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Health-related behaviors associated with subjective sleep insufficiency in Japanese workers: A cross-sectional study

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Abstract: Objectives: Sleep disturbances are related to somatic and mental disorders, industrial accidents, absenteeism, and retirement because of disability. We aimed to identify health-related behaviors associated with subjective sleep insufficiency in Japanese workers. **Methods:** This cross-sectional study included 5,297 employees (mean age: 43.6 ± 11.3 years; 4,039 men). Multiple logistic regression analysis was used to identify health-related behaviors associated with subjective sleep insufficiency. **Results:** Overall, 28.2% of participants experienced subjective sleep insufficiency. There was a significant difference between the genders in the proportion of participants with subjective sleep insufficiency (male: 26.4%; female: 34.3%; p<0.001). Multiple logistic regression analysis revealed that being a female or ≥40 years, experiencing a weight change of ≥3 kg during the preceding year, not exercising regularly, not walking quickly, and eating a late-evening or fourth meal were associated with subjective sleep insufficiency. After stratifying by gender, age ≥40 years, not exercising regularly, and eating a late-evening or fourth meal were significantly associated with subjective sleep insufficiency in both genders. Not walking quickly, experiencing a weight change, and eating quickly were positively associated with subjective sleep insufficiency only for males. Females who did not engage in physical activity were more likely to have experienced subjective sleep insufficiency, but this relationship was not observed in males. **Conclusions:** The results indicated that certain health-related behaviors, specifically not exercising regularly and nocturnal eating habits, were associated with subjective sleep insufficiency in a group of Japanese workers.

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Introduction

During the past two decades, there have been notable changes in working styles in Japan, such as a trend toward more shift work, flexible work schedules, discretionary labor system, and irregular working hours. The proportion of nighttime workers has increased to 21.8% and the annual average number of working hours in Japan was higher than that in the majority of western European countries as of 2012[1,2]. The duration of sleep among Japanese workers was the shortest among workers worldwide in 2012[3]. Insomnia and short sleep (also known as sleep insufficiency) contribute to a wide range of detrimental health effects[4-8]. Several epidemiological studies have revealed that sleep insufficiency is associated with mental disorders, industrial and traffic accidents, absenteeism, and retirement because of disability[9-12]. Sleep insufficiency and sleep disorders are considered to be among the most important health issues in Japan, especially in occupational settings.

Health-related behaviors, such as exercise, physical activity, alcohol consumption, body mass index (BMI), and demographic characteristics, including age and gender, are associated with sleep insufficiency[13,14]. Brief and low-intensity exercise, for instance, causes a rise in core body temperature and improves sleep quality[15]. In contrast, eating immediately before bedtime impairs peripheral circadian clocks, leading to poor sleep quality[16]. However, few epidemiological studies have investigated the demographic characteristics and health-related behaviors associated with subjective sleep insufficiency (feeling of inef-

ficient sleep) in large samples of full-time workers. We hypothesized that workers' daily behaviors would be associated with subjective sleep insufficiency. Thus, we aimed to reveal whether and which behaviors and demographic characteristics would be associated with subjective sleep insufficiency in Japanese workers.

Subjects and Methods

Study design and participants

At the Yamaha Health Care Center in Hamamatsu, Japan, we conducted a cross-sectional study to investigate the relationship between subjective sleep sufficiency and health-related behaviors in Japanese workers. Most of the participants were employees of manufacturing companies in Hamamatsu. The Japanese Industrial Safety and Health Law requires employers to conduct annual health examinations of all their employees. Our study used routinely collected data from these examinations.

Data collection

Participants were required to complete a self-administered, standardized questionnaire during their health examination. They answered all questionnaires subjectively. The study variables included subjective sleep insufficiency and 11 health-related behaviors, including smoking (never, former, or current smoker), weight gain (≥10 kg since 20 years), regular exercise (exercising ≥2 days/wk, for ≥30 minutes during the previous year), physical activity (walking ≥1 hour everyday or equivalent physical activity), walking speed (walking more quickly than people of your age and gender), weight change (gain or loss of ≥3 kg during the last year), eating speed (slow, moderate, or fast), eating a late-evening meal (≤2 hours before bedtime ≥3 days/wk), eating a fourth meal (after the evening meal for ≥3 days/wk), skipping breakfast (≥3 days/wk), and alcohol consumption (rare, sometimes, or everyday). Participants who did not feel refreshed after a night's sleep were considered to have "subjective sleep insufficiency."

