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Effects of brief CBT-I on sleep quality and psychological distress in shift workers without the midnight shift

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Objective: We provided brief cognitive behavioral therapy for insomnia (CBT-I) to shift workers who did not work midnight shifts and examined whether or not sleep quality and psychological distress improved.
Methods: Three hundred eleven workers participated in the study and were randomly assigned to the intervention (156) or control (155) groups. Workers in the intervention group received a 90-minute group-based brief CBT-I program, which focused on minimizing circadian disturbance resulting from working evening shifts. Sleep quality and psychological distress were measured using the Pittsburgh Sleep Quality Index (PSQI) and Kessler Screening Scale for Psychological Distress (K6), respectively. Both tools were administered pre- and two months postintervention.
Results: The results of both the PSQI and K6 showed that the group × time interaction was significant ($F_{1, 304.6} = 9.30$; $P < 0.01$; $F_{1, 305.1} = 3.83$; $P = 0.048$, respectively). The effect size (Cohen's *d*) was 0.42 (95% CI, 0.20－0.66) and 0.25 (95% CI, 0.02－0.47), respectively.
Conclusions: The brief CBT-I program may improve sleep quality and psychological distress in shift workers engaging in two-shift 8-hour schedules without midnight shifts. Additionally, group-based brief CBT-I is time-saving and could prevent mental health problems.

Key words: anxiety disorder, cognitive behavioral therapy for insomnia, depressive disorder, occupational health, shift work

Introduction

Shift work and irregular working hours are associated with sleep difficulty and psychological distress. According to Scott et al.,[1] lifetime risk for onset of major depressive disorder increases as exposure to shift work increases. The adverse health effects among shift workers are thought to be caused by circadian disruption and/or sleep deprivation related to irregular working hours and several psychological mechanisms.[2] Recently, the carcinogenicity of shift work has also received attention. Although adequate evidence for humans has yet to be established, laboratory animals have displayed such evidence. Indeed, in 2007, the International Agency for Research on Cancer classified "shiftwork that involves circadian disruption" as Group 2A (probably carcinogenic to humans).[3-5]

Pharmaceutical intervention may be effective in improving transient sleep difficulty and psychological distress. However, such interventions are not shift workers' first choice due to carry-over effects and dependency associated with long-term use.[6] It is thought that shift work including night shifts may be highly influenced by circadian disturbance. Although improvement in the hours of the shift schedule is considered to be the priority in reducing adverse effects on health, schedules are not easy to change in terms of practicalities. On the other hand, during non-night shifts, it may be possible to minimize circadian disturbance through efforts in daily life, such as simply ensuring appropriate sleeping hours.

In order to help shift workers achieve these behaviors,

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brief cognitive behavioral therapy for insomnia (CBT-I) should be provided to them. Brief CBT-I includes not only sleep-related physiology and desirable lifestyles for sleep, but also specific advice for shift workers on how to mitigate the influence of desynchronization on one's biological clock and sleep-wake patterns as much as possible. Furthermore, it explains ways to maintain a life rhythm that is matched to one's shift schedule as well as how to ensure timing for proper light exposure and nap-taking methods.

Although previous studies have demonstrated that the positive effects of sleep hygiene education are limited,[7] most participants in these studies were outpatients who received treatment for sleep disorders such as insomnia. Few studies have investigated workers scheduled for shift work without midnight shifts. In the present study, we provided brief CBT-I to shift workers without midnight shifts and examined whether their sleep quality and psychological distress improved.

Materials and Methods

Participants included 380 shift workers from one workplace, a machine-parts manufacturer. Eligibility was limited to those on two-shift (8-hour) without midnight shift schedules. Exclusion criteria were not defined. The shift work cycle at this workplace had the following pattern: (1) day shift (6:30 to 15:30 including a 1-hour lunch break) for five consecutive days from Monday to Friday; (2) 2 days off; (3) evening shift (15:00 to 24:00 including a 1-hour evening meal break) for five consecutive days; and (4) 2 days off.

Participation in this study was voluntary. Consent to participate was confirmed by documents after the study objective, procedures, and contents of intervention were explained both orally and in writing. Workers who gave consent to participate were randomly assigned to either the group in which brief CBT-I would be provided or the waiting list group. According to company rules that prohibited sharing employees' health information outside the company, approval to register participants with the randomized controlled trial (RCT) registration center was not granted.

