Industrial Health 2011, **49**, 634–641 **Original Article**

Correlates to Sleepiness on Night Shift among Male Workers Engaged in Three-shift Work in a Chemical Plant: Its Association with Sleep Practice and Job Stress

Takayuki KAGEYAMA[1]*, Toshio KOBAYASHI[2] and Ayano ABE-GOTOH[1, 3]

[1]Department of Mental Health and Psychiatric Nursing, Oita University of Nursing and Health Sciences, Megusuno 2944–9, Oita, Oita 870-1201, Japan
[2]Department of Health Development, Graduate School of Health Sciences, Hiroshima University, Kasumi 1–2–3, Minami-ku, Hiroshima, Hiroshima 734-8553, Japan
[3]Oita Red Cross Hospital

Received September 9, 2010 and accepted July 5, 2011
Published online in J-STAGE August 9, 2011

Abstract: The purpose of this study was to examine the correlation of sleepiness during night shift (SNS) in male shiftworkers with nonpharmacological self-management (nPSM) practices to facilitate good day sleep, and also with job stress. Sleepiness on the job and possible correlates to SNS among 157 male shiftworkers in a rotating three-shift schedule at a chemical plant were cross-sectionally investigated using a self-administered questionnaire. Multivariate analyses revealed that SNS was positively associated with drinking alcoholic beverages before day sleep, but inversely associated with subjective health status, being of the evening type, abstaining from caffeine before day sleep, having a bath before day sleep, job control, reward from work, feeling suited to the job, and support from colleagues. SNS correlated with certain nPSM practices and also with possible modifiers of job stress. These findings provide clues to developing countermeasures against SNS among shiftworkers. The effects of nPSM practices and job stress management on their day sleep and SNS should be examined in detail.

Key words: Alcohol, Bath, Caffeine, Job stress, Morningness-eveningness, Shiftwork, Sleep practice, Sleepiness

Introduction

Shiftwork and nightwork are globally becoming increasingly prevalent in the 24-h society. Prominent problems related to sleep among shiftworkers are important issues in occupational health[1, 2]. Shiftworkers' day sleep tend to be disturbed quantitatively and qualitatively and to be less restorative[2–4]. Insufficient sleep can increase the risk of various health problems[1, 2, 5]. Furthermore, sleepiness during night shift (SNS) frequently causes sleep attacks, which sometimes results in accidents[1, 6, 7]. Traffic accidents while driving home after a night shift are also important problems[8].

Various countermeasures against SNS have been proposed[2]. A direct countermeasure is arousing shiftworkers using environmental or pharmacological stimulants, although treating healthy shiftworkers with pharmaceutical products cannot be recommended without taking the risks associated with the treatment into consideration. Another countermeasure against SNS is time scheduling, such as avoiding too many successive night shifts, providing sufficient intervals between shifts, and providing enough possibilities for resting or napping on night shift[9]. However, it is sometimes difficult or impossible for shiftworkers or their managers to practice these

*To whom correspondence should be addressed.
E-mail: kageyama@oita-nhs.ac.jp

countermeasures for reasons specific to each work site. We therefore need to develop other ways of facilitating good sleep for shiftworkers from the aspects of individual- and work-site-based countermeasures. For this purpose, it is important to determine the correlates with SNS among shiftworkers.

Circadian adaptation and SNS among shiftworkers are partially associated with individual characteristics, such as age[10–12] and morningness-eveningness[13–15]. Drinking alcoholic beverages[16–18], smoking[17], and taking caffeine[19] can affect their sleep. Techniques promoting circadian adaptation (e.g., bright light, physical exercise, and pharmacological aids) have been proposed[13, 20]. Although nonpharmacological self-management (nPSM) practices, namely, personal efforts to facilitate better sleep such as exercising, correlate with good sleep among day workers[21, 22], only little evidence is available for shiftworkers. Since the effectiveness of sleep health education for nPSM practices among day workers has been reported[23, 24], similar effectiveness among shiftworkers should be examined.

The work environment also correlates with sleep or SNS among shiftworkers. Of course, shift systems and related variables such as bedtime can affect their sleep[21, 25]. Although many researchers have reported the association of job stress (e.g., work demand, insufficient support from coworkers, and job dissatisfaction) with sleep among day workers[17, 26–31], there are only a few reports on a similar association among shiftworkers[31–33]. If an environmental factor affects sleep or SNS among shiftworkers in a work site, their managers should make an effort to change the factor.