Statistical analysis

Chi-square tests were conducted to compare the prevalence of subjective sleep sufficiency between the genders and the prevalence of health-related behaviors between participants reporting subjective sleep sufficiency and those reporting subjective sleep insufficiency. The relationships among each health behavior, age, gender, and subjective sleep insufficiency were estimated using the odds ratio (OR) and 95% confidence interval (CI) obtained from univariate logistic regression models. Confounding factors were assessed using a stepwise method by including variables that were statistically significant in the univariate regression analysis in multivariate logistic regression models. Multicollinearity was assessed using the variance inflation factors for each variable. P-values <0.05 were considered to be statistically significant. Data analysis was conducted using EZR, version 1.32[17].

Ethics statement

The study protocol complied with the recommendations in the Declaration of Helsinki (1964, revised 1975, 1983, 1989, 1996, 2000, 2002, 2004, 2008, and 2013). The ethics committee of the Yamaha Health Insurance Society approved this study. The committee waived the requirement of obtaining informed consent from participants because the study was a retrospective observational analysis. Use of the "opt-out" approach to consent was approved. A written explanation of the use of data from clinical investigations was provided on the websites of participating companies. Participants did not provide written informed consent but were allowed to decline participation; none declined participation. Health examination data were downloaded, without personally identifiable information, from an electronic database.

Results

Sample description and prevalence of subjective sleep insufficiency

A total of 5,308 employees who underwent general health examinations between January and December 2014 were enrolled in the study. The examination response rate was 95.4% of employees for whom the examination was mandatory. All 5,308 individuals filled out at least part of the questionnaire (valid response rate: 100%), but eight males and three females who did not complete the questionnaire were excluded. Our analysis included 5,297 participants (4,039 males and 1,258 females) with complete data on all of the health-related behaviors. The age of study participants ranged from 18 to 73 years with a mean and standard deviation of 43.6 ± 11.3 years. Overall, the proportion of participants found to have subjective sleep insufficiency was 28.2%. There was a significant gender difference in the proportion of participants with subjective sleep insufficiency (males: 26.4%; females: 34.3%; p <0.001). Fig. 1 shows the proportion of participants with subjective sleep insufficiency by age and gender. Participants were divided into six age groups (n, % with subjective sleep insufficiency): ≤19 (n=7, 14.3%), 20-29 (n=720, 23.1%), 30-39 (n=1,226, 23.9%), 40-49 (n=1,540, 33.6%), 50-59 (n=1,519, 30.5%), and ≥60 (n=292, 20.5%) years. The number (% with subjective sleep insufficiency) of males and females in each age group was 5 (20.0%) and 2 (0%) ≤19, 480 (21.7%) and 230 (26.1%) 20-29, 974 (23.0%) and 252 (27.4%) 30-39, 1,164 (32.0%) and 376 (38.6%) 40-49, 1,152 (27.3%) and 367 (40.9%) 50-59, and 264 (19.7%) and 31 (25.8%) ≥60 years, respectively. Of the participants, females in their 40s and 50s were significantly and highly significantly

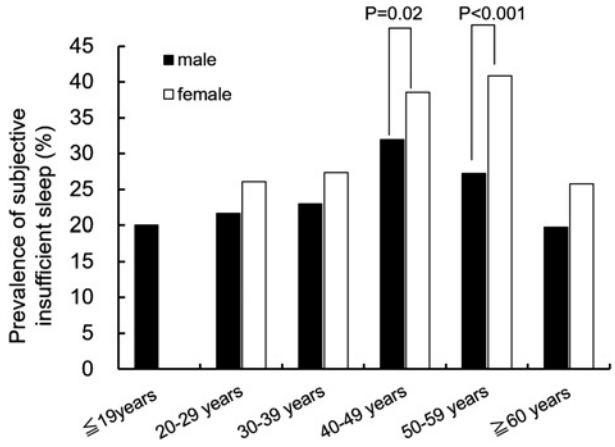

Fig. 1. Prevalence of subjective sleep insufficiency by gender and age (n=5,297). Chi-squared tests were conducted.

more likely to have subjective sleep insufficiency than males in the same age ranges ($p=0.02$ and $p<0.001$, respectively).