Due to ethical reasons, we provided similar brief CBT-I to the waiting list cohort after the study was completed. At this time, we also offered it to the workers who did not provide their consent to participate in the study but were interested in receiving the brief CBT-I. The effects of the brief CBT-I were evaluated immediately prior to the brief CBT-I intervention and 2 months after completion using a self-administered questionnaire. The questionnaires were collected after participants completed them and enclosed them in sealed envelopes. This study received approval from both the health and safety committee at the study institution and the Kitasato University ethics committee.

Intervention

A 90-minute group-based brief CBT-I program was conducted in the workplace after the evening meal. The program lecturer was a collaborator in this study with training in brief CBT-I.

Educational resources were prepared with reference to the *Guidelines for Diagnosis and Treatment of Sleep Disorders* (written by the Ministry of Health, Labor, and Welfare research group)[8]; *Sleep, Sleep Disorders, and Biological Rhythms* (a manual prepared by the National Institute of Health)[9]; and *Sleep Hygiene - The Healthy Habits of Good Sleep* (16 sleeping tips provided by the American Academy of Sleep Medicine).[10] The education focused on minimizing circadian disturbances that result from evening shift work. For example, the subjects were

Table 1. Contents of the sleep hygiene curriculum

1. Sleep structure
2. Number of sleeping hours needed and individual variations
3. Exposure to the morning sunlight upon awakening
4. Go to sleep as early as possible after coming back home after evening shifts and do not sleep for long periods of time the next morning.
5. Avoid taking longer daytime naps than needed.
6. Avoid the use of caffeinated products, nicotine, and alcohol, especially later in the day.
7. Avoid heavy meals within 1 hour before going to sleep.
8. Maintain appropriate environmental conditions for sleep.
9. Do something to relax before going to sleep.
10. Do not use the bedroom for activities other than sleep. (E.g., Do not read, watch TV, go online, or talk on the phone.)
11. If it takes a while to fall asleep (more than 30 minutes), get up and go into another room. Do something until you start to feel sleepy, and then go back into the bedroom to sleep.

advised to put off housework until the next day and to proactively adopt a relaxation method in order to prepare for initiation of sleep as soon as possible after coming back home. Details of the content provided in the brief CBT-I are shown in Table 1.

Outcome measurement

The Pittsburgh Sleep Quality Index (PSQI), the standard index used in clinical settings in public health research,[11] was used to measure sleep quality. The reliability and validity of the Japanese edition of the PSQI have been thoroughly tested.[12] Quantity and quality of sleep during the past month were assessed according to seven dimensions: sleep quality, sleep latency, sleep time, sleep efficiency, sleep disorder, use or nonuse of sleep medication, and daytime dysfunction. After considering these, a global sleep quality score (Global PSQI score: 0－21) was calculated. A higher score indicates poorer sleep quality.

Psychological distress was evaluated using the K6. The K6 is a simple and easy-to-use self-administered questionnaire assessing the frequency of depressive and anxiety symptoms over the past month. It was developed as a screening tool for depressive disorders and anxiety disorder[13] and has been widely used as a tool to assess psychological distress.[14,15] The reliability and validity of the Japanese edition of the K6 has been verified.[16] The total points of the K6 is shown as 0－24 points and is possible to be indicative of depressive disorders and/or anxiety disorder with a high score. The cut-off point is between 8 and 9 points. Regarding background characteristics, we examined the following items: gender, age, drinking habit, smoking habit, exercise habit, history of sleep, and psychiatric disorders.

The sample size required to achieve the main outcome was calculated using a two-tailed *t*-test. We assumed an effect size of 0.3 (small) in this study based on previous research.[17] The sample size necessary to obtain an effect size of 0.3 with a probability of Type I error (α) of less than 0.05 and Type II error (β) of less than 0.20 was 139 for each group.

An independent researcher who had no direct contact with the participants used computer-generated randomization with a 1:1 ratio with a block size of 4. No stratification was performed. Evaluators were masked to allocation. Given the nature of the intervention, participants were not blind to their allocation status.