This study had two purposes. The first was to search for nPSM practices correlated with SNS among shiftworkers. These variables may contribute to developing a sleep health education program for shiftworkers. The second was to examine the relationship of job stress among shiftworkers with their SNS. The workers in this study were, however, engaged in an almost uniform job and given an almost uniform workload at a plant. We therefore mainly focused on their perception of possible modifiers of job stress caused by workload (e.g., job control, social support, reward from work, and feeling suited to the job)[34, 35].

Subjects and Methods

Subjects

The subjects were 185 male shiftworkers at a chemical plant in Oita prefecture, Japan. They were in a rotating shift schedule, which comprised day shift (8:00–16:15), evening shift (16:00–0:15), and night shift (0:00–8:15), at least for five months. Each shift continued for five days (Mon–Fri), followed by two days off (Sat–Sun). Job contents were almost uniform among shifts and workers: e.g., carrying materials and products in the plant, monitoring indicators for machine conditions, or coping with machine troubles. The plant is highly automated, and, if there is no trouble, their job is relatively monotonous.

A self-administered questionnaire was distributed to the employees in September 2007, and 157 (84.9%) anonymously responded. Among the participants, 56% were in their thirties, 55% were married, and 77% had experience in the current shift schedule for three years or longer (Table 1). Since their age and experience in the current shift schedule were categorically given, the means of these variables could not be calculated. The study protocol was reviewed and approved by the Committee on Research Ethics and Safety of the univer-

Table 1. Background of participants

Variable	Category	n (%)
Age (yr)	–24 or below	15 (9.6)
	25–29	26 (16.6)
	30–34	45 (28.7)
	35–39	44 (28.0)
	40 or above	27 (17.2)
Marital status	Married	87 (55.4)
	Unmarried	70 (44.6)
Experience in the current shift (yr)	Under 3	36 (22.9)
	3–10	69 (43.9)
	10 or above	52 (33.1)
Current smoking (number of cigarettes/day)	20 or above	52 (33.1)
	1–19	50 (31.8)
	0	55 (35.0)
Frequency of exercise (days/week)	3 or above	14 (8.9)
	2	22 (14.0)
	1	28 (17.8)
	Less than 1	93 (59.1)
Subjective health status	Good	18 (11.5)
	Fairly good	34 (21.7)
	Neither good nor poor	75 (47.8)
	Fairly poor	29 (18.5)
	Poor	1 (0.6)
Adaptation to shiftwork	Adapted very well	13 (8.2)
	Adapted	80 (51.0)
	Fairly adapted	37 (23.6)
	Slightly adapted	16 (10.2)
	Not adapted	11 (7.0)
Morningness-eveningness	Morning type	21 (13.4)
	Fairly morning type	46 (29.3)
	Fairly evening type	61 (38.9)
	Evening type	28 (17.8)

N=157. The sums of % for morningness-eveningness does not equal to 100 because a nonrespondent to the question is not included here.

sity to which the first author belongs.

Questionnaire

The questionnaire was concerned with daily habits, subjective health status, presence of any disease under treatment, job stress, adaptation to shiftwork, morningness-eveningness, sleepiness on the job, sleep behaviors, and sleep health (subjective sleep quality).

Personal background

The participants were asked to provide their age in appropriate categories, and the categories were scored 1–5 for statistical analysis (1 = "24 or below", 2 = "25–29", 3 = "30–34", 4 = "35–39", 5 = "40 or above"). Marital status was dichotomically asked (1=married, 0=unmarried). Years engaged in the current shift schedule was provided by the participants into appropriate categories, and the categories were scored 1–3 (1 = "under 3 yr", 2 = "3–9 yr", 3 = "10 yr or above"). The presence of diseases under treatment was dichotomically asked (1 = "present", 0 = "absent").

Daily habits

Current smoking status was given as the number of cigarettes per day, namely 0, 1–19, and 20 or more, which were scored as 0, 1, and 2, respectively. The frequency of drinking alcoholic beverages per week was scored 0–3 (0 = "never", 1 = "less than once", 2 = "once or twice", 3 = "three times or more"). The frequency of physical exercise per week was scored 0–3 (0 = "less than once", 1 = "once", 2 = "twice", 3 = "three times or more"). Subjective health status was scored 0–4 (0 = "poor", 1 = "fairly poor", 2 = "neither poor nor good", 3 = "fairly good", 4 = "good").

