.0)	3 (14.3)	6 (14.6)
Smoker	4 (20.0)	3 (14.3)	7 (17.1)
Alcohol			
None-rarely	10 (50.0)	10 (47.6)	20 (48.8)
≥once per week	10 (50.0)	11 (52.4)	21 (51.2)
Exercise			
None	14 (70.0)	15 (71.4)	29 (70.7)
≥once per week	6 (30.0)	6 (28.6)	12 (29.3)
Use of medication (such as hypnotics and tranquilizers) in past 1 yr			
None	17 (85.0)	15 (71.4)	32 (78.0)
Yes (not now)	2 (10.0)	4 (19.0)	6 (14.6)
Yes (still now)	1 (5.0)	1 (4.8)	2 (4.9)

Numbers in parentheses are percentages among each group unless otherwise noted. Percentages do not necessarily add up to 100% due to missing data.

demographic differences between the two groups. When we compared the analyzed subjects, no significant differences were observed, either.

Sleep quality

Means and standard deviations for each condition on the subjective quality of sleep (CSQI) at each assessment period are shown in Table 2. No significant group effect was found. There was a significant time effect for the total CSQI score [$F(1.58, 44.28)=11.15$, $p<0.001$], and 5 of the 8 conditions: No. 1 (sleeping efficiently for a short period of time) [$F(2,56)=6.26$, $p=0.004$], No. 2 (waking up without difficulty) [$F(2,56)=5.836$, $p=0.005$], No.4 (no awakening after going to sleep) [$F(2,56)=3.31$, $p=0.044$], No. 5 (sleeping soundly) [$F(2,56)=4.03$, $p=0.023$], and No. 8 (sleeping for a long period of time) [$F(2,56)=6.04$, $p=0.004$]. Overall, there was no significant group × time interaction found. In the further analyses, we found that the CSQI increased in the intervention group at the post-intervention assessment (Week 4), with a significant interaction effect [$F(1,28)=5.19$, $p=0.031$]. However, when the pre-intervention and 3-wk follow-up (Week 7) were contrasted, no significant result was found [$F(1,28)=2.33$, $p=0.138$]. Effect sizes were calculated to compare the interaction effects from pre-intervention to post-intervention (contrast 1), and from pre-intervention to 3-wk follow-up (contrast 2) (Table 2). Effect sizes between pre- and post-intervention for the total CSQI score and No. 8 (sleeping for a long period of time) were greater than 0.30, which is above the typical cut-off score for defining a medium effect.

Means and standard deviations of the PSQI global score and other sleep parameters are shown in Table 3. A significant group effect was found in the sleep efficiency

Table 2. Pre-intervention, post-intervention, and 3-wk follow-up means and standard deviations for each group for the results of the Current Sleep Quality Index (CSQI): Japan, 2006

Condition	Pre-intervention		Post-intervention		3-wk follow-up		Effect sizes*	
	Mean	SD	Mean	SD	Mean	SD	Contrast 1	Contrast 2
1. Sleeping efficiently for a short period of time								
Intervention	32.50	28.64	42.50	27.68	54.17	21.09	0.19	0.18
Waiting-list	35.00	32.94	36.11	29.13	46.67	17.82		
2. Waking up without difficulty								
Intervention	35.00	30.00	48.33	25.53	55.83	23.53	0.24	0.25
Waiting-list	36.11	24.53	38.89	27.63	43.89	25.00		
3. No difficulty getting to sleep at bedtime								
Intervention	59.17	29.38	62.50	20.51	70.83	16.77	0.02	0.20
Waiting-list	58.89	26.98	61.11	24.71	60.56	24.13		
4. No awakenings after going to sleep								
Intervention	42.50	35.19	50.83	37.04	59.17	32.60	0.19	0.13
Waiting-list	55.56	36.98	54.44	35.35	65.00	29.16		
5. Sleeping soundly								
Intervention	43.33	28.07	53.33	24.25	60.00	23.36	0.22	0.36
Waiting-list	51.11	31.04	53.89	28.73	52.78	30.26		
6. No waking up too early in the morning								
Intervention	48.33	35.89	59.17	35.54	61.67	32.98	0.07	0.12
Waiting-list	66.67	28.28	73.33	29.31	72.78	28.04		
7. No sleepiness during the daytime								
Intervention	43.33	33.12	47.50	30.19	50.83	36.79	0.11	0.04
Waiting-list	37.22	25.85	37.78	29.62	46.67	29.51		
8. Sleeping for a long period of time								
Intervention	35.00	29.70	44.17	24.66	50.83	18.81	0.37	0.16
Waiting-list	45.56	34.34	38.33	25.03	54.44	30.34		
Total								
Intervention	339.17	191.52	408.33	149.90	463.33	146.25	0.40	0.28
Waiting-list	386.11	135.48	393.89	128.34	442.78	150.60		

