Relationships of Occupational Stress to Insomnia and Short Sleep in Japanese Workers

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Study Objective: The aims of this study were to (a) examine the association between occupational stress and insomnia and short sleep in Japanese workers and (b) demonstrate the difference between 2 occupational stress models—Effort Reward Imbalance and the Demand Control Model.

Design: All data were obtained via self-administrated questionnaires and annual health checkups. Insomnia was evaluated by the Athens Insomnia Scale, and short sleep was defined as less than 6 hours sleep per day.

Setting: Employees at local governments and a transit company who had annual health checkups during the period from April 2003 to March 2004.

Participants: After excluding participants without complete data, data from 6,997 men and 1,773 women were analyzed.

Intervention: N/A.

Measurements and Results: In men, high occupational stresses were significantly associated with insomnia, especially a high level of Effort Reward Imbalance (defined as the presence of high effort and low reward), had a remarkably higher odds ratio. In women, high occupational stresses were significantly associated with insomnia as well. High occupational stresses were significantly associated with short sleep in men. However, in women, only Effort Reward Imbalance showed a significant association with short sleep.

Conclusions: This study suggested that occupational stress is a possible risk factor for insomnia and short sleep.

Key words: Occupational stress, effort reward imbalance, demand control model, insomnia, short sleep, athens insomnia scale.

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INTRODUCTION

THE RELATIONSHIPS OF INSOMNIA AND SHORT SLEEP TO ALL-CAUSE MORTALITY AND HEALTH-OUTCOME DETERIORATION HAVE BEEN REPORTED FOR SOME DECADES.[1-8] Suka et al reported that persistent insomnia had a significant relationship to hypertension.[1] In a meta-analysis, Schwarts et al reported that there was a significant relationship between insomnia and cardiovascular disease.[2] But several studies have reported that there is no association between mortality and insomnia.[3-6]

For short sleep, Liu et al have reported that less than 5 hours of sleep had a significant relationship with acute myocardial infarction.[7] Ayas et al have also reported that women who sleep 5 hours per day have a significant positive risk of coronary events compared with women who sleep 8 hours per day.[8] Kripke et al reported that people reporting less than 3.5 or 4.5 hours of sleep have a significantly increased mortality risk.[3,4]

The effect of high stress as a risk factor for sleep disturbance has been reported in some previous studies.[9-11] Tachibana et al reported that perceived overinvolvement in the job is associated with difficulty in falling asleep and early-morning arousal.[9] However, in most of these studies, the stress was measured by using simple queries, "Do you have stress?"(yes/no), or "How would you assess your stress? (on the scale of 1 to 4)."

Effort Reward Imbalance (ERI) and the Demand Control Model (DCM) are widely used for theoretical occupational stress models. These models have demonstrated a relationship between physical and mental disorders and the influence of unhealthy behavior.[12,13] There have been a few studies on the association between occupational stress using theoretical occupational stress models and sleep disturbance. However, these studies using DCM have had some problems such as lack of covering fully confounding factors or small sample sizes,[14-16] and there has been no previous report using ERI.

In the present study, we examined the association between stress demonstrated by 2 theoretical occupational stress models and insomnia and short sleep in Japanese workers. In addition, we also demonstrated the differences between the 2 theoretical occupational stress models.

METHODS

Subjects and Data Collection

The subjects, employees of 3 local governments and 1 transit company, were aged 21 to 64 years who had their annual health checkups during the period from April 2003 through March 2004. We used a self-administered questionnaire. The questionnaires were distributed to the subjects in advance of the annual health checkup and were collected at the checkup. Answers to the questionnaire and written consent to view health-checkup data were obtained from 7,195 men and 1,858 women. The number of participants from each area was 5,013 in city A (men/women: 3,962/1,051; response rate: 47.5%/47.6%), 219 in city B (123/96; 46.1%/45.5%), 3,403 in area C (2,697/706; 27.4%/25.6%), and 418 at transit company D (413/5; 32.9%/5.3%). A total of 283 subjects (198 men, 85 women) were excluded due to incomplete questionnaires. Finally, data from 6,997 male and 1,773 female subjects were analyzed in this study.