Job environment

Job stress was measured using eight scales (job control, supervisor's support, colleagues' support, problem with interpersonal relationship, reward from work, skill utilization, fit to job content, and job satisfaction), each of which consists of 1–4 Likert scales. Among them, two (problem with interpersonal relationship and reward from work) were part of the Brief Scales for Job Stress[36], and the other six were part of the Brief Job Stress Questionnaire[37]. Although these questionnaires were developed in Japan, they are based on the "demands-control-support model" similarly to the Job Content Questionnaire (JCQ)[34, 38, 39], and validated in previous studies. The amount of workload was not measured, because the workers were objectively given an almost uniform workload.

Sleep behaviors and sleep health

On the basis of self-reported bedtime and wake-up time for main sleep at daytime in a night-shift week, time in bed was calculated. The frequency of napping between the main sleep at daytime and the following night shift was measured on a three-point scale (0 = "never", 1 = "once or twice per week", 2 = "three times or more per week"). Nap length was categorically scored 0–3 (0 = "0 min", 1 = "1–30 min", 2 = "31–90 min", 3 = "91 min or more"). If a participant never takes a nap between the main sleep and night shift, the nap length was assumed to be 0 min.

The participants were also asked to report subjective sleep health, namely, frequency of difficulty in initiating sleep, premature early waking, and the feeling of sound sleep for the main sleep at daytime. These frequencies for the main sleep at daytime in a night-shift week were measured on a three-point scale (0 = "never", 1 = "once or twice a week", 2 = "three times or more a week").

On the basis of the discussion between the authors and the health administration staff at the work site, eight examples of nPSM sleep practices before day sleep in a night-shift week were presented (keeping room temperature comfortable, keeping away from bright light, drinking alcoholic beverages, having a bath, asking family to be quiet, using silent mode of electronic devices such as mobile phones, putting sunglasses on the way home, and abstaining from tea/coffee). The participants were asked whether they usually do each of the above-mentioned sleep practices, which were dichotomically scored (1 = "practice", 0 = "do not").

The participants were asked to rate retrospectively their sleepiness (alertness) on the job. Sleepiness on the job was measured using the modified version of the Kalolinska Sleepiness Scale (at 2-h intervals during each shift; 1 = "very alert", 3 = "alert", 5 = "neither alert nor sleepy", 7 = "sleepy (not fighting sleep)", 9 = "very sleepy (fighting sleep)"). The reliability and validity of this scale have been confirmed in previous studies[14, 40].

Morningness-eveningness was assessed using a simple question, "Do you feel you are naturally a morning type or an evening type?", and their responses were scored on a four-point scale (0 = "morning type", 1 = "fairly morning type", 2 = "fairly evening type", 3 = "evening type").

Analysis

The means of sleepiness scores in the first half (2:00 and 4:00) and the latter half (6:00 and 8:00) of the night shift were calculated (abbreviated as SNS1 and SNS2), respectively. However, if the data at 0:00 were added to SNS1, this manipulation resulted in little difference in the following results. Then, forward step-

wise regression analysis was carried out to elucidate the variables associated with SNS1 and SNS2 as dependent variables. The possible independent variables examined in the analysis were age, marital status, years engaged in the current shift schedule, morningness-eveningness, current smoking status, frequency of drinking alcoholic beverages before sleep, frequency of physical exercise, subjective health status, diseases under treatment, bedtime, wake-up time, time in bed, nPSM practices before sleep at daytime in a night-shift week, frequency of napping at daytime in a night-shift week, nap length, and eight scales for job environment and stress.

In addition to the above analysis, the associations of the selected correlates with SNS with sleep behaviors and subjective sleep health were also examined, using Pearson's product-moment correlation coefficient (r), Spearman's rank correlation coefficient (r_S), and Mann-Whitney U-test. The statistical significance level was set at p=0.05. All the data were analyzed using SAS (version 9.1, SAS Institute Inc., Cary, NC, USA).

Results

In a night-shift week, the mean bedtime and wake-up time were respectively 11.82 o'clock (SD, 2.13) and 18.13 o'clock (SD, 2.07). As a result, time in bed was 6.32 h (SD, 1.68). Twenty-six percent of the participants took a nap during three days or more between the main sleep at daytime and the following night shift in a night-shift week, whereas 38% never did. The mean nap length was 56.3 (SD, 58.3) min.

Among nPSM practices before sleep at daytime in a night-shift week, keeping the room temperature comfortable was most prevalent, followed by keeping away from bright light and drinking alcoholic beverages (Table 2).

Trends of sleepiness scores are demonstrated in Fig. 1. Bedtime, wake-up time, frequency of nap, or nap length did not correlate with SNS. However, time in bed inversely correlated with SNS1 (r=–0.17, p<0.05) and SNS2 (r=–0.23, p<0.05).

