〔Original〕

Shift-Work Disorder and Sleep-Related Environmental Factors in the Manufacturing Industry

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Abstract **:** The aim of this study was to examine the relationship between shift-work disorder (SWD) and environmental and somatic factors related to falling asleep among rapidly rotating shift workers in a manufacturing industry. A total of 556 male workers were recruited to complete a self-administered questionnaire regarding age, shift work experience, lifestyle, and family structure; the Epworth sleepiness scale (ESS); the Pittsburgh sleep quality index (PSQI); and the Horne and Ostberg questionnaire, a questionnaire for environmental and somatic factors related to falling asleep. We classified workers according to having SWD or not, and compared workers with SWD with those without this disorder in terms of all items covered in the aforementioned questionnaires. A total of 208 workers (62.8%) working rapidly rotating shifts were diagnosed with SWD. The ESS and PSQI scores and scores for environmental and somatic factors were significantly higher in workers with SWD than in those without this disorder. The ESS scores and scores for environmental and somatic factors were also associated with SWD in the logistic regression analyses. We suggest that susceptibility to SWD in the manufacturing industry may be associated with environmental and somatic factors related to falling asleep.

Keywords **:** shift-work disorder, sleepiness, sleep environment.

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Introduction

In Japan, 18.6% of workers are engaged in shift work (shift workers) [1], with 9.2% of shift workers working on the midnight shift. Many shift workers experience excessive sleepiness while working at night and insomnia during the day, when they should be sleeping after working at night. This excessive sleepiness and insomnia interfere with the performance of night work, often resulting in them having to quit night work [2]. The sleep disturbance experienced by shift workers is known as "shift-work disorder" (SWD) [3]. The international classification of sleep disorders (ICSD-2) issued the following diagnostic criteria for SWD: 1) complaints of insomnia or excessive sleepiness that are temporally associated with a recurring work schedule that overlaps with the usual time for sleep, 2) symptoms must be associated with the shift-work schedule over the course of at least 1 month, 3) circadian and sleep-time misalignment, as demonstrated by sleep logs or actigraphical monitoring for 7 days or more and 4) the sleep disturbance cannot be explained by another sleep disorder, a medical disorder, neurological disorder, mental disorder, or medication, or use of other substances. Several studies of the prevalence of SWD in shift workers have been conducted [4–8]. Drake CL *et al*. [4] and Di Milia L *et al*. [5] reported that the prevalence of SWD was 26.1%

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and 32.1%, respectively, in mixed samples of different types of shift work schedules. Waage S *et al*. [6] found that the prevalence of SWD was 23.3% in shift workers following a slow rotating shift-work schedule that involved repeatedly working in the same factory during either the day or the night every 1 or 2 weeks. In Japan, the prevalence of SWD among nurses working in shift was 24.4% [7]. However, these nurses did not engage in continuous night work and could take a nap during night shifts.

We allowed for many shift workers in various industries in Japan tend to work two or three nights consecutively. We defined schedules involving two or three consecutive night shifts per week as a rapidly rotating shift work schedule. In the study similar to a rapidly rotating shift work schedule that we defined, Flo E *et al*. [8] reported that the prevalence of SWD was 37.6% among nurses. In contrast, research focused on industrial workers is not available, and sufficient attention has not been devoted to this issue. Previous studies have focused only on age, the distinction between morning and evening types, personality, and temperature as causes of individual differences in adaptation to shift work [2, 9−11]. However, almost no research related to the relationship between environmental and somatic factors (noise, room temperature, body pain, etc.) and SWD has been conducted.

The aim of this study was to examine the prevalence of SWD among rapidly rotating shift workers in the manufacturing industry, and the relationship between SWD and environmental and somatic factors related to falling asleep.