Comparison of health-related behaviors between subjective sleep sufficiency and insufficiency

Table 1 shows a comparison of the prevalence of participants who engaged in several health-related behaviors as shown between participants reporting subjective sleep sufficiency and those reporting subjective sleep insufficiency. Participants with subjective sleep sufficiency were more likely to engage in regular exercise, engage in physical activities, and walk quickly as compared with participants with subjective sleep insufficiency. However, participants with subjective sleep insufficiency were more likely to have gained weight, experience weight changes, and eat a late-evening or fourth meal. Variation between the genders was found in the differences in engagement in several health-related behaviors between those with and without subjective sleep insufficiency (Table 1). Among males, participants with subjective sleep insufficiency were more likely to be current smokers, have gained weight, experience weight changes, not walk quickly, and eat quickly, whereas these relationships were not observed in females. In contrast, participants with subjective sleep insufficiency were more likely to engage in physical activities and eat a late-evening or fourth meal than those with subjective sleep sufficiency in both genders.

Associations between subjective sleep insufficiency and health-related behaviors

We used univariate and multivariate logistic regression analyses to identify health-related behaviors associated with subjective sleep insufficiency (Table 2). In the univariate analysis, participants who were females or ≥40 years, did not engage in regular exercise or physical activity, and did not walk quickly were more likely to have subjective sleep insufficiency. Participants who gained weight, experienced weight change, and ate a late-evening or fourth meal were also more likely to have subjective sleep insufficiency in that analysis. After stepwise variable selection, the final multiple logistic regression model indicated that participants who were females, ≥40 years, experienced weight change, did not engage in regular exercise, did not walk quickly, and ate a late-evening or fourth meal were more likely to have subjective sleep insufficiency.

At last, we performed a subanalysis to identify health-related behaviors associated with subjective sleep insufficiency in each gender. This was because females were selected as independent variables associated with subjective sleep insufficiency. In the models for both genders, participants who were ≥40 years, did not engage in regular exercise, and ate a late-evening or fourth meal were more likely to have subjective sleep insufficiency. Among males, participants who were ≥40 years, experienced weight change, did not engage in regular exercise, did not walk quickly, ate a late-evening or fourth meal, and ate quickly were more likely to have subjective sleep insufficiency. Among females, participants who were ≥40 years, did not engage in regular exercise or physical activity, and ate a late-evening or fourth meal were more likely to have subjective sleep insufficiency.

Discussion

This study identified health-related behaviors and demographic characteristics associated with subjective sleep insufficiency in a large sample of Japanese employees. The results showed the following points: (1) Females and those aged ≥40 years, who had gained weight, experienced weight changes, did not exercise regularly, did not walk quickly, and ate a late-evening or fourth meal were more likely to have subjective sleep insufficiency; and (2) gender differences in which health-related behaviors were independently associated with subjective sleep insufficiency were also prevalent.