Results of multiple regression analysis for SNS are summarized in Table 3. SNS1 was positively associated with alcohol consumption before sleep, but inversely associated with subjective health status, eveningness, job control, and abstaining from tea/coffee before sleep. SNS2 was positively associated with alcohol drinking before sleep, but inversely associated with subjective health status, eveningness, reward from work, feeling suited to the job, colleagues' supports, abstaining from tea/coffee before sleep, and having a bath before sleep.

Table 4 shows the association of the above correlates to SNS, except nPSM practices (Table 3), with sleep

Table 2. Sleep practice before day sleep in night shift week

Ways	n (%)
Keeping room temperature comfortable	93 (59.2)
Keeping away from bright light	66 (42.0)
Drinking alcoholic beverages before sleep	51 (32.5)
Having a bath before sleep	40 (25.5)
Asking family to be quiet	37 (23.6)
Using silent mode of electronic devices such as mobile phone	30 (19.1)
Using sunglasses on way home	5 (3.2)
Abstaining from tea/coffee before sleep	5 (3.2)

N=157. Multiple choices were allowed.

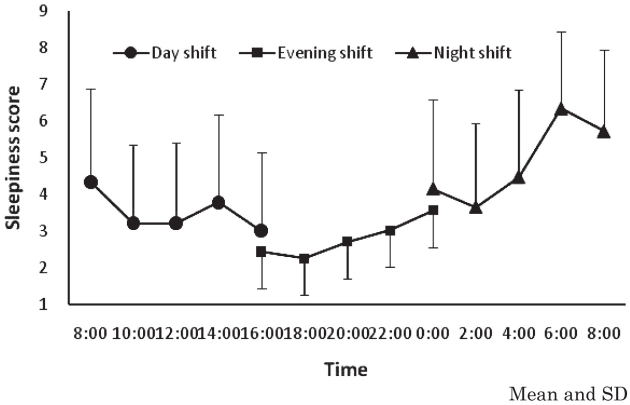

Fig. 1. Trends of sleepiness on day, evening, and night shifts.

Table 3. Multiple regression analysis of sleepiness on night shift

Independent variables	STB for SNS1	STB for SNS2
Subjective health status	–0.230*	–0.155*
Eveningness	–0.279***	–0.163*
Job control	–0.190*	
Reward from work		–0.413***
Feeling suited to job		–0.194*
Support from colleagues		–0.315***
Drinking alcoholic beverages before sleep	0.157*	0.157*
Abstaining from tea/coffee before sleep	–0.163*	–0.215**
Having a bath before sleep		–0.163**
F	9.05***	6.52***
R^{*2}	0.205	0.221

SNS1, mean sleepiness scores for 2:00 and 4:00.
SNS2, mean sleepiness scores for 6:00 and 8:00.
STB, standardized partial regression coefficient (***p<0.001, **p<0.01, *p<0.05).
R^{*2}, Coefficient of determination adjusted for degree of freedom.
Shown here are STB for the independent variables selected through stepwise multiple regression analysis.

Table 4. Association of correlates to sleepiness on night shift with sleep behaviors and sleep health for sleep at daytime in night–shift week

Variables	Bedtime	Wake–up time	Time in bed	Frequency of nap	Nap length	Frequency of difficulty in initiating sleep	Frequency of premature early waking	Frequency of feeling of sound sleep
Subjective health status	r=0.010	r=–0.084	r=–0.139	r=–0.120	r=0.115	r_s=–0.185*	r_s=–0.220**	r_s=0.251**
Eveningness	r=0.135	r=0.320***	r=0.314***	r=0.255**	r=–0.259**	r_s=–0.212**	r_s=–0.168*	r_s=0.114
Job control	r=–0.100	r=–0.052	r=0.047	r=0.065	r=–0.164*	r_s=–0.184*	r_s=–0.114	r_s=0.142
Reward from work	r=–0.177*	r=–0.089	r=0.089	r=0.026	r=–0.006	r_s=–0.248**	r_s=–0.187*	r_s=0.057
Feeling suited to job	r=–0.170*	r=–0.115	r=0.041	r=0.063	r=–0.042	r_s=–0.318***	r_s=–0.215**	r_s=0.166*
Colleagues' support	r=–0.163*	r=–0.100	r=0.055	r=0.096	r=–0.094	r_s=–0.055	r_s=0.090	r_s=0.117

r, Pearson's product-moment correlation coefficient; r_s, Spearman's rank correlation coefficients. (***p<0.001; **p<0.01, and *p<0.05 for both)

behaviors and sleep health for day sleep in a night-shift week. Subjectively good health correlated with frequent feeling of sound sleep and infrequent feeling of sleep problems. Eveningness did not correlate with bedtime, but with late wake-up time and long time in bed. Eveningness also appeared to correlate with frequent, short naps. Job control, reward from work, and feeling suited to the job correlated with infrequent feeling of sleep problems, particularly difficulty in initiating sleep. Feeling suited to the job was weakly correlated with frequent feeling of sound sleep. Reward from work, feeling suited to the job, and colleagues' support also weakly correlated with early bedtime.

