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Effect of the Interaction Between Employment Level and Psychosocial Work Environment on Insomnia in Male Japanese Public Service Workers

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Abstract
Background Little is known about the combined risk of socioeconomic status and psychosocial environment for insomnia.
Purpose The purpose of this study was to investigate the combined risk of employment level and psychosocial work environment for insomnia in a large Japanese male working population.
Method We investigated 5,951 male employees aged 34–59 years from two local governments in Japan. Data were obtained from a questionnaire distributed in advance of their annual health check-up. Employment level was categorized as higher-level non-manual workers, lower-level non-manual workers, and manual workers. Psychosocial work environment was assessed using the Demand-Control Model and the Effort-Reward Imbalance Model (ERI). Insomnia was assessed using the Athens Insomnia Scale.
Results The results showed that 1,382 (23.2 %) participants suffered from insomnia. Lower employment level was significantly associated with a higher risk of insomnia. Job strain (ratio of job demand to job control), E/R (ratio of job effort to job reward), and OC (over commitment) were also significantly associated with insomnia. The relative excess risk due to the interaction between employment level and psychosocial environment (job strain, E/R, and OC) was 0.09 (95 % CI −0.57 to 0.76), 2.61 (0.74 to 4.48), and 3.14 (0.82 to 5.45), respectively; synergy index=1.07 (0.66 to 1.74), 1.99 (1.37 to 2.90), and 2.25 (1.46 to 3.46), respectively.
Conclusion We found supra-additive interactions between employment level and psychosocial environment, assessed by the ERI (E/R and OC). Our findings suggested that lower level workers are more vulnerable to an adverse psychosocial environment than those at a higher level.

Keywords Athens insomnia scale · Employment level · Insomnia · Psychosocial work environment · Relative excess risk due to interaction · Synergy index

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Introduction

The association between low socioeconomic status (SES), such as low occupational class and poor health, is well established in both the West and Japan [1–7]. Differing exposures to harmful environments and unhealthy lifestyles are thought to be factors that explain health disparities based on SES among workers [7, 8]. However, it has also been indicated that such factors cannot sufficiently explain health inequalities [4, 9, 10]. Thus, it has been proposed that psychosocial factors, particularly work-related, are important in the generation of social health inequalities [1, 11, 12].

To assess psychosocial factors in the working population, the Demand Control Model (DCM) and Effort-Reward Imbalance Model (ERI) are widely used as theoretical occupational stress models. A number of epidemiologic studies have reported that a stressful work environment, assessed by the DCM and ERI, is a risk factor for heart disease, depression, and unhealthy behaviors in both the West and Japan [1, 11, 13–15]. However, it has not been fully elucidated the extent to which the differences in psychosocial work environment account for social health inequalities.

Sleep disturbances, especially insomnia, are common and major health concern in many countries [16–18]. They are also significant predictors for morbidity and mortality [19–21]. Several studies have reported that the prevalence of insomnia was higher among workers in lower levels of employment than those at a higher level [6, 22, 23]. Furthermore, the effect of being under high levels of stress, as defined by the DCM and ERI, has also been reported to be a risk factor for sleep disturbance in previous studies [6, 22, 24–26]. However, little is known about whether the combined risk of employment level and psychosocial work environment for insomnia is additive (i.e., a simple sum of its components' risks), or if they act as effect modifiers on each other [synergistic (i.e., greater than the simple sum), or antagonistic (i.e., less than the simple sum)].

The purpose of this study was to investigate whether psychosocial work environment contributes to some of the differences found in employment level and insomnia using a large Japanese male working population. In this study, we assessed the psychosocial work environment using the DCM and ERI. Furthermore, in order to investigate any supra-additive (sometimes called biological or causal) interactions between psychosocial work environment and employment level, the relative excess risk due to interactions and the synergy index was obtained using the methodology of Andersson et al. [27–29]. The hypothesis was that the combined effects of high employment level and occupational stress would be greater than the simple additive effects of each factor separately. In such cases, the relative excess risk due to interaction would be greater than zero and the synergy index would be greater than one.