Disclosure Statement

This was not an industry supported study. Drs. Utsugi, Saijo, Yoshioka, Horikawa, Sato, Gong, and Kishi have indicated no financial conflicts of interest.

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Variables

Theoretical Stress Models

Occupational stress models were assessed by ERI and DCM. The Japanese version of ERI consists of 7 questions on efforts spent (demands, obligations) and 10 questions on rewards received (money, esteem, career opportunities, career and security).[17] The subjects were then asked to rate severity from "not at all distressed" (1 point) to "very distressed" (4 points). The scores were calculated for effort and demand separately and then divided into thirds to indicate low, medium, and high levels for each scale. Then subjects who were categorized as high in effort and low in reward were rated as having a high level of ERI. "Overcommitment" indicates a state of exhaustive coping that reflects frustrated but continued efforts and associated negative feelings. Scores were divided into thirds to indicate low, medium, and high levels. The upper tertile (high overcommitment) indicated a critically high level associated with adverse health effects. In this study, Cronbach's alpha coefficients were 0.80 in men and 0.81 in women for effort, 0.83 in men and 0.83 in women for reward, and 0.77 in men and 0.79 in women for overcommitment.

The Japanese version of the DCM consists of 5 questions on psychological demands (job demands, time pressures, and conflicting demands) and 6 questions on decision latitude (influence or control over work, job variety, and the possibilities for learning new skills).[18,19] Each question has 4 frequency-based response categories ranging from never to always. Scores for demand and control were calculated separately and then divided into thirds to indicate low, medium, and high levels for each scale. After that, subjects who were categorized as low for control and high for demand were categorized as having high job strain. In this study, Cronbach's alpha coefficients were 0.66 in men and 0.63 in women for job control, and 0.76 in men and 0.76 in women for job demand.

Assessment of Insomnia and Short Sleep

The AIS is based on International Classification of Diseases-10 criteria and was validated by Soldatos.[20,21] The AIS is a self-administered inventory consisting of 8 items; 5 items assess difficulty with sleep induction, awakening during the night, early-morning awakening, total sleep time, and overall quality of sleep and 3 items pertaining to the next-day consequences of insomnia (problems with sense of well-being, overall functioning, and sleepiness during the day). Each item of the AIS can be rated from 0 (no problem at all) to 3 (very serious problem). The total score ranges from 0 to 24 and is divided between more than 6 (the presence of insomnia) and less than 6. The responders were requested to choose rating options only if they had experienced their sleep difficulty at least 3 times a week during the last month. To assess the short sleep, for the preceding 1-month period, the participants were asked to use the following question: "How many hours did you usually sleep per day?" We classified it as "< 6 hours per day" and "> 6 hours per day." Though there have been many reports suggesting that short sleep may have adverse effects on health outcomes, it has remained controversial how many hours of sleep should be defined as "good sleep." However, excess mortality has been associated with sleep durations of less than 7 hours.[1,9,11, 22-24] In Japanese subjects, Tamakoshi and Ohno reported in a 9.9-year cohort study that there was a significant association between short sleep of 6.5 to 7.4 hours and all-cause mortality.[11] Therefore, we chose 6 hours per day as the cutoff point in the present analysis.

Other Putative Confounding Factors Related to Sleep

Work was divided into white collar and blue collar. Educational attainment was categorized into "high school education or less" or "more than high school education." Working hours were calculated in average working hours per week. The number of days off was also calculated in days off per month. Smoking habits were classified as "never," "exsmoker," "1 to 19 cigarettes per day," or "≥ 20 cigarettes per day." The total average consumption of alcohol was calculated in grams per day, after taking into account the frequency, amount, and alcohol content of specific beverages. Then, it was categorized into "never," "≥ 19.9 g per day," "20.0 to 39.9 g per day," "40.0 to 59.9 g per day," or "≥ 60.0 g per day" for men and "rarely or never," "≤19.9 g per day," or "≥ 20.0 g per day" for women.[25] The frequency of leisure-time exercise (at least with perspiration) was categorized into "rarely or never," "1 to 2 per week," or "≥ 3 per week." Anthropometric measures (height and body weight) were recorded by a standardized protocol. The body mass index (BMI) was calculated as weight (kg)/height (m^2).