* Effect sizes were computed for the interaction effects between the two groups. Contrast 1 was made between pre-intervention and post-intervention, and contrast 2 was made between pre-intervention and the 3-wk follow-up.

Table 3. Pre-intervention and 3-wk Follow-Up Means and Standard Deviations for Each Group for the Results of the Pittsburgh Sleep Quality Index (PSQI) and the Sleep Parameters: Japan, 2006

Condition	Pre-intervention		3-wk follow-up		Effect size
	Mean	SD	Mean	SD	
PSQI					
Intervention*	7.70	3.40	7.40	2.88	0.009
Waiting-list	6.72	2.89	6.22	2.51	
Sleep-onset latency, min					
Intervention	23.33	14.82	15.42	6.20	0.33
Waiting-list	18.78	16.69	19.33	13.63	
Total sleep time, h†					
Intervention	5.83	0.84	5.88	0.91	0.09
Waiting-list	6.03	1.08	6.26	1.57	
Sleep efficiency, %‡					
Intervention	90.10	10.86	87.50	10.46	0.23
Waiting-list	93.98	8.06	96.58	3.91	

* Two subjects in the intervention group had a missing value and were excluded from the analysis of the PSQI. †Total sleep time = (time between turning out the lights and getting up) minus (total wake time). ‡Sleep efficiency (%) = (total sleep time divided by bedtime) × 100

Table 4. Pre-intervention, post-intervention, and 3-wk follow-up means and standard deviations for each group for the results of the Sleep-related Behaviors Index (SBI): Japan, 2006

Condition	Pre-intervention		Post-intervention		3-wk follow-up		Effect sizes*	
	Mean	SD	Mean	SD	Mean	SD	Contrast 1	Contrast 2
1. Being active immediately before going to bed†								
Intervention	2.33	1.67	3.00	1.21	2.67	1.37	0.14	0.03
Waiting-list	1.94	1.55	2.28	1.36	2.33	1.46		
2. Having dinner more than 3 hours before going to bed								
Intervention	2.08	1.44	2.17	1.59	2.17	1.47	0.17	0.13
Waiting-list	2.28	1.18	1.89	1.53	2.11	1.61		
3. Restricting drinks containing caffeine (e.g. coffee and tea) to no more than 3 cups a day								
Intervention	0.92	1.51	1.67	1.67	1.75	1.66	0.19	0.28
Waiting-list	1.50	1.62	1.72	1.45	1.56	1.65		
4. Drinking alcohol with the intention of falling asleep immediately†								
Intervention	2.67	1.72	2.75	1.76	2.67	1.72	0.10	0.14
Waiting-list	3.22	1.44	3.22	1.35	3.06	1.21		
5. Oversleeping more than 1 hour on the weekend†								
Intervention	0.75	0.97	0.67	0.78	0.92	1.24	0.23	0.08
Waiting-list	0.78	1.11	1.06	1.39	1.11	1.37		
6. Avoiding being worried too much about business and human relations								
Intervention	2.08	1.31	2.08	1.38	1.92	1.62	0.10	0.02
Waiting-list	1.83	1.30	2.11	1.18	1.61	1.24		
7. Napping for more than 30 minutes after 3 pm†								
Intervention	3.33	0.89	3.83	0.39	3.75	0.62	0.37	0.33
Waiting-list	3.33	1.19	3.33	1.03	3.22	1.40		
8. Reading or watching TV or working in bed†								
Intervention	2.33	1.56	3.00	1.54	2.75	1.60	0.37	0.40
Waiting-list	3.50	0.92	3.22	1.11	3.00	1.28		
9. Leaving bed if awake								
Intervention	1.33	1.16	1.92	1.17	1.42	1.56	0.37	0.12
Waiting-list	2.17	1.34	1.89	1.41	2.44	1.42		
10. Being relaxed while taking a bath								
Intervention	1.67	1.50	1.58	1.17	1.58	1.00	0.05	0.10
Waiting-list	1.83	1.15	1.67	1.19	1.56	1.10		
11. Using hypnotics†								
Intervention	3.67	1.15	3.67	1.15	3.67	0.89	0.00	0.07
Waiting-list	3.89	0.32	3.89	0.32	3.94	0.24		
12. Exercising regularly								
Intervention	1.08	1.38	1.17	1.19	1.33	1.30	0.04	0.02
Waiting-list	1.00	1.46	1.17	1.43	1.28	1.53		
13. Reading in bed when having difficulty in falling asleep†								
Intervention	3.17	1.11	3.50	0.80	3.25	1.06	0.19	0.01
Waiting-list	3.39	1.04	3.44	1.04	3.33	1.08		