On the other hand, two nPSM practices associated with SNS (Table 3; having a bath and abstaining from tea/coffee before sleep) showed no correlation with any of the sleep behaviors. However, those who drank alcoholic beverages to facilitate day sleep infrequently felt sound sleep, and frequently experienced premature early waking, compared with those who do not (U-test, p<0.05 for both).

Discussion

The trends of sleepiness scores (Fig. 1) agreed well with previous reports on shiftworkers[2, 14]. The participants seemed to be alert in the sleep forbidden zone[41], whereas their sleepiness was highest in the night shift, particularly in the early morning.

Among nPSM practices for day sleep in a night-shift week (Table 2), keeping the room temperature comfortable was most prevalent, probably because this survey was conducted in late summer. It was reasonable that many participants kept away from bright light using such items as light-insulating curtains and eye masks.

Among our participants, 32.5% used alcohol to facilitate day sleep. This is comparable to previous reports in the general population. Jefferson *et al.*[16] reported that 11.2% of noninsomniac adults and 29.1% of insomniac adults among the Detroit general population used alcohol to sleep, whereas Kaneita *et al.*[4] reported that the prevalence was 48.3% among the general male population in Japan.

The following explanation for having a bath in Japan will help in understanding the results of this study. Bathrooms in Japan are waterproof, and bathtubs are usually very deep and filled with hot water (40–43°C). After washing the body, Japanese soak in the bath tub for a long time. Since this affects body temperature, heart rate, and blood pressure, and also relaxes mentally and physically, many day workers have a bath after work. This is the most prevalent nPSM practice for night sleep in Japan (59% of the male general population do this after work), being actually related to good sleep[21]. Compared with the above report, the prevalence of this for day sleep in our participants seems low. Since the capacity of shower equipment in this plant is not large, few shiftworkers take a shower just after work; most of them take a shower or have a bath at home. It is probable that the shiftworkers after a night shift only take a shower, instead of having a bath, because family members who usually have night sleep often have a bath successively using the same bath in the evening in order to save water and energy, and taking a shower after a night shift is more economical than having a bath.

Multivariate analysis revealed that subjective health status, morningness-eveningness, job environment, and some nPSM practices independently correlated with SNS (Table 3). Since the correlates to SNS1 fairly agreed with those to SNS2, we would like to discuss them together.

Subjective poor health was associated with SNS, in disagreement with a previous study on the female general population[54]. It is probable that poor health or some diseases may disturb sleep, and may also induce low tolerance during night shift. Our participants were, however, basically healthy workers who have an

annual health check-up; furthermore, the presence of any disease under treatment did not correlate with SNS. Therefore, other possibilities should also be examined. Poor sleep may cause low tolerance during night shift. Poor sleep and low tolerance during night shift may make an individual perceive poor health. Thus, we can hypothesize an interactive causal relationship between poor health and SNS.

Morningness was a risk factor for SNS, in agreement with previous studies[13, 14]. Eveningness correlated with late wake-up time and long time in bed, whereas those who classified themselves as being more of the morning type seem to have difficulty in initiating and maintaining day sleep (Table 4). It is interesting that the evening-type participants frequently had a nap in the afternoon or evening, although nap length was rather short. It appears that they can nap easily and efficiently to compensate for their day sleep. Since it is difficult to exclude the morning-type workers from shiftwork, they need to take care of other conditions that may contribute to SNS.

Although drinking alcoholic beverages appears to help in initiating sleep, this habit was associated with increased SNS (Tables 3 and 4). Habitual alcohol intake results in alcohol tolerance[43], which requires more alcohol for inducing pharmacological effects including sleep initiation[44]. Alcohol intake also increases the need for urination and causes intermittent waking, and consequently, may reduce the quantity and quality of sleep. As a result, habitual alcohol intake is associated with sleep disturbance and sleepiness[16–18, 45]. These previous findings agree with the findings of this study, suggesting that abstaining from alcoholic beverages before day sleep may be good for the sleep, and consequently, for preventing SNS. However, SNS did not correlate with the frequency of alcoholic consumption, suggesting that drinking alcoholic beverages before day sleep is specifically associated with the quantity/quality of day sleep.