Methods

Participants

Participants were male employees of two local governments, aged 34–59 years, who underwent their annual health checkups between April 2003 and March 2004. We contacted 18,071 male employees. The number of male employees in each local government was 8,229 in city A and 9,842 in area B. We used a self-administered questionnaire, which included items on age, gender, educational background, alcohol consumption, smoking, exercise, occupation, paid working hours, the number of days off, shift work, duration of visual display terminal (VDT) work, occupational stress, and insomnia. The questionnaires were distributed to the potential participants before their annual health checkup and collected during the checkup. Answers to the questionnaires and written consent to allow us to view health checkup data were obtained from 6,659 employees (response rate, 36.8 %). The number of participants from each area was 3,962 in city A (response rate, 48.1 %) and 2,697 in area B (response rate, 27.4 %). A total of 713 participants were excluded from the study: 104 because they were older than 60 years, 80 because of more than 13 days off in 1 month, and 529 because of incomplete data. The data from the remaining 5,946 participants were analyzed for this study.

This study was conducted with the written informed consent of all participants and was approved by the institutional ethical board for epidemiological studies of Hokkaido University Graduate School of Medicine.

Employment Level

Classification of employment level was performed as in previous studies on Japanese civil servants [3, 5]. It was defined according to occupation (clerical workers, professional workers, teachers, firefighters, and manual workers) and positional rank (department director, section chief, chief clerk, and non-managerial position), based on data from the questionnaires. Employment level was thus categorized as higher-level non-manual workers (HNM), lower-level non-manual workers (LNM), and manual workers (MW). Non-manual workers included clerical workers (e.g., office workers, social workers, kindergarten teachers, exercise instructors, and librarians), professional workers (doctors, nurses, pharmacists, radiographers, physiotherapists, dieticians, public health nurses, and technicians), teachers, and fire fighters. HNM held positions of section manager or higher. LNM held a position of chief clerk or non-managerial positions. MW included school janitors, cooks, drivers, traffic guides, and garbage workers, regardless of positional rank.

Theoretical Stress Models

Psychosocial work environment was assessed using the DCM and the ERI model. The DCM model focuses on job task profiles, evaluating psychological job demands and job control at work [30]. Psychological job demands are indicated by quantitative and conflicting demands of work. Job control consists of decision authority and skill utilization for a task. Furthermore, the ERI model focuses on both situational and personal conditions at work [12, 31, 32]. This model defines stressful work experiences as an imbalance between high effort and low reward. Effort is part of a socially organized exchange process to which society contributes in terms of occupational rewards. Rewards are distributed via the following three channels: money, esteem, and opportunities, including job security. Another unique feature of the ERI model is over commitment to work, defined as a set of attitudes, behaviors, and emotions that reflect excessive endeavors combined with a strong desire for approval and esteem.

The Japanese version of DCM consists of five questions on job demand and six questions on job control [15, 33, 34]. Each question has four frequency-based response categories ranging from never (1 point) to always (4 points). Scores for job demand and job control were summed to calculate a scale score separately. High scores of job demand and low job control meant unfavorable psychological work conditions. Job strain was defined as the ratio of job demand to job control. Job strain scores were divided into tertiles to indicate low, medium and high levels. We defined the upper tertile as the “High job strain” group, the medium tertile as the “Medium job strain” group, and the lower tertile as the “Low job strain” group. Cronbach’s alpha coefficients were 0.65 for job control, and 0.76 for job demand.

The Japanese version of ERI consists of 6 questions on effort spent; 11 questions on rewards received; and 6 questions on over commitment [35, 36]. Participants were then asked to rate the severity from not at all distressed (1 point) to very distressed (4 points). The scores were calculated separately for effort, reward, and over commitment. High scores of effort, low scores of reward and high scores of over commitment meant unfavorable psychological work conditions. To examine the joint effect of an unfavorable distribution of effort and reward, a ratio was computed between the two scales using the formula: Effort/(Reward×6/11) [24]. In this formula, 6/11 is a correction factor for the difference in the number of items in the numerator and denominator. The corrected effort-reward ratios (E/R) were divided into tertiles to indicate low, medium and high levels. We defined the upper tertile as the “High E/R” group, the medium tertile as the “Medium E/R” group, and the lower tertile as the “Low E/R” group. Over commitment scores (OC) were divided into thirds, and we defined the upper tertile as the “High OC” group, the medium tertile as the “Medium OC” group, and the lower tertile as the “Low OC” group. Cronbach’s alpha coefficients were 0.81 for effort, 0.83 for reward, and 0.77 for OC.