[F(1,28)=7.85, p=0.009]. No significant time effect was found. Both groups showed an improving tendency in the PSQI global score with no significant interaction effect [F(1,26)=0.055, p=0.817]. No significant interactions were found among the other sleep parameters although marginal improvement was found in sleep-onset latency [F(1,28)=3.52, p=0.071]. The effect size of sleep-onset latency was greater than 0.30.

Sleep-related Behaviors Index

Means and standard deviations for each condition on the Sleep-related Behaviors Index at each assessment period are shown in Table 4. No significant group effect was found. There was a significant time effect for 2 of the 21 variables: No. 1 (being active immediately before going to bed) [F(2,56)=3.32, p=0.044], and No. 18 (having breakfast every day) [F(1.52, 42.53)=3.70,

Table 4. (Continued)

Condition	Pre-intervention		Post-intervention		3-wk follow-up		Effect sizes*	
	Mean	SD	Mean	SD	Mean	SD	Contrast 1	Contrast 2
14. Going to bed earlier with the intention of longer sleep†								
Intervention	2.83	1.27	2.67	1.37	2.17	1.19	0.10	0.34
Waiting-list	2.94	1.21	3.06	1.11	3.17	1.04		
15. Complementing sleep deprivation with napping†								
Intervention	3.33	0.98	3.42	1.16	3.58	1.16	0.09	0.14
Waiting-list	3.50	1.04	3.44	1.04	3.56	0.98		
16. Having serious talks and thoughts in the bedroom†								
Intervention	2.58	1.24	3.08	1.24	3.08	1.00	0.32	0.17
Waiting-list	2.94	1.11	2.78	1.00	3.11	0.83		
17. Being concerned about the bedroom environment (e.g. noises, temperature, lighting)†								
Intervention	2.75	1.76	2.92	1.62	3.25	1.36	0.24	0.27
Waiting-list	3.22	1.06	2.89	1.08	3.00	1.19		
18. Having breakfast every day								
Intervention	3.50	1.00	3.50	1.00	3.75	0.62	0.16	0.11
Waiting-list	2.56	1.62	2.78	1.48	3.00	1.28		
19. Being able to concentrate on work								
Intervention	2.42	1.08	2.75	0.75	2.42	1.08	0.29	0.07
Waiting-list	2.28	1.02	2.11	0.76	2.17	0.92		
20. Not feeling sleepy during the daytime								
Intervention	1.33	0.89	1.50	1.09	1.67	1.37	0.18	0.09
Waiting-list	1.61	1.04	1.39	0.92	1.72	1.23		
21. Good mood when waking up								
Intervention	1.83	1.27	1.92	1.08	2.08	1.08	0.16	0.32
Waiting-list	1.61	1.04	1.44	0.92	1.33	0.91		
Total								
Intervention	48.00	8.73	52.75	9.72	51.83	7.58	0.45	0.28
Waiting-list	51.33	8.65	50.78	9.97	51.61	9.08		

* Effect sizes were computed for the interaction effects between the two groups. Contrast 1 was made between pre-intervention and post-intervention, and contrast 2 was made between pre-intervention and the 3-wk follow-up. † reversed items.