Caffeine adversely affects sleep[19], although this is not evident in some population studies[16, 46]. Our findings suggest that abstaining from caffeine intake before day sleep may be good for day sleep, and consequently for preventing SNS.

It was a new finding that having a bath before day sleep is associated with decreased SNS in the latter half of the night shift. It is probable that having a bath before day sleep facilitates good day sleep, and consequently, reduces the following SNS, because the correlation of this practice before night-sleep with good sleep has already been reported[21]. This possible effect should be confirmed in intervention studies. The reason why this practice was not associated with SNS1 should also be examined.

Perceiving more reward from work, job control, support from colleagues, and feeling suited to the job were inversely associated with SNS, particularly in the second half of the night shift (Table 3). Since these variables exhibited a moderately positive correlation with one another (r=0.31 to 0.66, data not shown), they should be discussed together. The above associations with SNS confirm the previous findings among day workers[17, 26–31], and shift workers[31–33]. Job control, reward from work, and suitability to the job were associated with infrequent sleep disturbance (Table 4). Since these work conditions are modifiers of job stress[34, 35], their insufficiency may induce shiftworkers' stress, persistent thought about work[31], and sleep disturbance. According to the job demand-control-support model[34] or the effort-reward imbalance model[35], the effects of these work conditions on occupational stress is particularly large when job demand is large. This buffering effect may explain why reward from work and support from colleagues were particularly associated with SNS2 in the time zone when sleepiness is highest. It is also probable that the above positive work conditions directly stimulate workers during night shift and reduce SNS. However, we cannot argue whether workload (job demand) affects SNS, because workload was almost uniform among our participants, and we did not assess the perceived workload. Another possibility is that feeling unsuited to the job is the results of disadaptation to shiftwork shown by high SNS2 in the time zone when sleepiness is highest.

Although previous researchers showed that age[10–12], physical exercise[47], and smoking[17] were associated with SNS, this was not confirmed in this study. Since our participants were relatively young (Table 1), the effects of ageing on sleep might be unclear. However, we cannot exclude the possibility of healthy workers effect. We did not specifically differentiate the time of taking physical exercise or smoking. The effects of exercise or smoking on day sleep or SNS in a night-shift week may depend on the time of the day. It is also probable that our participants abstained from exercise that was intensive enough to result in good sleep, because this study was conducted in late summer.

This study has some limitations as follows. Since this study was cross-sectionally designed, we cannot determine the causality among the above discussed variables. The second limitation is that our subjects were a small male sample from a plant. However, the uniformity of their workload contributed to analyzing the relationship between sleepiness and perceived job environment other than workload. Further research is needed to examine whether the current findings could

be generalized to different groups of shiftworkers. The third limitation was that the measures used in this study were self-reported, although they were already validated scales. In addition to the above limitations, we did not assess depressive symptoms in this study. Since depression or affective disorders disrupt individuals' sleep and cause excessive sleepiness[48], these symptoms should be taken into account in the future.

Despite these limitations, our findings present important clues to promoting sleep health among shiftworkers. The associations of nPSM practices with SNS help in developing a sleep health education program to obtain good sleep and to prevent excessive SNS among shiftworkers[21]. This program may be carried out at less cost by occupational health staff members without prescribing hypnotics[22–24]. The association of job environment with SNS suggests that systematic management of job stress may be a countermeasure against SNS as a result. These hypotheses should be examined in the future.

Acknowledgements

We are grateful to the staff members of the Occupational Health and Safety Center of the plant, and also to the participants. This study was partially supported by a Grant-in-Aid for Scientific Research (No. 21592868) from the Ministry of Education, Culture, Sports, Sciences, and Technology in Japan. Part of this study was presented at the 83rd Annual Meeting of the Japanese Society of Occupational Health, Fukui, on May, 2010.