Methods

Subjects

651 male workers employed at a factory making base material for semiconductors were recruited to be participants in this study, which was conducted at the beginning of December 2010. Because few females worked in this factory, only male participants were recruited. Questionnaires were delivered to participants through their health support unit, and they were returned under sealed conditions. We excluded individuals undergoing psychiatric treatment and those with incomplete responses. A total of 556 workers were selected to participate in this study (response rate: 82.0%). The mean age of the participants was 42.0 years (SD = 8.8), and the age range was 20−62 years. A total of 193 (34.7%) workers permanently worked during the day (day workers), whereas 363 workers (65.3%) followed a rapidly rotating shift schedule (shift workers) (Table1).

The rapidly rotating shift schedule included two cycles, and different combinations of these two cycles formed two schedules (A and B). One cycle involved working from 8:30 to 17:45 for three consecutive days, followed by three consecutive night shifts lasting from 20:30 to 5:45 (workers did not work for 27 h between the day and night shifts), followed by 3 days off. The other cycle involved working for 3 consecutive days from 10:45 to 20:30, followed by working from 22:45 to 8:30 for 3 consecutive days, followed by 3 days off. The A schedule repeated the two cycles alternately (177 workers) and the B schedule repeated

Table 1. Characteristics of shift workers and day workers

Parameters	Shift workers n = 363 Mean ± SD	Day workers n = 193 Mean ± SD	*P*
Age (y)	39.6 ± 8.4	46.8 ± 6.9	< 0.001[a]
Smokers (%)	56.3	51.3	0.36[b]
Drinkers (%)	70.4	75.9	0.26[b]
Caffeinated drink (cups / day)	3.8 ± 2.1	3.6 ± 2.0	0.41[a]
rH&O score	14.7 ± 2.9	16.3 ± 3.4	< 0.001[a]
ESS score	8.1 ± 4.3	7.2 ± 3.8	0.02[a]
PSQI score	5.4 ± 2.4	4.8 ± 2.3	0.004[a]

rH&O: reduced Horne and Ostberg questionnaire, ESS: Epworth Sleepiness Scale, PSQI: Pittsburgh Sleep Quality Index, a: *t*-test, b: *chi*-square test, $P < 0.05$, SD: standard deviation only the former cycle (186 workers). We summarized the two schedules and evaluated SWD.

The Institutional Review Board of Miyazaki Medical College approved this study. Written informed consent was obtained from each participant.

Questionnaires

Background data

Participants completed questionnaires soliciting information regarding age, present smoking state (yes: every day or sometimes; no: never) and drinking habits (yes: every day or sometimes; no: never), caffeine intake per day, family structure, and shift work experience.

Shift-work disorder

We used three questions to detect SWD according to the aforementioned ICSD-2 definition [6]: (1) Do you experience difficulties with sleeping or experience excessive sleepiness? (yes or no), (2) Is the sleep or sleepiness problem related to a work schedule that involves working when you would normally sleep? (yes or no), (3) Have you had this sleep or sleepiness problem related to your work schedule for at least 1 month? (yes or no). These items were also used by Flo E *et al*. [8], who confirmed its ability for assessing SWD in epidemiological studies. Participants who responded "yes" to all three questions were classified as the SWD group. We also attempted to evaluate the severity of SWD with the following question: Do you think that the experience of difficulty in falling asleep or excessive sleepiness is always unpleasant? (yes or no). Participants who answered "yes" to all four questions were classified as the severe SWD group.

Circadian preference

We used the reduced Horne and Ostberg questionnaire (rH&O) [12] to divide participants into morning and evening types. The rH&O consists of five items derived from the Horne and Ostberg questionnaire [13]. High scores are associated with morning types. The validity and reliability of this scale have been confirmed [12].

Sleepiness evaluation

The sleepiness of shift workers and day workers at work was measured using the Japanese version of the Epworth Sleepiness Scale (ESS) [14], which consists of eight items rated on a scale from 0 to 3, yielding total scores between 0 and 24. A score of ≥ 11 may indicate excessive daytime sleepiness. The reliability and validity of the Japanese version of the ESS that we used have been confirmed [14].