Statistical analyses

Statistical analyses were conducted based on an intention-to-treat (ITT) principle. The rate of missing outcomes was 1.9% in the follow-up. To satisfy the ITT requirement that analyses be undertaken on all participants, we used multiple imputation with the assumption that the data could be considered to be missing at random. Multiple imputation allows for the uncertainty of missing data by generating several different plausible imputed data sets using a set of external covariates and appropriately combining results obtained from each.[18-19] We used a sequential regression approach for the imputation step and generated 20 imputations for each missing value, as recommended by previous research.[20]

To assess the intervention effects on sleep quality and psychological distress, linear mixed models (an unstructured covariance structure) with group, time, a group × time interaction as a fixed effect, and randomized participants as a random effect were used. Statistical significance of group × time effects using the type III Wald test was examined. Group differences in the outcomes 2 months after the intervention were examined after adjusting for the baseline values. Statistical significance was set at $P < 0.05$. IBM SPSS Statistics 22 and IBM SPSS Missing Values 22 (IBM Corp, Armonk, NY, USA) were used for statistical analyses.

Results

Figure 1 presents a flow chart of participation in the present study. Of 380 eligible workers, 311 individuals were enrolled in the study. Eligibility was restricted to those who worked a two-shift system (8-hour shift work). These 311 participants were randomly allocated to an intervention (n = 156) or control (n = 155) group. In the intervention group, 149 of 156 participants (95.5%) received brief CBT-I. Two months following the intervention, 154 of the 156 intervention participants (98.76%) and 151 of the 155 control participants (97.4%) responded to the follow-up survey.

Characteristics of the study participants

Baseline attributes of participants are shown in Table 2. Of the 311 participants, 170 (54.7%) were male (intervention group, 83 [53.2%]; control group, 87 [56.1%]), and the mean age was 38.7 years (intervention group, 39.7 years; control group, 37.8 years). Other basic attributes, such as the PSQI score and K6 score did not differ between groups.

Effect on sleep quality

Table 3 presents the differences in change over time (group × time interaction) as well as the mean score of the PSQI 2 months post-brief CBT-I. The group × time