Assessment of Insomnia

We assessed insomnia using the Athens Insomnia Scale (AIS). AIS is based on the International Classification of Diseases, 10th Revision (ICD-10) criteria, and has been validated [37, 38]. The scale is a self-administered inventory consisting of eight items. The first five items assess difficulty with sleep induction, awakening during the night, final awakening earlier than desired, total sleep duration, and overall quality of sleep. The remaining three items pertain to the next-day consequences of insomnia (sense of well-being during the day, functioning during the day, and sleepiness during the day). Each item of AIS can be rated from 0 (*no problem at all*) to 3 (*very serious problem*). The total score ranged from 0 to 24 and was divided into two categories: ≧6 (*presence of insomnia*) and <6 (*absence of insomnia*). Respondents were requested to calculate their score if they had experienced sleep difficulties at least 3 times a week during the previous month.

Covariates

Educational background was categorized into “high school education or less” or “more than high school.” Frequency of leisure time exercise (with perspiration) was categorized into either “rarely or never”, “1-2 times per week” or “3 times per week or more”. Current smoking was classified as *yes* or *no*. Alcohol consumption was categorized into “rarely or never”, “1–5 times/week” or “6–7 times/week”. Anthropometric measures (height and body weight) were recorded according to a standardized protocol. The body mass index (BMI) was calculated as weight (kilograms)/height (meter squared) and divided into four groups: <18.5, 18.5–25, 25–30, and ≧30. Marital status was grouped into *unmarried* and *married*. Working hours (hours/week) were classified into four groups: <40 h, 40 to <50 h, 50 to <60 h, and ≧60 h. The number of days off (days/month) was classified into three groups: ≦5 days, 6–9 days, and ≧10 days. Shift work was categorized into “no” or “yes.” The duration of daily VDT work (hours/day) was specified into the following four categories: <2 h, 2 to <4 h, 4 to <6 h, and ≧6 h.

Statistical Analysis

First, differences in the distribution of variables by employment grade were tested for statistical significance with the chi-square test. Second, logistic regression analysis was performed to examine whether there were grade differences in insomnia before and after adjustment for job strain, E/R, and OC. Third, multivariable-adjusted odds ratios for insomnia were obtained for employment level and occupational stresses combined. For these analyses, we constructed nine groups of employment level and occupational stresses; “HNM and low stress”, “LNM and low stress”, “MW and low stress”, “HNM and medium stress”, “LNM and medium stress”, “MW and medium stress”, “HNM and high stress”, “LNM and high stress”, and “MW and high stress”. “HNM and low stress” was used as the reference category. Fourth, to investigate any supra-additive interactions between employment level and occupational stress, the relative excess risk due to interaction and the synergy index was obtained using the methodology of Andersson et al. [27–29]. For these analyses, low employment level was defined as manual workers, and high occupational stresses defined as the upper tertile of occupational stress (high job strain, high E/R, and high OC).

For all analyses, statistical significance was defined as a two-tailed P value of <0.05. All analyses were conducted using IBM SPSS Statistics SPSS 19 for Macintosh (SPSS Inc., Chicago, USA).

Results

The characteristics of participants by employment level are presented in Table 1. There were significant differences in all variables except body mass index. One thousand three hundred eighty-two (23.2 %) participants suffered from insomnia. The prevalence of insomnia was highest in MW (26.2 %), and lowest in HNM (17.0 %). A large proportion of participants with high job strain was associated with lower level of employment grade. The proportions of high E/R and high OC were the largest in LNM (37.4 and 33.5 %, respectively).