Statistical Analysis

All analyses were performed separately for men and women. First, 2-way analyses of variance (ANOVA) or the χ^2 test was used to test for significant differences of baseline characteristics by sex. The data of the subjects are presented as mean + SD or numbers (percentages). Next, logistic regression analysis was used to obtain odds ratios (OR) and 95% confidence intervals (95% CI) of each stress model for sleep duration (0: ≥ 6 hours per day; 1: < 6 hours per day), and AIS (0: total score < 6;1: total score ≥ 6) before and after adjustment for potential confounders. Possible confounding factors included in the logistic-regression models as independent variables were, age, working status, shift work, working hours, number of days off, BMI, smoking status, alcohol consumption, frequency of exercise, and educational attainment. Subjects with missing data were excluded list wise per each stress model.[26,27] The 95% CI were calculated with standard errors and multiple-regression coefficients. Two-tailed values of less than .05 were considered statistically significant. All analyses were conducted using SPSS software Version 12 for Windows (SPSS Inc., Chicago, Ill.).

RESULTS

Information on characteristics of all subjects is presented in Table 1. The prevalence of insomnia, defined as a total score ≥ 6 of the AIS, was 23.9% for men and 31.4% for women. There were significant differences between men and women in age, marital status, educational attainment, working position, smoking status, alcohol consumption, frequency of exercise, working hours, shiftwork, days off, sleep duration, and AIS.

The associations between the occupational stress models and insomnia are presented in Table 2 for men and Table 3 for women. In male subjects, those who perceived high stress in the occupational stress model were more likely to suffer from insomnia than those who perceived low stress before and after adjustment, and a high level of ERI had a remarkably higher OR (high level of ERI:

Table 1—Subject Characteristics*

Factors	Men	Women	*P* value
No.	6997 (79.8)	1773 (20.2)	
Age, y	47.7 ± 6.9	45.8 ± 7.4	‡
Married	6050 (86.5)	1089 (61.4)	‡
Educational attainment			‡
High school education or less	3394 (48.5)	611 (34.5)	
More than high school education	3603 (51.5)	1162 (65.5)	
Working position			†
White collar	5077 (72.6)	1325 (74.7)	
Blue collar	1920 (27.4)	448 (25.3)	
Smoking status, cigarettes/day			‡
Never	1999 (28.6)	1228 (69.3)	
Exsmoker	1918 (27.4)	180 (10.2)	
1-19	751 (10.7)	259 (14.6)	
≥ 20	2329 (33.3)	106 (6.0)	
Alcohol consumption, g/day			‡
Never	1805 (25.8)	871 (49.1)	
≤ 20	1988 (28.4)	669 (37.7)	
21-40	1323 (18.9)	161 (9.1)	
41-60	836 (11.9)	44 (2.5)	
61-80	526 (7.5)	14 (0.8)	
≥ 81	519 (7.4)	14 (0.8)	
Frequency of exercise, times/wk			‡
0	4056 (58.0)	1215 (68.5)	
1 or 2	1830 (26.2)	379 (21.4)	
≥ 3	1111 (15.9)	179 (10.1)	
Working hours, h/wk	45.3+8.5	43.7+7.8	‡
Shift work	1201 (17.2)	401 (22.6)	‡
Days off, no./month	9.0 ± 2.1	9.2 ± 1.7	‡
Sleep duration, h/day	6.7 ± 0.9	6.3 ± 0.9	‡
Athens Insomnia Scale, score			
< 6	5390 (77.0)	1223 (69.0)	‡
≥ 6	1607 (23.0)	550 (31.0)	
Body mass index, kg/m^2, mean	23.9 ± 2.8	21.9 ± 3.2	‡