References

1) Rajaratnam SM, Arendt J (2001) Health in a 24-h society. Lancet **358**, 999–1005.
2) Åkerstedt T, Kenneth PWJ (2009) Sleep loss and fatigue in shift work and shift work disorder. Sleep Med Clin **4**, 257–71.
3) Soldatos CR, Allaert FA, Ohta T, Dikeos DG (2005) How do individuals sleep around the world? Results from a single-day survey in ten countries. Sleep Med **11**, 339–46.
4) Kaneita Y, Uchiyama M, Takemura S, Yokoyama E, Miyake T, Harano S, Asai T, Tsutsui T, Kaneko A, Nakamura H, Ohida T (2008) Use of alcohol and hypnotic medication as aid to sleep among the Japanese general population. Sleep Med **8**, 723–32.
5) Muecke S (2005) Effects of rotating night shifts: literature review. J Adv Nurs **50**, 433–9.
6) Åkerstedt T, Ingre M, Broman JE, Kecklund G (2008) Disturbed sleep in shiftworkers, day workers, and insomniacs. Chronobiol Int **25**, 333–48.
7) Ohayon MM, Smolensky MH, Roth T (2010) Consequences of shiftworking on sleep duration, sleepiness, and sleep attacks. Chronobiol Int **27**, 575–89.
8) Åkerstedt T, Kecklund G, Gillberg M (2007) Sleep and sleepiness in relation to stress and displaced work hours. Physiol Behav **92**, 250–5.
9) Bonnefond A, Tassi P, Roge J, Muzet A (2004) A critical review of techniques aiming at enhancing and sustaining worker's alertness during the night shift. Ind Health **42**, 1–14.
10) Costa G (2003) Shiftwork and occupational medicine: an overview. Occup Med **53**, 83–8.
11) Gander P, Signal L (2008) Who is too old for shiftwork? Developing better criteria. Chronobiol Int **25**, 199–213.
12) Conway PM, Campnin P, Sartori S, Dotti R, Costa G (2008) Main and interactive effects of shiftwork, age and work stress on health in an Italian sample of healthcare workers. Appl Ergon **39**, 630–9.
13) Härmä M (1993) Individual difference in tolerance to shiftwork: a review. Erogonomics **36**, 101–9.
14) Takahashi M, Tanigawa T, Tachibana N, Mutou K, Kage Y, Smith L, Iso H (2005) Modifying effects of perceived adaptation to shiftwork on health, wellbeing and alertness on the job among nuclear power plant operators. Ind Health **43**, 171–8.
15) Ursin R, Baste V, Moen BE (2009) Sleep duration and sleep-related problems in different occupations in the Hordland health study. Scand J Work Environ Health **35**, 193–202.
16) Jefferson CD, Drake CL, Scofield HM, Myers E, McClure T, Roehrs T, Roth T (2005) Sleep hygiene practices in a population-based sample of insomniacs. Sleep **28**, 611–5.
17) Härmä M, Tenkanen L, Sjoblom T, Alukoski T, Heinsalmi P (1998) Combined effects of shift work and lifestyle on the prevalence of insomnia, sleep deprivation and daytime sleepiness. Scand J Work Environ Health **24**, 300–7.
18) Takamatsu S, Sekine M, Tatsuse T, Kagamimori S (2010) Alcohol drinking patterns and sleep quality of Japanese civil servants. San Ei Shi **52**, 1–11 (in Japanese with English abstract).
19) Sin CWM, Ho JSC, Chung JWY (2008) Systematic review on the effectiveness of caffeine abstinence on the quality of sleep. J Clin Nurs **18**, 13–21.
20) Nachreiner F (1998) Individual and social determinants of shiftwork tolerance. Scand J Work Environ Health **24**(Suppl 3), 35–42.
21) Aritake-Okada S, Kaneita Y, Uchiyama M, Ohida T (2009) Nonpharmacological self-management of sleep among the Japanese general population. J Clin Sleep Med **15**, 464–9.
22) Yamatsu K, Adachi Y, Kunitsuka K, Yamagami T (2004) Self-monitoring and bibliotherapy in brief behavior therapy for poor sleepers by correspondence. Sleep