Table 2 shows grade differences in insomnia before and after adjustment for job strain, E/R, and OC. In comparison with HNM, the adjusted odds ratio of LNM and MW for insomnia was 1.29 (95 % confidence interval: 1.05 to 1.59) and 1.63 (1.23 to 2.15), respectively (model 1). A significant increase in trend for insomnia was observed with lower employment level. The inclusion of job strain in the model (model 2) attenuated the grade difference, but the significant trend remained. The inclusion of E/R in the model (model 3) attenuated the grade difference slightly, and once again the significant trend remained. Conversely, the inclusion of OC in the model (model 4) enhanced the difference in employment level. When all of the occupational stress factors were added to the model (model 5), the adjusted odds ratio of LNM and MW for insomnia were 1.17 (0.94 to 1.45) and 1.74 (1.30 to 2.34), respectively. The significant trend also remained. In model 5, high job strain, medium E/R, high E/R, medium OC, and high OC were significantly associated with insomnia.

Table 3 shows the multivariate adjusted odds ratio for insomnia by employment level and exposure to job strain, E/R and OC. With the participants divided into nine groups by employment level and job strain, significantly higher odds ratio for insomnia were seen for MW in any job strain category, LNM with medium and high job strain, and HNM with medium and high job strain, compared with HNM with low job strain. The participants with a higher risk of insomnia were associated with lower levels of employment and higher categories of job strain. As for the groups by employment level and E/R, significantly higher odds ratio for insomnia were seen for participants with medium or high E/R at any level of the employment, compared with HNM with low E/R. The participants with a higher risk of insomnia were associated with lower level of employment and higher categories of E/R. As for the groups by employment level and OC, significantly higher odds ratio for insomnia were seen for participants with medium or high OC at any level of employment compared with HNM with low OC. Participants with a higher risk of insomnia were associated with lower levels of employment and higher categories of OC.

Figures 1, 2, and 3 show the excess risks due to employment level, psychosocial work environments (job strain, E/R, and OC), and their interaction in an analysis of insomnia adjusted for the possible confounding factors. The relative excess risk due to interaction between manual workers and high job strain was 0.09 (95 %CI, −0.57 to 0.76), and the synergy index was 1.07 (0.66 to 1.74). The relative excess risk due to the interaction of E/R was 2.61 (0.74 to 4.48), and the synergy index was 1.99 (1.37 to 2.90). The relative excess risk due to interaction of OC was 3.14 (0.82 to 5.45), and the synergy index was 2.25 (1.46 to 3.46).

Discussion

We found that lower employment level was significantly associated with the risk of insomnia after being adjusted for multivariate factors, including job strain, E/R, and OC, in male Japanese public service workers. The effect of the combination of low employment level and high E/R or high OC on insomnia was clearly greater than the additive effect of the two separately; in that low employment level and high E/R or high OC led to a greater risk of insomnia. However, there was not a supra-additive interaction between employment level and job strain.

Though the DCM and ERI are widely used to assess psychosocial work environment, there is the difference in focus between these two models. The DCM model focuses on job task profiles [30], while the ERI model focuses on both situational and personal conditions at work [12, 31, 32]. Because of the difference in focus, the implications of ERI on the association of employment level with insomnia are thought to be different from that of the DCM. Siegrist et al. [12] indicated that exposure to an adverse psychosocial environment might be implicated in the association of socioeconomic health status in two ways. First, these exposures are likely to be experienced more frequently among lower socioeconomic groups (the mediation hypothesis). Second, the extent of the effect on health produced by adverse working conditions may be higher in lower status groups, due to their increased vulnerability (the effect modification hypothesis). With respect to the effect modification hypothesis, several studies have shown that susceptibility to exposure of an adverse psychosocial environment, assessed