Evaluation of sleep conditions

We used the Japanese version of the Pittsburgh Sleep Quality Index (PSQI) [15], an instrument with confirmed validity and reliability for Japanese samples, to evaluate quality of sleep. This questionnaire assesses the quality of sleep conditions and identifies sleep disorders during the previous month. It consists of seven questions concerning sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medications, and daytime insomnia. Each question is scored from 0 to 3, with total scores ranging from 0 to 21. A PSQI score > 5 may indicate the presence of a sleep disorder. However, as the PSQI may not be suitable for evaluation of workers following a rotating shift schedule, we asked shift workers to complete this questionnaire with regard to their day shift only. The Cronbach's alpha for this scale was 0.60 in the present study.

Environmental and somatic factors influencing sleep onset

Sleep is affected by complex interactions among various factors. We used the questionnaire developed by the National Institute of Mental Health, National Center of Neurology and Psychiatry [16] to evaluate psychological and somatic variables that affect falling asleep. This questionnaire has been shown to be valid and reliable among Japanese individuals. In this study, we used 11 items from this questionnaire (the Cronbach alpha was 0.89), and shift workers responded to each question about sleeping at night (working during the day) and sleeping during the day (working at night) separately. Five questions concern environmental factors, including temperature and humidity, noise, the smell and brightness of the bedroom, and outside noise and vibrations (e.g., "Do you worry about the temperature and humidity of your bedroom when you fall asleep?"). The remaining six questions pertain to body pain, body discomfort, limb jerks, hot flashes in the limbs, and anxiety (somatic factors) (e.g., "Do you feel a bodily pain when you fall asleep?"). Each question was answered on a four-point scale (1 = very much; 4 = not at all) and carried a different weight (Table 2). The average score on these questions was used as the score for environmental and somatic factors, and high scores indicated that these factors had a strong impact on falling asleep.

Table 2. Weighted scores for environmental and somatic factors related to falling asleep

Environmental and somatic factors	Score			
	4	3	2	1
Temperature & humidity	0	4	15	29
Brightness	0	10	23	38
Outside noise & vibration	0	9	19	33
Inside noise	0	10	22	37
Smell	0	5	18	34
Limb hot flash	0	11	21	34
Body pain	0	12	22	33
Body discomfort	0	12	24	38
Limb jerks	0	12	24	38
Anxiety	0	11	20	32
Bedroom environment	0	10	21	33

a four-point scale (1 = very much; 4 = not at all), Table 2 was quoted from a part of Table 1 of "Yamamoto Y, Tanaka H, Yamazaki K & Shirakawa S (2003): Construction of a standard rating scale to estimate sleep onset and the analysis of influencing factors. Shinrigaku Kenkyu 74(2): 140−147" and modified to English. In a publication to UOEH, We got permission from The Japanese Psychological Association with all authors.

Daytime sleeping

Shift workers frequently try to avoid light and noise when they sleep during the day. Thus, we asked participants about the methods they used for trying to sleep during the day, offering them a choice among ways to avoid light (lightproof curtains, storm windows, mask, other, nothing) and/or noise (earplugs, asking the family to be quiet, other, nothing).