p=0.44]. A significant group × time interaction was found for the total SBI score [F(2,56)=3.93, p=0.025] and 2 variables: No. 8 (reading or watching TV or working in bed) [F(2,56)=3.20, p=0.048], and No. 9 (leaving bed if awake) [F(2,56)=3.65, p=0.032]. In the further analyses, it was shown that the score of SBI also greatly increased in the intervention group at the post-intervention (Week 4) assessment, with a significant interaction effect [F(1,28)=7.14, p=0.012] (Table 4). However, a significant result was not found when the pre-intervention and 3-wk follow-up (Week 7) were contrasted [F(1,28)=2.42, p=0.131]. Of the 21 items, the greatest changes were observed for No. 7 (napping), No. 8 (using the bed only for sleep), and No. 9 (leaving bed if awake) at the post-intervention assessment (Week 4) with significant interaction effects [F(1,28)=4.58, p=0.041; F(1,28)=4.47, p=0.044; and F(1,28)=4.33, p=0.047, respectively]. Further, these changes tended to be maintained at the 3-wk follow-up (Week 7) for behaviors No. 7 and No. 8 with a marginally significant interaction effect [F(1,28)=3.36, p=0.077] and a significant interaction effect [F(1,28)=5.39, p=0.028], respectively. Effect sizes were also calculated to compare the interaction effects between pre-intervention and post-intervention (contrast 1), and pre-intervention and 3-wk follow-up (contrast 2) (Table 4). The effect size between pre- and post-intervention for the total score of SBI was greater than 0.40, and those for each contrast of No. 7 and No. 8 were greater than 0.30 (Table 4).

Mental health

Means and standard deviations of K6 scores are shown in Table 5. Neither significant group effect nor significant time effect were found. No significant interaction effect between group and assessment time was observed either (Table 5).

Table 5. Pre-intervention and 3-wk follow-up means and standard deviations for each group for the results of the K6: Japan, 2006

Condition	Pre-intervention		3-wk follow-up		Effect size
	Mean	SD	Mean	SD	
Intervention	5.08	3.42	5.08	3.99	0.061
Waiting-list	7.29	4.55	7.17	4.71	

Characteristics of unanalyzed subjects

Of the 41 participants, 11 were excluded from the analyses (intervention, n=8; waiting-list, n=3). Of these, 8 were men. Their mean age was 41. The means of CSQI, PSQI, and SBI at the pre-intervention assessment were 364.29, 7.20, and 53.22, respectively. No remarkable discrepancies in the participants were found in the analyses.

Discussion

In the present study, a new Internet-based, interactive two-week self-help program improved subjective sleep quality among adult workers immediately after finishing the program (Week 4). Quality of sleep as measured by the CSQI was still improved at the three-week follow-up (Week 7), although the intervention effect at the follow-up was not significant. The main reason for this insignificance was because sleep quality also improved in the control group between the post-intervention and three-week follow-up. We also observed a marginally significant reduction of sleep-onset latency in the intervention group. These results add evidence to the effectiveness of Internet-based self-help programs for improving sleep quality[9].

The Internet-based program showed a moderate interaction effect size for improvement in sleep quality as measured by the CSQI. However, we could not compare this effect size with the results of a previous Internet-based study because the previous study did not report an effect size[9]. Our observed effect size, however, seems comparable with those reported in previous studies of non-Internet-based self-help treatment based on CBT or BT[10, 12, 13]. The marginally significant reduction of sleep-onset latency is consistent with previous non-Internet-based studies that have reported that stimulus control/sleep restriction was associated with improvement in sleep latency[31]. In our program, we provided participants with knowledge on sleep hygiene, stimulus control, relaxation, and cognitive restructuring, including specific examples. This was done through a website interface without detailed instructions, face-to-face counseling, or follow-up interviews. Moreover, unlike a previous Internet-based program that reported non-significant and weak effects[9], we allowed participants to choose up to three behaviors for improving their sleep quality, since it has been argued that customized sleep hygiene is preferable, helping participants to focus on specific behaviors that target their specific problems[19, 21]. The program was also interactive, including visual summary feedback and personalized messages and advice designed to encourage and reinforce participation in the program[13]. We feel that this had the effect of increasing compliance among the participants, resulting in a slightly greater effect than that found in the previous study[9]. In addition, our program was developed with minimal intervention strategy and a relatively short duration. To our knowledge, this is the first randomized controlled trial to evaluate a self-help intervention program for better quality of sleep in a working population. Since most of the self-help programs for insomnia in previous studies required more than one month of participation[9, 10, 12–16], these seemed too demanding, particularly when applied to people with a job.