*Variables are presented as number (%) unless otherwise specified.
† P < .05
‡ P < .001

OR 11.45, 95% CI, 9.00-14.57; high effort: OR 4.14, 95% CI, 3.57-4.81; low reward: OR 4.64, 95% CI, 4.00-5.39; high level of ERI overcommitment: OR 3.49, 95% CI, 3.09-3.94; high job strain: OR 4.05 , 95% CI, 2.82-5.18; high job demand: OR 2.45, 95% CI, 2.12-2.83). On the other hand, in female subjects, those who perceived high stress in each occupational stress model were also more likely to suffer from insomnia than those who perceived low stress before and after adjustment, and high job strain had the highest OR (high level of ERI: OR 4.54, 95% CI, 2.92-7.08; high effort: OR 2.28, 95% CI, 1.71-3.04; low reward: OR 3.39, 95% CI, 2.58-4.47; high level of ERI overcommitment: OR 3.77, 95% CI, 3.02-4.71; high job strain: OR 8.03, 95% CI, 2.79-23.10; high job demand: OR 1.83, 95% CI, 1.39-2.41), but an association between job control and insomnia was not found for either sex.

The associations between occupational stress models and short sleep (an average sleep duration < 6 hours per day) are presented in Table 4 for men and Table 5 for women. In male subjects, those who perceived high stress in each occupational stress model were more likely to have less than 6 hours sleep than those who perceived low stress, except for any levels of job control, before and after adjustment (high level of ERI: OR 2.47, 95% CI, 1.85-3.30; high effort: OR 1.65, 95% CI, 1.35-2.02; low reward: OR 1.89, 95% CI, 1.56-2.28; high level of ERI overcommitment: OR 1.67, 95% CI, 1.42-1.97; high job strain: OR 1.72, 95% CI, 1.07-2.76; high job demand: OR 1.38, 95% CI, 1.13-1.68). In female subjects, those who perceived high stress in the ERI except for any levels of ERI effort were more likely to have less than 6 hours of sleep than those who perceived low stress (high level of ERI: OR 1.77, 95% CI, 1.09-2.90; low reward: OR 1.48, 95% CI, 1.09-1.99; high level of ERI overcommitment: OR 1.63, 95% CI, 1.28-2.09), but in the DCM, those who perceived high stress had no significant association with < 6 hours sleep.

DISCUSSION

To the best of our knowledge, this is the first study to examine the associations among 2 theoretical occupational stress models, insomnia, and short sleep. The foregoing analysis indicated that high levels of stress evaluated by 2 theoretical occupational stress models (ERI and DCM) were associated with insomnia and short sleep. These significant relationships of high occupational stress to insomnia and short sleep were found after adjustment for confounding variables.

We revealed the prevalence of insomnia defined as a total score ≥ 6 on the AIS. Though Ohayon reported in a review that the prevalence of insomnia varied among studies,[28] the prevalence among daytime workers ranged from approximately 17.3% to 29.9% in Japanese workers.[9,10,29] Nakata et al reported that 23.6% of 1,161 white-collar employees in an electric equipment manufacturing company had insomnia.[29] Doi et al reported that 17.3% of 3,030 white-collar workers suffered from insomnia in Japan.[10] We found that prevalence ratios were 23.9% for men and 31.4% for women, similar to previous studies. Previous investigations have also found that insomnia are more prevalent in women than men.[30-32] The present study also demonstrated the same result.