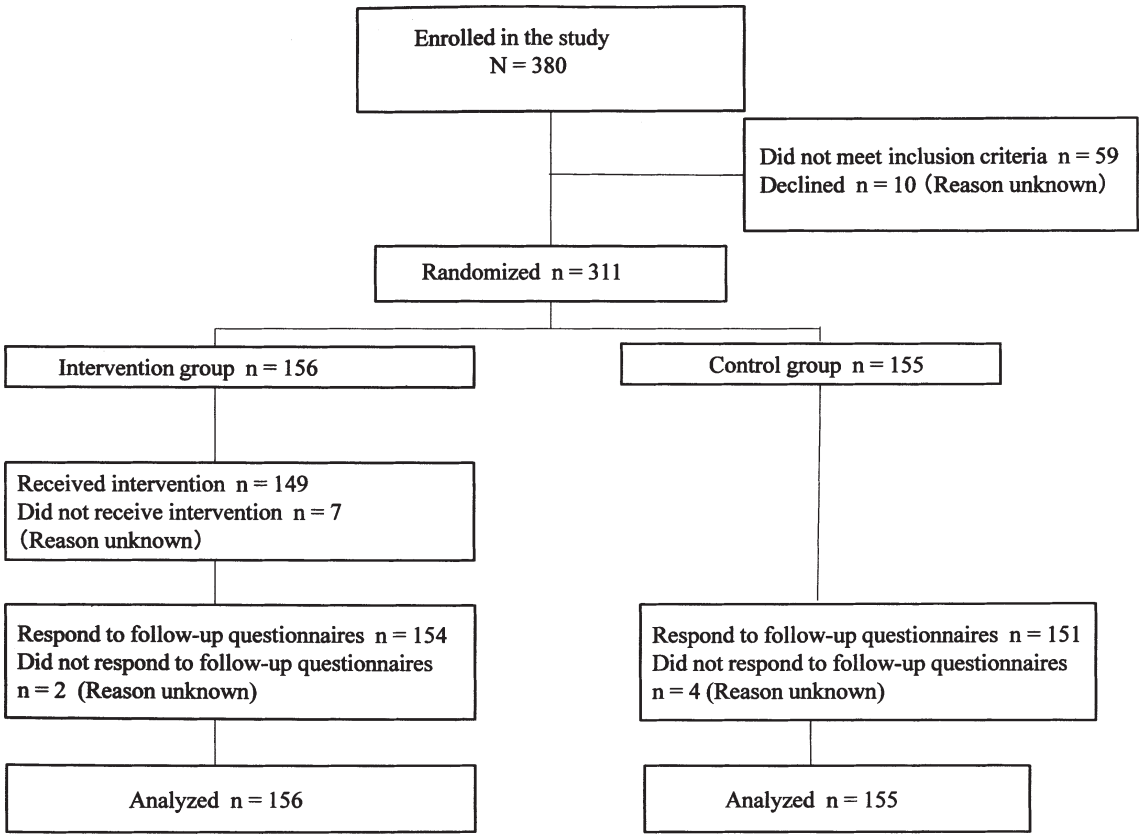

Figure 1. Flow diagram of participant allocation

Table 2. Demographic and baseline characteristics of participants by intervention and control group

	Total (n = 311)	Intervention group (n = 156)	Control group (n = 155)
Gender: men, n (%)	170 (54.7)	83 (53.2)	87 (56.1)
Age: years, M (SD)	38.7 (10.4)	39.7 (10.7)	37.8 (10.1)
Drinking habit: >1 day/week, n (%) *Yes*	236 (75.9)	126 (80.7)	110 (71.0)
Smoking habit, n (%) *Yes*	77 (24.8)	46 (29.5)	31 (20.0)
Exercise habit: >1 day/week, n (%) *Yes*	88 (52.4)	41 (49.4)	47 (55.3)
History of sleep or psychiatric disorders *Yes*	14 (4.5)	6 (3.8)	8 (5.2)
PSQI, M (SD)	7.95 (3.43)	7.95 (3.22)	7.95 (3.63)
K6, M (SD)	3.48 (4.14)	3.49 (4.15)	3.47 (4.14)

Abbreviations: SD, standard deviation; PSQI, Pittsburgh sleep quality index

Table 3. Effect of brief CBT-I on improving sleep quality and psychological distress (assessed 2 months postintervention)

Outcome variables	Estimated mean (SE)†	Group difference in means (95% CI)	P-value	Group × time interaction‡		Effect size
				F (df)	P-value	F (df)
PSQI scores						
Intervention group	6.95 (0.20)	0.93 (0.44 to 1.42)	< 0.01	9.30 (1, 304.6)	<0.01	0.42 (0.20－0.66)
Control group	7.88 (0.27)					
K6 scores						
Intervention group	3.07 (0.26)	0.62 (0.05 to 1.19)	0.03	3.81 (1, 305.1)	0.048	0.25 (0.02－0.47)
Control group	3.69 (0.30)					

Abbreviations: PSQI, Pittsburgh Sleep Quality Index; SE, standard error

† Asesssed after adjusting for baseline scores

‡ Asessed using a linear mixed model including group, time, and group × time

interaction term was significant ($F_{1, 304.6} = 9.30$, $P < 0.01$) for sleep quality. Mean PSQI scores significantly differed between the two groups, with 6.95 in the intervention group and 7.88 in the control group (mean difference, 0.93 [95% CI, 0.44－1.42], $P < 0.01$). The effect size (Cohen's *d*) was 0.42 (95% CI, 0.20－0.66).

Effect on psychological distress

The group × time interaction term was significant ($F_{1, 305.1} = 3.83$, $P = 0.048$) for psychological distress as well. Mean K6 scores 2 months after the brief CBT-I were 3.07 in the intervention group and 3.69 in the control group, resulting in a significant difference between the groups (mean difference, 0.62 [95% CI, 0.05－1.19], $P = 0.03$). The effect size (Cohen's *d*) was 0.25 (95% CI, 0.02－0.47).

Study safety

No participants reported any detrimental effects on their sleep or mental health as a result of the study intervention.

Discussion

This study revealed that brief CBT-I significantly improved sleep quality and psychological distress in shift workers with two-shift (8-hour) schedules, without midnight shifts. This brief CBT-I program was a nonpharmacological intervention conducted over 90 minutes. It was meaningful to demonstrate the effects of the intervention improving of sleep quality and psychological distress as the education could be implemented in many workplaces.