Biol Rhythms **2**, 73–5.
23) Adachi Y, Sato C, Kunitsuka K, Hayama J, Doi Y (2008) A brief behavior therapy administered by correspondence improves sleep and sleep-related behavior in poor sleepers. Sleep Biol Rhythms **6**, 16–21.
24) Adachi Y, Kunitsuka K, Taniyama K, Hayashi C, Tanaka M, Sato C (2010) Non-face-to-face sleep improvement program in a workplace: bibliotherapy with and without behavioral self-control procedure. San Ei Shi **52**, 276–84.
25) Ingre M, Kecklund G, Åkerstedt T, Sodestrom M, Kecklund L (2008) Sleep length as a function of morning shift-start time in irregular shift schedules for train drivers: self-rated health and individual differences. Chronobiol Int **25**, 349–58.
26) Kageyama T, Nishikido N, Kobayashi T, Oga J, Kawashima M (2001) Cross-sectional survey on risk factors for insomnia in Japanese female hospital nurses working rapidly rotating shift systems. J Human Ergol **30**, 149–54.
27) Smith L, Tanigawa T, Takahashi M, Mutou K, Tachibana N, Kage Y, Iso H (2005) Shiftwork locus of control, situational and behavioral effects on sleepiness and fatigue in shiftworkers. Ind Health **43**, 151–70.
28) Kupperman M, Lubeck DP, Mazonson PD, Patrick DL, Stewart AL, Buesching DP, Fifer SK (1995) Sleep problems and their correlates in a working population. J Gen Int Med **10**, 25–32.
29) Pelfrene E, Vlerick P, Kittel F, Mark RP, Kornitzer M, Backer GD (2002) Psychosocial work environment and psychological well-being: assessment of the buffering effects in the job demand-control (-support) model in BELSTRESS. Stress Health **18**, 43–56.
30) Nakata A, Haratani T, Takahashi M, Kawakami N, Arito H, Kobayashi F, Araki S (2004) Job stress, social support and prevalence of insomnia in a population of Japanese daytime workers. Soc Sci Med **59**, 1719–30.
31) Åkerstedt T, Knutsson A, Westerholm P, Theorell T, Alfredsson L, Kecklund G (2002) Sleep disturbance, work stress and work hours: a cross-sectional study. J Psychosoma Res **53**, 741–8.
32) Nakata A, Haratani T, Takahashi M, Kawakami N, Arito H, Fujioka Y, Shimizu H, Kobayashi Y, Araki S (2001) Job stress, social support at work, and insomnia in Japanese shift workers. J Human Ergol **30**, 203–9.
33) Takahashi M, Nakata A, Haratani T, Otsuka Y, Kaida K, Fukasawa K (2006) Psychosocial work characteristics predicting daytime sleepiness in day and shift workers. Chronobiol Int **23**, 1409–22.
34) Karasek R, Theorell T (1990) Healthy work: stress, productivity, and the reconstruction of working life. Basic Books, New York.
35) Siegrist J (1996) Adverse health effects of high-effort/low-reward conditions. J Occup Health Psychol **1**, 27–41.
36) Nishikido N, Kageyama T, Kobayashi T, Haratani T (2000) Assessment of job stress using a brief questionnaire: its relations to depression among male workers of an information processing company. Occup Ment Health **8**, 73–82.
37) Kato M (Ed.) (2000) Research report on occupational stress and its effects on health. pp.117–64, Department of Public Health, Tokyo Medical University, Tokyo.
38) Karasek R (1985) Job Content Questionnaire and Users' Guide. University of Massachusetts at Lowell, Lowell.
39) Kawakami N, Kobayashi F, Araki S, Haratani T, Furui H (1995) Assessment of job stress dimensions based on the job demands-control model of employees of telecommunication and electric power companies in Japan: reliability and validity of the Japanese version of the Job Content Questionnaire. Int J Behav Med **2**, 358–75.
40) Folkard S, Spelton E, Totterdell P, Barton J, Smith L (1995) The use of survey measures to assess circadian variations in alertness. Sleep **18**, 355–61.
41) Folkard S, Barton J (1993) Does the 'forbidden zone' for sleep onset influence morning shift sleep duration? Ergonomics **36**, 85–91.
42) Kageyama T, Kabuto M, Nitta H, Kurokawa Y, Taira K, Suzuki S, Takemoto T (1997) A population study on risk factors for insomnia among adult Japanese women: a possible effect of road traffic volume. Sleep **20**, 963–7.
43) Roehrs TA, Blasidell B, Cruz N, Roth T (2004) Tolerance to ethanol's effects in insomniacs. Sleep **27**, A52.
44) Roehrs TA, Blaisdell B, Richardson G, Roth T (2003) Insomnia as a path to alcoholism: dose escalation. Sleep **26**, A307.
45) Roehrs TA, Roth T (2001) Sleep, sleepiness, sleep disorders and alcohol use and abuse. Sleep Med Rev **5**, 287–97.
46) Sanches-Ortuno M, Moore N, Taillard J, Valtat C, Leger D, Bioulac B, Philip P (2005) Sleep duration and caffeine consumption in a French middle-aged working population. Sleep Med **6**, 247–51.
47) Thorpy MJ (2010) Managing the patients with shift-worker disorder. J Fam Pract **59** (Suppl 1), S24–31.
48) Peterson MJ, Benca RM (2006) Sleep in mood disorders. Psychiatr Clin North Am **29**, 1009–32.