This study used 2 different theoretical occupational models. Previous studies have shown that DCM is restricted to the situational aspects of the psychosocial work environment, whereas ERI includes both extrinsic (situational) and intrinsic (person) characteristics.[27,33-35] Calnan et al suggested that the ERI reflected the current working environment more than the DCM.[34] Bosma et al, however, suggested in a prospective cohort study, that adverse personal characteristics such as competitiveness or hostility in ERI could be the result of low job control and high job demand.[33] Ostry et al showed that the combination of high ERI and low control had better predictive validity of self-reported health status and chronic condition than did high ERI alone or high DCM alone.[36] Another study also reported that the 2 occupational stress models identify different aspects of stressful occupational conditions.[37] In our study, for insomnia, though the OR for ERI among men was substantially larger than that for DCM, with no overlap in CI, the OR for DCM was larger than that of ERI among women with overlap in CI. Also, for short sleep, the ORs for ERI and DCM were similar among both sexes. Further studies are, therefore, needed to specify the differences between ERI and DCM and to examine the effect of their combination.

Furthermore, it is important to take sex-specific effects into account. For the association between insomnia and occupation-

Table 2—The Association Between Insomnia* and Occupational Stress Models in Men

	Stress Model	No.	Unadjusted OR (95% CI)	P Value	Adjusted OR (95% CI)	P Value
Effort Reward Imbalance	Low	1352	1.00		1.00	
	Medium	4669	3.35 (2.70-4.13)	< .0001	3.17 (2.56-3.93)	< .0001
	High	976	12.58 (9.93-15.95)	< .0001	11.45 (9.00-14.57)	< .0001
	Effort					
	Low	2895	1.00		1.00	
	Medium	2062	1.60 (1.38-1.87)	< .0001	1.55 (1.33-1.81)	< .0001
	High	1977	4.35 (3.78-5.00)	< .0001	4.14 (3.57-4.81)	< .0001
	Reward					
	High	2592	1.00		1.00	
	Medium	2174	1.85 (1.58-2.17)	< .0001	1.86 (1.59-2.18)	< .0001
	Low	2086	4.62 (3.98-5.35)	< .0001	4.64 (4.00-5.39)	< .0001
ERI overcommitment	Low-risk	4886	1.00		1.00	
	High-risk	2057	3.51 (3.12-3.94)	< .0001	3.49 (3.09-3.94)	< .0001
Demand Control Model	Low	400	1.00		1.00	
	Medium	6137	2.18 (1.60-2.97)	< .0001	1.98 (1.45-2.70)	< .0001
	High	460	4.78 (3.35-6.84)	< .0001	4.05 (2.82-5.18)	< .0001
	Job control					
	High	2143	1.00		1.00	
	Medium	2364	0.91 (0.79-1.05)	0.611	0.96 (0.83-1.10)	0.526
	Low	2462	1.04 (0.90-1.19)	0.203	1.07 (0.92-1.23)	0.394
	Job demand					
	Low	2536	1.00		1.00	
	Medium	2038	1.33 (1.14-1.54)	< .0001	1.32 (1.13-1.54)	< .0001
	High	2400	2.54 (2.22-2.91)	< .0001	2.45 (2.12-2.83)	< .0001

*Insomnia is defined as a score ≥ 6 on the Assessment of Insomnia (AIS).
Adjusted by age, educational attainment, working position, body mass index, frequency of exercise, smoking status, alcohol consumption, working hours, shiftwork, and days off. Effort Reward Imbalance (ERI) low indicates the combination of low effort and high reward, high indicates the combination of high effort and low reward, and others indicate others except for ERI low and ERI high. Demand Control Model (DCM) low indicates the combination high control and low demand, high indicates low control and high demand, and medium indicates others, except for DCM low and DCM high. OR refers to odds ratio; CI, confidence interval.