Consistent with previous studies, we found that inadequate activity (not engaged in regular exercise) and not walking quickly (which might indicate inferior muscle strength) were independently associated with subjective sleep insufficiency among all participants. In previous studies, a positive association was observed between exercise and sleep quality[18,19]. Exercise has been proposed as a means of improving sleep quality through providing central nervous system fatigue, body temperature elevation, and stress reduction[20]. The present study also determined a positive association between exercise and sleep sufficiency, irrespective of the participant's gender. We generally believe that the intensity and volume of exercise may affect sleep sufficiency and this may also depend on the type of exercise[21]. Wang et al. showed that moderate-

Table 1. Comparison of the prevalence of health-related behaviors between participants reporting subjective sleep sufficiency and those reporting subjective sleep insufficiency

	Total (n=5,297)			Male (n=4,039)			Female (n=1,258)		
Health-related behaviors	Subjective sleep sufficiency (n=3,798)	Subjective sleep insufficiency (n=1,499)	p-value[a]	Subjective sleep sufficiency (n=2,972)	Subjective sleep insufficiency (n=1,067)	p-value[a]	Subjective sleep sufficiency (n=826)	Subjective sleep insufficiency (n=432)	p-value[a]
Current smoker, n (%)	704 (18.5%)	295 (19.7%)	0.349	667 (22.4%)	272 (25.5%)	0.047	37 (4.5%)	23 (5.3%)	0.490
Weight gain, n (%)	1,038 (27.3%)	468 (31.2%)	0.005	926 (31.2%)	298 (37.3%)	<0.001	112 (13.6%)	70 (16.2%)	0.206
Regular exercise, n (%)	929 (24.5%)	293 (19.5%)	<0.001	813 (27.4%)	251 (23.5%)	0.015	116 (14.0%)	42 (9.7%)	0.031
Physical activity, n (%)	1,452 (38.2%)	488 (32.6%)	<0.001	1,200 (40.4%)	389 (36.5%)	0.026	252 (30.5%)	99 (22.9%)	0.004
Walking quickly, n (%)	2,097 (55.2%)	741 (49.4%)	<0.001	1,716 (57.7%)	554 (51.9%)	0.001	381 (46.1%)	187 (43.3%)	0.341
Weight change, n (%)	903 (23.8%)	420 (28.0%)	0.002	715 (24.1%)	318 (29.8%)	<0.001	188 (22.8%)	102 (23.6%)	0.778
Eating quickly, n (%)	998 (26.3%)	429 (28.6%)	0.086	842 (28.3%)	355 (33.3%)	0.002	156 (18.9%)	74 (17.1%)	0.490
Late evening meal, n (%)	1,102 (29.0%)	528 (35.2%)	<0.001	926 (31.2%)	395 (37.0%)	<0.001	176 (21.3%)	133 (30.8%)	<0.001
Fourth meal, n (%)	482 (12.7%)	284 (18.9%)	<0.001	358 (12.0%)	194 (18.2%)	<0.001	124 (15.0%)	90 (20.8%)	0.011
Skipping breakfast, n (%)	381 (10.0%)	168 (11.2%)	0.211	322 (10.8%)	134 (12.6%)	0.128	59 (7.1%)	34 (7.9%)	0.651
Alcohol consumption, n (%)	778 (20.5%)	301 (20.1%)	0.762	727 (24.5%)	273 (25.6%)	0.482	51 (6.2%)	28 (6.5%)	0.808

Data are expressed as number (%).

[a] Chi-squared tests were used to compare the prevalence of health-related behaviors between participants reporting subjective sleep sufficiency and those reporting subjective sleep insufficiency.

intensity exercise improved sleep quality, while light-intensity exercise did not have a statistically significant advantage over no exercise at all, and suggested that an increased intensity of exercise may improve sleep quality in older adults[22]. However, many studies found no difference among the effects on sleep of exercise at various intensities or volumes[23,24]. In this study, walking quickly, which may be indicative of lower muscle strength, and physical activity, also related to sleep sufficiency, although specific intensities and volumes that have a positive correlation are unclear. Furthermore, it is noteworthy that not only exercise but also normal physical activity, such as working, may have some impact on sleep. Working conditions, such as long hours and shift work, could interrupt regular exercise habits of workers. This study does not extend to information about intensity or certain amounts of exercise, or to working environments. Such information is important for identifying factors interrupting exercise habits of workers. Future research could examine such effects and populations.