Statistical analysis

Results are presented as means ± standard deviations (SDs), and categorical variables are expressed as frequencies. We investigated the prevalence of SWD not only by the total of shift workers, but also by each of the two schedules. Comparisons between day workers and shift workers and between the group with SWD and that without SWD relied on *t*-tests for continuous variables (age, shift work experience, number of cups of a caffeinated drink per day, rH&O scores, ESS scores, PSQI scores, and scores for the environmental and somatic factors (sleeping at night and sleeping during the day separately)) and *chi*-square tests for categorical variables (smoking and drinking habits and family structure). Logistic regression analyses were performed to examine the risk for SWD, treating the descriptive variables (age, shift work experience, family structure, smoking and drinking habits, daily caffeine intake, rH&O scores, ESS scores, and scores for the environmental and somatic factors) as independent variables. The working at daytime model used the night sleep-related scores for the environmental and somatic factors, and the working at night model used the day sleep-related scores for the environmental and somatic factors. We also explored all the specific items related to environmental and somatic factors using a Wilcoxon rank–sum test to identify differences between workers with and without SWD according to shift. Additionally, approaches to avoiding brightness and noise while trying to sleep during the day were analyzed with *t*-tests comparing shift workers with and without SWD. Significance was set at $P = 0.05$. R for Windows (version R-2.15.1) was used for the statistical analyses.

Results

Table 1 presents the characteristics of the shift workers (n = 363) and day workers (n = 193). The mean age of the day workers was significantly greater than that of the shift workers. The PSQI and the ESS scores of the shift workers were significantly higher than were those of the day workers. However, the rH&O scores were significantly higher in the day workers than in the shift workers.

Our evaluation of the prevalence of SWD among the shift workers (n = 363) identified 228 (62.8%) workers with SWD and 135 workers without SWD (according to the aforementioned criteria). Additionally, 62.7% of those following schedule A and 62.9% of those following schedule B met the criteria for SWD (data not shown). As we found no significant difference between these two groups, we mixed the groups following schedules A and B in additional analyses (Table 3). The ESS and PSQI scores of workers with SWD were significantly higher than were those of workers without this condition. The scores for environmental and somatic factors were significantly higher among workers with SWD than among those without SWD, irrespective of shift. The rate of living alone was significantly lower among the workers with SWD than among those without SWD. However, we found no significant differences between the two groups in age, shift work experience, smoking and drinking habits, caffeine consumption, and family structure. When the percentage of respondents who always experienced difficulty with falling asleep was added as a criterion for SWD, the percentage of workers with this condition dropped to 39.1%.

Logistic regression analyses were performed to identify the factors associated with SWD according to shift (Table 4). In the working at daytime model and the working at night model, the ESS scores and scores for environmental and somatic factors were associated with SWD.

Because there were significant differences between the two groups in the rate of living alone in Table 3 and there were few numbers of workers of living alone, we excluded 20 workers of living alone from the shift workers with SWD and 23 workers of living alone from the shift workers without SWD and analyzed tables 5 and 6 only in the workers living with a family. Among the remaining shift workers (n = 320), we detected 208 with SWD and 112 without SWD.

Table 5 presents the relationship between environmental and somatic factors and SWD in shift workers according to shift. The sleep onset of shift workers with SWD was significantly more likely to be disturbed by temperature and humidity, body pain, body discomfort, limb jerks, and anxiety than that of those without SWD, irrespective of shift. Brightness and outside noise and vibration also affected only those

Table 3. Differences between shift workers with and without shift work disorder n=363

Parameters	Mean ± SD		*P*
	With SWD n = 228	Without SWD n = 135	
Age (y)	40.0 ± 8.1	38.6 ± 8.8	0.21[a]
Shift work experience (y)	17.7 ± 6.5	16.5 ± 7.5	0.15[a]
Living alone (%)	8.8	17.2	0.03[b]
Living with family (no children) (%)	29.6	26.6	0.63[b]
Living with family (have children) (%)	61.6	56.2	0.39[b]
Smokers (%)	55.0	57.5	0.80[b]
Drinkers (%)	71.8	67.8	0.61[b]
Caffeinated drink (cups / day)	3.7 ± 2.1	3.9 ± 2.2	0.54[a]
rH&O score	14.7 ± 2.9	14.7 ± 2.9	0.90[a]
ESS score	8.9 ± 4.5	6.8 ± 3.7	< 0.001[a]
PSQI score	6.0 ± 2.4	4.6 ± 2.3	< 0.001[a]
Environmental and somatic factors score (working at daytime)	12.7 ± 6.8	9.7 ± 7.4	< 0.001[a]
Environmental and somatic factors score (working at night)	14.5 ± 6.6	10.6 ± 7.5	< 0.001[a]

SWD: shift work disorder, rH&O: reduced Horne and Ostberg questionnaire, ESS: Epworth sleepiness scale, PSQI: Pittsburgh sleep quality index, a: *t*-test, b: *chi*-square test, $P < 0.05$, SD: standard deviation workers with SWD who slept during the day.