Table 3—The Association Between Insomnia* and Occupational Stress Models in Women

	Stress Model	No.	Unadjusted OR (95%CI)	P Value	Adjusted OR (95%CI)	P Value
Effort Reward Imbalance	Low	170	1.00		1.00	
	Medium	1150	1.59 (1.05-2.40)	.027	1.72 (1.14-2.60)	.010
	High	453	4.16 (2.70-6.40)	< .0001	4.54 (2.92-7.08)	< .0001
	Effort					
	Low	407	1.00		1.00	
	Medium	450	1.03 (0.75-1.41)	.867	1.08 (0.78-1.49)	.638
	High	896	2.08 (1.60-2.72)	< .0001	2.28 (1.71-3.04)	< .0001
	Reward					
	High	493	1.00		1.00	
	Medium	581	1.43(1.06-1.90)	.019	1.41 (1.05-1.89)	.022
	Low	649	3.34 (2.55-4.39)	< .0001	3.39 (2.58-4.47)	< .0001
ERI overcommitment	Low-risk	1041	1.00		1.00	
	High-risk	715	3.33 (2.69-4.11)	< .0001	3.77 (3.02-4.71)	< .0001
Demand Control Model	Low	58	1.00		1.00	
	Medium	1476	5.98 (2.15-16.61)	.001	5.90 (2.11-16.50)	.001
	High	239	8.60 (3.01-24.53)	< .0001	8.03 (2.79-23.10)	< .0001
	Job control					
	High	470	1.00		1.00	
	Medium	528	1.12 (0.85-1.47)	.436	1.06 (0.80-1.41)	.671
	Low	758	1.34 (1.04-1.72)	.024	1.28 (0.96-1.70)	.090
	Job demand					
	Low	463	1.00		1.00	
	Medium	521	1.08 (0.77-1.50)	.670	1.18 (0.89-1.58)	.252
	High	770	1.49 (1.10-2.00)	.009	1.83 (1.39-2.41)	< .0001

*Insomnia is defined as a score > 6 on the Assessment of Insomnia (AIS).
Adjusted by age, educational attainment, working position, body mass index, frequency of exercise, smoking status, alcohol consumption, working hours, shiftwork, and days off. Effort Reward Imbalance (ERI) low indicates the combination of low effort and high reward, high indicates the combination of high effort and low reward, and others indicate others except for ERI low and ERI high. Demand Control Model (DCM) low indicates the combination high control and low demand, high indicates low control and high demand, and medium indicates others, except for DCM low and DCM high. OR refers to odds ratio; CI, confidence interval.

Table 4—The Association Between Short Sleep* and Occupational Stress Models in Men

	Stress Model	No.	Unadjusted OR (95%CI)	P Value	Adjusted OR (95%CI)	P Value
Effort Reward Imbalance	Low	1352	1.00		1.00	
	Medium	4669	1.87 (1.46-2.39)	< .0001	1.52 (1.19-1.95)	.001
	High	976	3.64 (2.75-4.82)	< .0001	2.47 (1.85-3.30)	< .0001
	Effort					
	Low	2895	1.00		1.00	
	Medium	2062	1.53 (1.25-1.87)	< .0001	1.23 (1.00-1.51)	.049
	High	1977	2.54 (2.10-3.06)	< .0001	1.65 (1.35-2.02)	< .0001
	Reward					
	High	2592	1.00		1.00	
	Medium	2174	1.23 (1.00-1.50)	.046	1.24 (1.01-1.53)	.037
	Low	2086	1.94 (1.61-2.34)	< .0001	1.89 (1.56-2.28)	< .0001
ERI overcommitment	Low-risk	4886	1.00		1.00	
	High-risk	2057	1.95(1.67-2.28)	< .0001	1.67 (1.42-1.97)	< .0001
Demand Control Model	Low	400	1.00		1.00	
	Medium	6137	1.61 (1.08-2.39)	.020	1.31 (0.88-1.94)	.192
	High	460	2.40 (1.50-3.83)	< .0001	1.72 (1.07-2.76)	.026
	Job control					
	High	2143	1.00		1.00	
	Medium	2364	0.80 (0.66-0.97)	.025	0.94 (0.77-1.15)	.565
	Low	2462	0.89 (0.74-1.08)	.237	1.11 (0.91-1.35)	.313
	Job demand					
	Low	2536	1.00		1.00	
	Medium	2038	1.11 (0.90-1.37)	.330	1.01 (0.81-1.24)	.962
	High	2400	1.91 (1.59-2.29)	< .0001	1.38 (1.13-1.68)	.001