Nocturnal eating habits, such as having a late-evening or fourth meal, were independently associated with subjective sleep insufficiency in all participants. One study reported that food intake near the sleeping period was negatively correlated with sleep quality, such as sleep efficiency, latency, and rapid eye movement sleep latency[16]. In addition to eating time, dietary macronutrient composition may also relate to sleep insufficiency. Another study showed an association between a high-fat dinner and persistently short sleep duration[25]. Our result is in line with these findings. As we do not have any data on macronutrient composition in nocturnal food intake, we could not determine whether this influences subjective sleep insufficiency. Another study determined that protein and carbohydrate intake in daily diet was associated with insomnia; however, no such association was determined with fat intake[26]. Although we could not reach a conclusion on the impact of macronutrient composition on sleep, diet is an important behavioral factor that may influence sleep insufficiency.

Short sleep duration reflects nocturnal eating habits. A previous intervention study showed that sleep restriction

Table 2. Odds ratio (OR) and 95% confidence interval (CI) for subjective sleep insufficiency by sex, age, and health-related behaviors

Independent variable		Univariate analysis		Multivariate analysis[a]					
		Total (n=5,297)		Total (n=5,297)		Male (n=4,039)		Female (n=1,258)	
		OR (95% CI)	p-value[b]	OR (95% CI)	p-value[c]	OR (95% CI)	p-value[c]	OR (95% CI)	p-value[c]
Sex	Male	reference		reference					
	Female	1.46 (1.27-1.67)	<0.001	1.43 (1.24-1.64)	<0.001				
Age	<40 years	reference		reference		reference		reference	
	≥40 years	1.46 (1.28-1.66)	<0.001	1.54 (1.35-1.75)	<0.001	1.45 (1.24-1.69)	<0.001	1.78 (1.38-2.29)	<0.001
Smoking status	Current smoker	reference							
	Never or former smoker	0.93 (0.80-1.08)	0.349						
Weight gain	Yes	reference							
	No	0.83 (0.73-0.95)	0.005						
Weight change	Yes	reference		reference		reference			
	No	0.80 (0.69-0.92)	0.002	0.78 (0.68-0.89)	<0.001	0.76 (0.65-0.89)	<0.001		
Regular exercise	Yes	reference		reference		reference		reference	
	No	1.33 (1.14-1.55)	<0.001	1.28 (1.10-1.49)	0.001	1.23 (1.04-1.46)	0.013	1.53 (1.04-2.26)	0.031
Physical activity	Yes	reference						reference	
	No	1.28 (1.13-1.46)	<0.001					1.35 (1.02-1.78)	0.036
Walking quickly	Yes	reference		reference		reference			
	No	1.26 (1.12-1.42)	<0.001	1.21 (1.07-1.37)	0.002	1.28 (1.11-1.48)	<0.001		
Late evening meal	Yes	reference		reference		reference		reference	
	No	0.75 (0.66-0.86)	<0.001	0.76 (0.67-0.86)	<0.001	0.82 (0.70-0.95)	0.007	0.61 (0.49-0.80)	<0.001
Fourth meal	Yes	reference		reference		reference		reference	
	No	0.62 (0.53-0.73)	<0.001	0.64 (0.64-0.88)	<0.001	0.62 (0.51-0.76)	<0.001	0.72 (0.53-0.99)	0.040
Eating quickly	Yes	reference				reference			
	No	0.89 (0.77-1.02)	0.086			0.81 (0.70-0.95)	0.009		
Skipping breakfast	Yes	reference							
	No	0.88 (0.73-1.08)	0.211						
Alcohol consumption	Everyday	reference							
	Sometimes or rarely	1.03 (0.88-1.19)	0.762						

[a] Variables that were statistically significant in the univariate logistic regression were analyzed.
[b] Chi-squared tests were conducted.
[c] Multivariate stepwise logistic regression was conducted.

increased food intake late in the evening, especially when following dinner[27]. Another study established that short sleep duration increased serum ghrelin and reduced serum leptin[6], which leads to increased appetite. Although eating habits (e.g., late-evening meals, fourth meals, and breakfast skipping) and alcohol intake evidently influ-

enced sleep in previous studies[13,28], no effects of alcohol intake and breakfast skipping on subjective sleep insufficiency were observed in this study. This inconsistency maybe due to differences in socioeconomic backgrounds as seen in factors, such as work hours, family structure, and differing definitions of short sleep.