Remarkable behavior changes as an effect of the intervention were observed for the behaviors of “no napping for more than 30 min after 3 pm” and “no reading or watching TV or working in bed” for both of the assessment periods, and “leaving bed if awake” at post-intervention (Week 4). These behaviors could be classified as stimulus control and sleep hygiene techniques. Since we did not monitor the behaviors of each participant, we do not know which behaviors were selected as the three target behaviors among the participants. However, the greater changes in these behaviors in the intervention group suggest that stimulus control and sleep hygiene techniques (particularly avoiding a nap) were effective in improving sleep quality in this sample. These results are consistent with previous findings that stimulus control/sleep restriction was most associated with sleep improvement, but they differ with respect to the effect of sleep hygiene, as previous studies found that sleep hygiene had little effect[31, 32]. This contradiction might be due to the fact that participants were allowed to choose their own behaviors, and this might have resulted in more involvement and better compliance by the participants.

In the intervention group, sleep quality continued to improve from post-intervention (Week 4) to the three-week follow-up (Week 7). Indeed, the long-term benefits of self-help programs have been observed in

past studies[10, 12]. However, sleep quality also improved in the waiting-list group between the post-intervention and three-week follow-up, resulting in no significant interaction effect. There is the possibility of the unintended contamination of information provided by the program to the waiting-list group. Regarding sleep-related behaviors, on the other hand, no significant improvement of behaviors was observed among the waiting-list group for the entire observation period, although there was a tendency of improvement in the behavior of "leaving bed if awake" at Week 7, which was the result most associated with improvement in sleep quality in this sample. Since we randomly allocated subjects on an individual basis, some intervention and waiting-list group participants may have worked at the same workplace or even known each other. If this was true, then the information on favorable sleep-related behaviors given to the intervention group may have also been provided to the waiting-list group. Another possibility is "self-learning" among the members of the waiting-list group. Although told merely to wait until the start of the program, they may have been motivated to change their overall sleep-related behaviors, and they may have already been intending to change some of the generally more well-known behaviors. In addition, the intervention group had a slightly lower quality of sleep at baseline than the control group did. The intervention group may have had a greater responsiveness to the intervention program, which could have resulted in a favorable intervention effect at the post-intervention assessment, but not at the three-week follow-up. Such possibilities should be examined with a future study with a greater number of subjects for randomization.

We failed to find a significant intervention effect on the PSQI score, which slightly improved during the follow-up in both groups. The PSQI requires participants to recall their sleep conditions over the previous one month. The PSQI may not be sensitive to the effects of a short-term program on sleep quality like ours. In addition, in a supplementary analysis conducted on each of the seven components of the PSQI, two components on "sleep latency" and "sleep disturbances" showed favorable changes in the intervention group compared with the waiting-list group (data not shown). Although this Internet-based program did not affect changes in sleep quality as measured by the global PSQI score, the program may have had more effects on these PSQI components. While a strong association was observed between insomnia and depressive/anxiety symptoms[26], no significant effect was observed for mental health measured by K6. Although these two conditions probably affect each other, the effect of depression/anxiety as a symptom on the development of insomnia is often discussed in the literature[26, 33]. An intervention on sleep quality may not have a strong effect on these symptoms. However, our sample was rather homogeneous, that is, it did not include anyone with clinically severe depression or anxiety. This may be a reason for the non-significant results related to mental health.

Since an important objective of this study was to evaluate the efficacy of the program among participants who feel dissatisfaction with their quality of sleep, liberal selection criteria were used, and participants were enrolled through not only the Internet but also other media. Although it is not clear how representative the participants were of the Japanese working population due to lack of information regarding jobs and working hours of the participants, the results seem broadly applicable to Japanese workers. However, we need to further consider the applicability of the current program to workers in special conditions, such as shift workers.