Table 6 shows the proportion of shift workers who tried to avoid the effects of brightness and noise. There was no difference between workers with and without SWD with regard to their efforts to deal with brightness. However, workers with SWD tended to ask family members to be quiet more frequently than those without SWD (61.1% vs. 48.0%, $P = 0.04$).

Table 4. Logistic regression analyses of factors associated with shift work disorder

Influence factors		Working at daytime model			Working at night model		
		Odds ratio	95% CI	*P*	Odds ratio	95% CI	*P*
Age (y)		1.00	0.95 ～ 1.06	0.90	1.00	0.94 ～ 1.05	0.91
Shift work experience (y)		1.05	0.98 ～ 1.11	0.15	1.05	0.99 ～ 1.12	0.12
Family structure	Living alone	1.00			1.00		
	Living with family (no children)	2.62	0.86 ～ 8.30	0.09	2.34	0.74 ～ 7.64	0.15
	Living with family (have children)	2.33	0.80 ～ 7.03	0.12	2.35	0.78 ～ 7.34	0.13
Smokers	no	1.00			1.00		
	yes	0.99	0.51 ～ 1.92	0.98	0.98	0.50 ～ 1.92	0.96
Drinkers	no	1.00			1.00		
	yes	1.30	0.64 ～ 2.64	0.46	1.34	0.65 ～ 2.74	0.42
Caffeinated drink	no	1.00			1.00		
	yes	0.97	0.83 ～ 1.14	0.73	0.96	0.82 ～ 1.12	0.57
rH&O score		0.96	0.85 ～ 1.08	0.49	0.94	0.84 ～ 1.06	0.35
ESS score		1.15	1.07 ～ 1.25	< 0.01	1.15	1.06 ～ 1.25	< 0.01
Environmental and somatic factors score (working at daytime)		1.07	1.02 ～ 1.12	< 0.01	—	—	
Environmental and somatic factors score (working at night)		—	—		1.09	1.04 ～ 1.15	< 0.01

rH&O: reduced Horne and Ostberg questionnaire, ESS: Epworth sleepiness scale, CI: confidence interval, $P < 0.05$

Table 5. Relationship between scores for environmental and somatic items and shift work disorder by shift

The factors concerning sleep onset	Sleeping at night (Mean ± SD)			Sleeping at daytime (Mean ± SD)		
	With SWD n = 208	Without SWD n = 112	*P*	With SWD n = 208	Without SWD n = 112	*P*
Temperature & humidity	10.9 ± 9.5	8.6 ± 9.0	0.01	13.8 ± 10.5	10.6 ± 10.5	< 0.01
Brightness	17.1 ± 13.6	15.6 ± 14.3	0.26	23.7 ± 13.2	19.7 ± 14.6	0.02
Outside noise & vibration	15.8 ± 11.7	13.8 ± 12.0	0.13	21.6 ± 10.7	18.0 ± 12.3	0.01
Inside noise	15.2 ± 12.2	14.4 ± 13.1	0.45	18.2 ± 12.7	16.0 ± 13.3	0.13
Smell	8.7 ± 10.3	7.5 ± 9.5	0.21	8.8 ± 10.4	7.5 ± 9.5	0.14
Limb hot flash	8.7 ± 7.6	7.5 ± 8.4	0.13	9.1 ± 8.3	7.5 ± 8.2	0.08
Body pain	13.4 ± 9.7	11.0 ± 9.1	0.04	13.8 ± 9.8	10.9 ± 9.1	0.01
Body discomfort	11.6 ± 9.6	8.6 ± 9.4	< 0.01	12.0 ± 10.1	8.9 ± 9.8	< 0.01
Limb jerks	10.9 ± 9.4	8.3 ± 8.1	0.02	11.3 ± 9.8	8.1 ± 8.3	< 0.01
Anxiety	15.3 ± 8.8	11.1 ± 9.5	< 0.01	14.9 ± 9.0	11.2 ± 9.5	< 0.01