Table 1 Characteristics of subjects by employment level

	Total	HNM	LNM	MW	
Number	5,946	960	4,112	874	
Insomnia					
Non-insomniacs	4,564 (76.8)	797 (83.0)	3,122 (75.9)	645 (73.8)	***
Insomniacs	1,382 (23.2)	163 (17.0)	990 (24.1)	229 (26.2)	
Age					
≦39	948 (15.9)	4 (0.4)	817 (19.9)	127 (14.5)	***
40–44	1,169 (19.7)	18 (1.9)	1,008 (24.5)	143 (16.4)	
45–49	1,325 (22.3)	174 (18.1)	996 (24.2)	155 (17.7)	
50–54	1,531 (25.7)	438 (45.6)	885 (21.5)	208 (23.8)	
55–59	973 (16.4)	326 (34.0)	406 (9.9)	241 (27.6)	
Educational background					
More than high school	3,233 (54.4)	749 (78.0)	2,392(58.2)	92 (10.5)	***
High school or less	2,713 (45.6)	211 (22.0)	1,720 (41.8)	782 (89.5)	
Frequency of drinking					
0 days/week	1,538 (25.9)	181 (18.9)	1,078 (26.2)	279 (31.9)	***
1 ~ 5 days/week	2,538 (42.7)	431 (44.9)	1,805 (43.9)	302 (34.6)	
6 ~ 7 days/week	1,870 (31.4)	348 (36.3)	1,229 (29.9)	293 (33.5)	
Smoking habit					
Non-smoker	3,315 (55.8)	598 (62.3)	2,316 (56.3)	401 (45.9)	***
Current smoker	2,631 (44.2)	362 (37.7)	1,796 (43.7)	473 (54.1)	
Frequency of exercise					
Rarely or never	3,470 (58.4)	509 (53.0)	2,515 (61.2)	446 (51.0)	***
1–2 times/week	1,536 (25.8)	285 (29.7)	1,010 (24.6)	241 (27.6)	
≧ 3 times/week	940 (15.8)	166 (17.3)	587 (14.3)	187 (21.4)	
Body mass index					
<18.5	74 (1.2)	6 (0.6%)	58 (1.4)	10 (1.1)	
18.5–25	4,016 (67.5)	666 (69.4)	2,762 (67.2)	588 (67.3)	
25–30	1,676 (28.2)	269 (28.0)	1,166 (28.4)	241 (27.6)	
≧30	180 (3.0)	19 (2.0)	126 (3.1)	35 (4.0)	
Marital status					
Married	5,148 (86.6)	881 (91.8)	3,513 (85.4)	754 (86.3)	***
Unmarried	798 (13.4)	79 (8.2)	599 (14.6)	120 (13.7)	
Working hours					
<40 h/week	568 (9.6)	103 (10.7)	340 (8.3)	125 (14.3)	***
40–50 h/week	3,944 (66.3%)	730 (76.0)	2,618 (63.7)	596 (68.2)	
50–60 h/week	1,011 (17.0)	102 (10.6)	777 (18.9)	132 (15.1)	
≧60 h/week	423 (7.1)	25 (2.6)	377 (9.2)	21 (2.4)	
Days off (days/month)					
≧10 days	2,345 (39.4)	348 (36.3)	1,651 (40.2)	346 (39.6)	***
6–9 days	3,300 (55.5)	578 (60.2)	2,272 (55.3)	450 (51.5)	
≦5 days	301 (5.1)	34 (3.5)	189 (4.6)	78 (8.9)	
Shift work					
No	5,039 (84.7)	941 (98.0)	3,603 (87.6)	495 (56.6)	***
Yes	907 (15.3)	19 (2.0)	509 (12.4)	379 (43.4)	
Duration of VDT work					
<2 h/day	1,704 (28.7)	268 (27.9)	693 (16.9)	743 (85.0)	***
2–4 h/day	1,716 (28.9)	436 (45.4)	1,224 (29.8)	56 (6.4)	
4–6 h/day	1,646 (27.7)	207 (21.6)	1,393 (33.9)	46 (5.3)	
≧6 h/day	880 (14.8)	49 (5.1)	802 (19.5)	29 (3.3)	

Table 1 (continued)

	Total	HNM	LNM	MW	
Job strain					
Low	1,870 (31.4)	356 (37.1)	121 (29.6)	297 (34.0)	***
Medium	2,089 (35.1)	386 (40.2)	1,486 (36.1)	217 (24.8)	
High	1,987 (33.4)	218 (22.7)	140 (34.3)	360 (41.2)	
E/R					
Low	1,988 (33.4)	389 (40.5)	122 (29.8)	373 (42.7)	***
Medium	1,976 (33.2)	355 (37.0)	1,349 (32.8)	272 (31.1)	
High	1,982 (33.3)	216 (22.5)	1,537 (37.4)	229 (26.2)	
OC					
Low	2,286 (38.4)	339 (35.3)	1,450 (35.3)	497 (56.9)	***
Medium	1,862 (31.3)	353 (36.8)	1,286 (31.3)	223 (25.5)	
High job	1,798 (30.2)	268 (27.9)	1,376 (33.5)	154 (17.6)	