It is noteworthy that nocturnal eating habits were related to sleep insufficiency for workers irrespective of gender in this study. Our results indicated that weight gain and weight changes, which were supposed to be associated with increased unhealthy eating habits, were also found to have statistically significant relationships with insufficient sleep. We found a statistically significant association between eating quickly and subjective sleep insufficiency only among males. Consideration of the mechanism underlying the negative influence of eating quickly on sleep for males was beyond the scope of this study, but we speculate that lack of control of work conditions may cause greater stress among males than females. In sum, eating habits appear especially important with regard to sleep-related lifestyle issues for all study participants.

We found gender and age differences in the prevalence of subjective sleep insufficiency. Many studies, after accounting for gender differences, have revealed that sleep disturbances and short sleep durations were associated with age[14,29,30]. In this study, females were more likely to have subjective sleep insufficiency than males in nearly all age groups. The prevalence of subjective sleep insufficiency was lower for males in their 50s than for those in their 40s but higher among females in their 50s than among those in their 40s. For those in their 60s, the prevalence of subjective sleep insufficiency also tended to be higher among females; however, it did not reach a statistically significant level because of the small number of participants in this age group. Females usually enter menopause in their mid-40s to mid-50s. A previous study reported that female sex hormones affect sleep during these periods[31]. In females, estrogen strongly affects several biological factors that directly influence sleep, including body temperature regulation, circadian rhythms, and stress reactivity[32]. Decreased estradiol was found to be associated with self-reported sleep disturbances[33]. In contrast, other studies have shown that menopause does not contribute to sleep disturbance[34]. Depression and anxiety are common during menopause[35] and both have been found to contribute to sleep disturbance. The effects of age-related changes and female reproductive hormones on sleep problems have yet to be definitively clarified. As we had no data on the menopausal status, we could not determine the most plausible mechanism. Human sleep occurs with circadian periodicity, and variation in hormones related to the menstrual cycle may contribute to cyclical sleep disturbance in females[36]. We also lacked data on work contents for males and females; moreover, this factor could present confounding variables that affect sleep insufficiency.

Our study had several limitations. First, self-reported subjective sleep insufficiency and other health-related behaviors may be subject to misclassification bias. In addition, we could not evaluate the association between objective sleep insufficiency and health-related behaviors. Second, reports of subjective sleep insufficiency may not be consistent with actual sleep duration and quality. Previous studies have indicated that inferior sleep measured by polysomnography in males was not always correlated with subjective sleep assessments[37]. Furthermore, female participants currently in menopause were two to four times more likely to complain of sleep deficiency than non-menopausal females, while in a study using polysomnography as an objective evaluation, no differences were observed between relevant states of females before and after menopause[38]. Although subjective observation of sleep does not directly correspond with objective monitoring, it has some advantages. Our self-administered questionnaire was used in annual health examinations of all employees, which allowed us to collect large amounts of data without extensive effort by the study participants. Moreover, assessment of subjective sleep quality is a common practice for evaluating the relationship between sleep disorders and mental illnesses. Third, we did not examine individual or combined effects of work schedules, occupational categories, and work settings—which varied greatly in our sample—on subjective sleep insufficiency. Work schedules and occupational categories may influence health-related behaviors, such as physical activity levels during work and the timing and duration of meals. Further research should assess the relationship between sleep insufficiency and occupational classification.

At last, biological or social factors outside the scope of this study may be associated with sleep. Although etiologic relationships are unclear, our results suggest that preferentially education of people likely to experience sleep disturbances—because of their age, gender, or health-related behaviors—on their risk factors could be conducted in workplaces to improve employee health.

In conclusion, we found that older age, female gender, physical inactivity, and nocturnal eating habits were independently associated with subjective sleep insufficiency in a sizeable group of Japanese workers. The effects of workplace health educational interventions on insufficient sleep should be examined in a future longitudinal study.

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