SWD: shift work disorder, $P < 0.05$

Table 6. Methods of avoiding light and noise while trying to sleep during the day

Parameters	The device or measure	With SWD n = 208	Without SWD n = 112 %	P
Brightness	Lightproof curtain	71.7	67.0	0.47
	Storm window	8.6	7.8	0.97
	Eye mask	6.1	6.8	0.99
	Other	3.6	0.0	0.13
	Nothing	16.8	20.4	0.54
Noise	Earplugs	10.9	13.3	0.69
	Family asked to be quiet	61.1	48.0	0.04
	Other	1.6	3.1	0.67
	Nothing	21.8	27.6	0.34

multiple answers allowed, SWD: shift work disorder, $P < 0.05$

Discussion

This study was designed to evaluate the prevalence of SWD in shift workers and to analyze relationships involving environmental and somatic conditions and SWD in employees in the semiconductor industry, who follow a rapidly rotating shift schedule. We found that the prevalence of SWD among these workers was 62.8% in our sample, which is very high compared with the rates found by other studies using the same criteria for SWD [5, 6, 8]. The participants in the study conducted by Di Milia L *et al*. [5] were drawn from the community and worked various types of shift, including some involving few nights, which may explain the low prevalence reported by that study. In contrast, the participants in a research conducted by Waage S *et al*. [6] followed a slow rotation shift schedule. It is possible that rapidly rotating shift work tends to cause sleep disorders because of its association with a reduction in the total duration of sleep [17]. Also, the questionnaires used in Waage's study were given out during the first day of a work period that followed 4 weeks off work. Thus, sleep disorders may have been diminished because the investigation was carried out after a holiday. Furthermore, the workers in their study did not have domestic responsibilities, which may increase sleep duration. These factors might explain why the prevalence of SWD in the study of Waage *et al.* was lower than that in our study.

It is also possible that the prevalence of SWD varies depending on race, sex, lifestyle, eating habits, workload, and industry. For example, the sample of rapidly rotating shift workers examined by Flo E *et al*. [8] included many females (90% of the subjects), and they reported that a woman has 0.57 times the rate of SWD than a man. Rajaratnam SM *et al*. [18] estimated that SWD, defined as excessive sleepiness and insomnia, was present in 14.5% of police officers who worked night shifts. However, their estimate increased markedly, to 53.9%, when the ICSD-2 criteria (excessive sleepiness or insomnia) were applied, and 82% of their subjects were male.

Indeed, the ICSD-2 criteria for SWD are of limited utility as they do not evaluate the severity of the condition. Thus, when we included responses to question 4 in the criteria for SWD, confining the diagnosis to only those with severe symptoms, the prevalence dropped to 39.1%. When workers with less severe symptoms were included, the prevalence was 62.8%. Indeed, the validity of using only the first three questions as criteria for a diagnosis of SWD in a Japanese sample has not been evaluated sufficiently. Moreover, our data may have been biased [19] by our use of self-administered questionnaires.

Our rH&O data are consistent with the results of a previous study [20], which suggested that there are fewer morning-type workers in shift work (Table 1). However, the rH&O scores of the two shift worker groups were not different (Table 3), and we cannot conclude that morning-type workers are less likely to experience SWD. Consistent with our results, Waage S *et al*. [6] found no difference between morning- and evening-type workers regarding SWD. According to our logistic regression analysis (Table 4), the scores for environmental and somatic factors and the ESS scores were associated with SWD. It is possible that environmental and somatic factors lead to SWD, and that high ESS scores are a result of SWD.