*Short sleep is defined as an average sleep duration < 6 hours per day.
Adjusted by age, educational attainment, working position, body mass index, frequency of exercise, smoking status, alcohol consumption, working hours, shiftwork, and days off. Effort Reward Imbalance (ERI) low indicates the combination of low effort and high reward, high indicates the combination of high effort and low reward, and others indicate others except for ERI low and ERI high. Demand Control Model (DCM) low indicates the combination high control and low demand, high indicates low control and high demand, and medium indicates others, except for DCM low and DCM high. OR refers to odds ratio; CI, confidence interval.

Table 5—The Association Between Short Sleep* and Occupational Stress Models in Women

	Stress Model	No.	Unadjusted OR (95%CI)	P Value	Adjusted OR (95%CI)	P Value
Effort Reward Imbalance	Low	170	1.00		1.00	
	Medium	1150	1.38 (0.87-2.17)	.172	1.25 (0.79-1.97)	.339
	High	453	2.05 (1.27-3.31)	.004	1.77 (1.09-2.90)	.021
	Effort					
	Low	407	1.00		1.00	
	Medium	450	1.09 (0.77-1.56)	.618	1.03 (0.72-1.47)	.868
	High	896	1.40 (1.03-1.89)	.032	1.25 (0.90-1.73)	.179
	Reward					
	High	493	1.00		1.00	
	Medium	581	1.12 (0.82-1.54)	.479	1.09 (0.79-1.50)	.604
	Low	649	1.56 (1.15-2.10)	.004	1.48 (1.09-1.99)	.011
ERI overcommitment	Low-risk	1041	1.00		1.00	
	High-risk	715	1.68 (1.33-2.14)	< .0001	1.63 (1.28-2.09)	< .0001
Demand Control Model	Low	58	1.00		1.00	
	Medium	1476	1.31 (0.64-2.71)	.459	1.39 (0.67-2.89)	.376
	High demand	239	1.59 (0.73-3.44)	.240	1.74 (0.79-3.82)	.168
	Job control					
	High	470	1.00		1.00	
	Medium	528	0.98 (0.72-1.34)	.912	1.11 (0.81-1.52)	.520
	Low	758	1.01 (0.76-1.35)	.955	1.33 (0.96-1.84)	.088
	Job demand					
	Low	463	1.00		1.00	
	Medium	521	1.08 (0.77-1.50)	.670	1.05 (0.75-1.47)	.777
	High	770	1.49 (1.10-2.00)	.009	1.30 (0.95-1.78)	.105

*Short sleep is defined as an average sleep duration < 6 hours per day.
Adjusted by age, educational attainment, working position, body mass index, frequency of exercise, smoking status, alcohol consumption, working hours, shiftwork, and days off. Effort Reward Imbalance (ERI) low indicates the combination of low effort and high reward, high indicates the combination of high effort and low reward, and others indicate others except for ERI low and ERI high. Demand Control Model (DCM) low indicates the combination high control and low demand, high indicates low control and high demand, and medium indicates others, except for DCM low and DCM high. OR refers to odds ratio; CI, confidence interval.

al stress models, our study revealed that stronger effects of the extrinsic (situational) component of ERI were observed in male subjects. However, in female subjects, stronger effects were observed in the DCM rather than the ERI. Calnan et al have reported that the characteristics of DCM had a significant effect on mental distress,[34] and Hallman et al have reported that women appeared to be more sensitive to psychosocial factors than men.[35] We could not compare the sex difference of influence of occupational stress directly because the number of female subjects in our study was smaller than that of male subjects. Brezinka et al have suggested in a review that it may be inappropriate to apply the men's report to women.[38] Since there is a possible method to compare the sex difference of risks of occupational stress when the number of subjects differs considerably between men and women,[35] further study is needed to be considered the difference between them.