Previous studies have shown limited effects of sleep hygiene education on sleep.[7] However, this may be because the participants in previous studies consisted of patients with sleep disorders and that studies involving shift workers included those working night shifts. On the other hand, enough effect of improvement of insomnia is shown by adding non-standard CBT-I which is through the Internet, and are seen, and the effect continued up to 12 months later.[21] Additionally, because the key to improving sleep difficulty varies depending on the individual, not only group brief CBT-I but also individual treatment seems to be necessary.[22,23] Above all, as a nonpharmacological intervention, sleep hygiene education combined with behavior therapy, such as stimulation control and sleep restriction, relaxation methods, and CBT-I, have been recommended as standard methods.[24-28] However, substantial time and support by specialists in CBT-I are required for individual programs. The fact that there are few specialists in CBT-I in Japan is a problem. Therefore, this study focuses on the benefits of group education.

The present study suggests that brief CBT-I is effective in improving sleep when provided to shift workers without midnight shifts. Some explanations for this are as follows: first, the severity of circadian disturbance is mild in evening shift work compared to night shift work. Second, shift systems were regulated and systematic: the shifts of the participants in this study were 8 hours and during normal hours. Conditions included no overtime work. Participants took a rest on the weekend for two days after weekday evening shifts. Further, although circadian disturbance may result from workers staying awake for a longer time than required after coming back home, or by sleeping for a longer time than required, this issue can be improved with advice on sleep hygiene and through individual effort.

At the end of brief CBT-I intervention, the participants in the intervention group were asked to describe the habits

that they were going to try to adopt to improve their sleep in a free description field of the questionnaire. Of 49 participants who responded to the inquiry, the habits most commonly described as future goals were, to put off housework in order to sleep, as soon as possible, after working the evening shift (described by 42 [85.7%]). This could be responsible for the positive results of the present study.

To our knowledge, the mechanism by which CBT-I alleviates depression and anxiety is unknown, although previous studies have suggested the endocrine system as one contributing factor.[29] For example, functional disorders of the hypothalamic-pituitary-adrenal axis, which are considered a pathogenic mechanism of insomnia,[30] are also considered to be related to other conditions such as depression and anxiety.[31] Further, CBT-I improves not only insomnia but also metabolic disorders in waking areas of the brain.[32] CBT-I might, therefore, improve not only subjective sleep quality but also alleviate depression and anxiety via the endocrine system or the central nervous system.

In this study, brief CBT-I improved not only the sleep quality but also psychological distress (although the effect size was small). A national survey in Japan reported that the percentage of workers who felt strong anxiety, troubled, and stressed about work and working life is 58%.[33] However, it has also been reported that among workers feeling strong psychological distress, which seemed to require some kind of care, approximately only 20% receive appropriate care.[34] Continuation and exacerbation of psychological distress may lead to various psychiatric and physical disorders and may also reduce work performance and productivity.[35-38] Hence, effort to reduce psychological distress among workers is an urgent issue in this field of research. However, to our knowledge, few studies have aimed to show simple and effective steps for minimizing this distress. Although it is shown that CBT-I significantly improves psychological distress,[39] it is difficult to perform CBT-I in most workplaces due to the need for specialist support and extensive time.

Not all tools in this study were effective in reducing psychological distress for all workers. However, this study suggests that group brief CBT-I is highly useful for improving psychological distress among shift workers without midnight shifts and that implementing this type of intervention is favorable.

Limitations

There are some limitations in generalizing these results. First, the observation period was short. The observation period in this study was 2 months because the safety and health committee in the workplace requested that we minimize the control group's wait time for receiving the brief CBT-I. A longer follow-up period for evaluation of sleep quality and psychological distress would have been preferred. Second, evaluation of the sleep quality was based only on subjective evaluation; objective evaluations such as polysomnography were not used. In future research, actigraphy should be considered because it can be adopted relatively easily. Third, this study was performed in a workplace with nicer working conditions than many other shift-based workplaces. This workplace introduced a two-shift, 8-hour system without midnight shifts or overtime work, and the content of the work was to produce and assemble small machine parts, which has low physical and psychological burdens. Fourth, some content of the brief CBT-I may have been acquired by the control group because both the intervention group and control group worked in the same workplace.

It has also been reported that the influence of shift work and irregular working hours on sleep and mental health is not uniform and varies depending on personal characteristics and environments.[40-42] Therefore, to examine the validity of these results, it would be important that future research performs similar intervention studies in various workplaces.

Conclusions

The present study indicates that a 90-minute group-based brief CBT-I program can improve sleep quality and psychological distress among shift workers engaging in two-shift 8-hour schedules without midnight shifts. Our group-based brief CBT-I required little time from shift workers and, most importantly, appears to be an effective protective measure for mental health.

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