We hypothesized that the environment (temperature and humidity, brightness, noise, smell) in which one tries to fall asleep may induce SWD, as several reports have associated these factors with sleep [21−27]. For example, temperatures under 21°C and above 29°C have been associated with arousal during sleep [21]. Humidity has been correlated with increased wakefulness and decreased slow-wave sleep and rapid eye movement (REM) sleep [22], and brightness has been reported to cause awakening [23], melatonin inhibition [24], high body temperature [25], and stimulation of the sympathetic nervous system [26]. Noise also reduced slow-wave sleep and REM sleep [27]. Consistent with our results, the aforementioned previous studies identified temperature and humidity, brightness, body pain, body discomfort, limb jerks, and anxiety as risk factors that influenced the difficulty of falling asleep in SWD (Table 5). Environmental and somatic factors may have a major influence on the ability to sleep well and combat the development of SWD.

As shift workers frequently use various approaches to sleep well during the day, we assumed that workers without SWD would rely on such methods more frequently than would those with SWD. However, with the exception of requests that their family be quiet, we found no differences between the groups in this regard (Table 6).

In this study, it was shown that Sleep-Related Environmental Factors might influence SWD. An education about how to create a good environment for sleep may be necessary for the workers with SWD for treatment and the prevention of SWD.

Our study had several limitations. Although we identified a relationship between the environmental and somatic factors that affected sleep onset and SWD (Table 4), we could not conclude that these factors played a causal role, as this study used a cross-sectional design. Thus, we cannot conclude whether those environmental and somatic factors led to SWD or whether workers with SWD are more sensitive to these factors. Second, we did not use polysomnography or a multiple Sleep Latency Test to evaluate sleep. Therefore, we did not precisely measure the quality and quantity of participants' sleep. Third, this study was limited to male shift workers and one type of factory, which may limit the ability to generalize our results to female shift workers or other factories. Finally, in a recent ICSD-3 [28], it was reported that the condition of shift work disorder is thought to be directly related to circadian misalignment and sleep loss. However, in this study we were not able to evaluate the physiological aspects of sleep, such as melatonin and body temperature.

In conclusion, we found that 62.8% of shift workers employed at a factory that manufactures base material for semiconductors met the diagnostic criteria for SWD. Based on our data, we suggest that susceptibility to SWD may be associated with the environmental and somatic factors related to falling asleep. However, causal relationships could not be proven, so additional investigations of these factors are needed.

Conflict of interest

None of the authors have a conflict of interest in relation to this work.

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製造業における交代勤務障害と睡眠関連環境要因

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要　　旨：今回の研究の目的は, 製造業の交代勤務者の中で交代勤務障害と寝付きと関連する環境や身体要因を, 調査することである．全556名の男性労働者が, 年齢や交代勤務経験年数, ライフスタイル, 家族構成, エプワース眠気尺度(ESS), ピッツバーグ睡眠質問票(PSQI), 朝型夜型質問紙, 入眠感影響要因調査に関する自記式質問紙に回答した．我々は交代勤務障害の有無で分類し, 各調査項目を比較した．交代勤務障害と診断されたのは, 交代勤務者のうち208名(62.8%)だった．ESS点数とPSQI点数の平均値および入眠感影響要因点数の平均値は, 交代勤務障害の有る労働者の方が交代勤務障害の無い労働者よりも有意に高くなっていた．ロジスティック回帰分析では, ESS点数と入眠感影響要因点数が交代勤務障害とポジティブに関連していた．我々は製造業における交代勤務障害の耐性に, 入眠感影響要因が関係している可能性を示唆した．

キーワード：交代勤務障害, 眠気, 睡眠環境.

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