The cause-effect mechanism between occupational stress and sleep disturbance could not be fully clarified. It has been reported that occupational stress defined by DCM and ERI is associated with cortisol elevation.[39-42] Cortisol and hypothalamic-pituitary-adrenal axis activation are also associated with sleep disturbances.[43,44] Thus the hypothalamic-pituitary-adrenal axis activation may be related to sleep disturbances induced by occupational stress.

As with stressful life events that have a major effect of the onset of insomnia, daily minor stressors (eg, job strain and interpersonal relationships) have been correlated with sleep disturbance.[45] Urporen et al have pointed out that work-related pressure is considered to cause disturbed sleep.[46] Ribet et al have reported that exposure to vibration and "having to hurry" are associated with sleep disturbance.[47] Martikainen et al have shown that psychosocial factors are more significantly associated with prolonged insomnia than are somatic health problems.[48] Thus, further study should take into account the role of stress as a factor in sleep disturbance.

The present study did not examine the association between long sleeping time and occupational stress models because there were few subjects who sleep more than 9 hours. Tamakoshi et al mentioned that prolonged sleep also has a significant mortality risk.[11]

Several limitations of the present study need to be discussed. First, since the present study was cross-sectional, it is probable that workers with severe mental and/or physical health problems had already left the workplace or moved to one with low stress. That could possibly lead to underestimation of the effects of occupational stress. Since the response rate of the present study was rather low, those who perceived a large amount of stress might not have answered the questionnaire, and those who perceived very low stress might have no interest in the stress and sleep questionnaire. However, since our results suggested that the overall prevalence of insomnia in the study is similar to prior studies, the presence or absence of insomnia did not affect study participation. So, we believe that occupational stress was truly associated with insomnia and short sleep even if those who perceived a large amount of stress and very low stress were excluded. Though they work at various kinds of occupations, such as office worker, physician, nurse, clerical, crafts, production process, construction, services, transport, communication, and emergency services, our study subjects were mainly employees followed by 2 industry sectors—local public government and transportation. There may be a limit in applying these results to a general population.

Second, we could not estimate mental disorders, such as depression, which could affect sleep. Ohayon et al have reported that insomnia related to other mental disorders and primary insomnia is more frequent in women than in men.[28] Since occupational stress has had a strong association with mental disorders in previous studies, occupational stress may be a comprehensive indicator for sleep affected by mental disorders. Finally, we did not ask about the use of sleeping pills. It is possible that some "sleeping pills" that were not hypnotics or sedatives but other drugs were taken to promote sleep. Piko et al reported for female nurses that the frequency of sleeping pills was associated with work-related stress levels.[49] Crutchfield et al also reported that the sleeping pill use had a relationship with a coping perspective.[50] It is possible that the connection between stress and insomnia was underestimated. In a future report, additional analyses of the association of work-schedule variables, such as overtime work and lack of days off, with insomnia and short sleep would be needed from this large sample. We used these variables as adjustment variables of our study, but there were positive relationships of overtime work and lack of days off to insomnia and short sleep (data not shown). For this study, since we asked the subjects to assess insomnia using AIS, we did not grasp the length of time to fall asleep and to remain awake during night (eg, > 30 minutes to fall asleep; remaining awake > 60 minutes at night).[29] There are many methods to assess the prevalence of insomnia.[28,51,52] Additional analyses could be needed to assess the relationship between stress and other definitions of insomnia.

The working environment has profoundly changed in Japanese society due to the prolonged recession. Japan's Ministry of Health, Labour and Welfare survey has shown that the number of people who feel stressed has increased.[53] Our study revealed the association between sleep disturbance and occupational stress. Occupational stress was associated with illness, which affects productivity in the society.[54] Even if the cause-effect relationships of stress to insomnia and short sleep are unclear, stress management programs for those at high risk might be needed in terms of public health. Further prospective studies and intervention trials are needed to clarify whether alleviation of occupational stress reduces insomnia and other health problems.

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