In addition to those described earlier, possible limitations of the present study include the lack of the use of a standardized sensitive measure of sleep quality. Most well-established sleep questionnaires, such as the PSQI, require a longer time frame of recall, e.g., one month. A recent review suggested that a weekly time frame of self-reporting is optimal for studies that investigate the stability or safety of longitudinal interventions in a clinical setting[34]. However, we considered it necessary to use a shorter time frame in the present study and to that end developed the CSQI to measure the effects of our short-term program. However, the CSQI has yet to be fully validated, and the use of an original measure clearly limits the comparability of our findings with those of previous studies. Although sleep diaries are most often used to assess the impact of interventions[26], we could not use our sleep diary data for the analyses out of consideration of the privacy of the participants. However, in future studies, the use of sleep diary data should be encouraged, particularly in Internet-based programs, since it may provide more precise assessments of sleep quality.

Other methodological limitations must also be mentioned. First, the three dropouts occurred only in the intervention group. Some participants may have felt that completing an e-diary every day was troublesome and that they were being pressed by the program. The possibility of overestimation of the intervention effect could not be rejected, although we believe that the degree of overestimation seems limited in our study. Second, the lack of objective assessment and non-blindness precludes the unequivocal attribution of intervention effects, making it difficult to determine to what extent the improvements can be attributed to the intervention program itself. Thus, some participants in the intervention group might have reported improvements because they were simply enthusiastic about their participation in the program even if they actually did not experience any improvements. The third limitation is related to the nature

of the sample. The present sample did not include workers who were reluctant to access the Internet daily. Moreover, no information was obtained on the socioeconomic status or education of the participants. Thus, we must use caution when estimating the extent of the generalizability of these results. Finally, the low statistical power resulting from the relatively small sample size was another limitation. With a greater number of participants, additional stratified analyses could be conducted.

The present findings suggest that our Internet-based self-help program is effective for improving subjective sleep quality among adult workers. Considering the high prevalence of insomnia among various populations and the limited availability of and accessibility to non-pharmacological treatments, future research should aim to determine the comprehensive contents and formats for Internet-based self-help programs with minimal requirements of both time and effort.

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Appendix A. Current Sleep Quality Index

On a scale of 0 to 100, to what extent do you feel that the following eight questions correspond to your current sleep habits? A score of '50' indicates that you agree 'somewhat', '0' indicates 'not at all', and '100' indicates 'extremely'. Please circle the one answer that best describes you for each question.

1. Sleeping efficiently for a short period of time
2. Waking up without difficulty
3. No difficulty getting to sleep at bedtime
4. No awakenings after going to sleep
5. Sleeping soundly
6. No waking up too early in the morning
7. No sleepiness during the daytime
8. Sleeping for a long period of time

Note. For each statement, participants rated their level of agreement on a 10-point Likert scale ('0'=not at all, '100'=extremely).

Appendix B. Sleep-related Behaviors Index

The following questions ask about your sleep habits over the past 2 wk. Please circle the one answer that most applies to you for each question.

1. Being active immediately before going to bed*
2. Having dinner more than 3 h before going to bed
3. Restricting drinks containing caffeine (e.g. coffee and tea) to no more than 3 cups a day
4. Drinking alcohol with the intention of falling asleep immediately*
5. Oversleeping more than 1 h on the weekend*
6. Avoiding being worried too much about business and human relations
7. Napping for more than 30 min after 3 pm*
8. Reading or watching TV or working in bed*
9. Leaving bed if awake
10. Being relaxed while taking a bath
11. Using hypnotics*
12. Exercising regularly
13. Reading in bed when having difficulty in falling asleep*
14. Going to bed earlier with the intention of longer sleep*
15. Complementing sleep deprivation with napping*
16. Having serious talks and thoughts in the bedroom*
17. Being concerned about the bedroom environment (e.g. noises, temperature, lighting)*
18. Having breakfast every day
19. Being able to concentrate on work
20. Not feeling sleepy during the daytime
21. Good mood when waking up

Note. For each statement, participants rate their level of frequency on a 5-point Likert scale ('0'=never, '4'=always).
*reversed items.