Variables are presented as number (%)

VDT visual display terminal, *HNM* higher level of non-manual workers, *LNM* lower level of non-manual workers, *MW* manual workers, E/R effort–reward ratio, *OC* over commitment

*$p<0.05$, **$p<0.01$, ***$p<0.001$

by the DCM or the ERI, was higher among lower social status workers compared to those of a higher status, and that the risk of cardiovascular diseases increased among lower status workers [15, 39–41]. Our results showed that supra-additive interactions between employment level and E/R or OC were significant, but that job strain was not. These may signify that the extent of effects on insomnia produced by E/R or OC is higher in lower level workers, due to their

Table 2 Grade differences in insomnia before and after adjustment for occupational stress

	Odds ratio (95% confidence interval)				
	Model 1	Model 2	Model 3	Model 4	Model 5
Employment level					
HNM	Reference	Reference	Reference	Reference	Reference
LNM	1.29 (1.05 to 1.59) *	1.20 (0.98 to 1.48)	1.16 (0.94 to 1.44)	1.29 (1.05 to 1.60) *	1.17 (0.94 to 1.45)
MW	1.63 (1.23 to 2.15) **	1.48 (1.11 to 1.96) **	1.61 (1.20 to 2.14) **	1.92 (1.43 to 2.56) ***	1.74 (1.30 to 2.34) ***
p for trend	0.001	0.007	0.002	<0.001	<0.001
Job strain					
Low		Reference			Reference
Medium		1.43 (1.21 to 1.70) ***			0.98 (0.82 to 1.17)
High		2.44 (2.07 to 2.87) ***			1.22 (1.01 to 1.47) *
E/R					
Low			Reference		Reference
Medium			1.72 (1.43 to 2.06) ***		1.43 (1.18 to 1.73) ***
High			5.05 (4.23 to 6.02) ***		3.05 (2.50 to 3.73) ***
OC					
Low				Reference	Reference
Medium				2.00 (1.69 to 2.38) ***	1.68 (1.40 to 2.00) ***
High				4.95 (4.19 to 5.85) ***	3.16 (2.64 to 3.79) ***

Model 1 adjusted for age, education, marital status, drinking, smoking, exercises, BMI, working hours, days off, shift work, and VDT work; *Model 2* model 1 + adjusted for job strain; *Model 3* model 1 + adjusted for E/R; *Model 4* model 1 + adjusted for OC; *Model 5* model 1 + adjusted for job strain, E/R, and OC

HNM higher level of non-manual workers, *LNM* lower level of non-manual workers, *E/R* effort–reward ratio, *OC* over commitment

*$p<0.05$, **$p<0.01$, ***$p<0.001$

Table 3 Multivariate adjusted odds ratio for insomnia by employment grade and exposure to occupational stresses

	Multivariable adjusted odds ratio[a] (95 % confidence interval)		
	HNM	LNM	MW
Job strain			
Low	Reference	1.29 (0.88 to 1.88)	1.78 (1.10 to 2.86)*
Medium	1.74 (1.14 to 2.65)*	1.82 (1.26 to 2.63)**	2.24 (1.38 to 3.65)**
High	2.42 (1.53 to 3.83)***	3.25 (2.26 to 4.68)***	3.72 (2.41 to 5.73)***
E/R			
Low	Reference	1.10 (0.75 to 1.62)	1.31 (0.81 to 2.10)
Medium	1.77 (1.14 to 2.74)*	1.86 (1.28 to 2.70)**	2.24 (1.40 to 3.59)**
High	3.92 (2.51 to 6.13)***	5.36 (3.71 to 7.74)***	9.43 (5.95 to 14.97)***
OC			
Low	Reference	1.18 (0.78 to 1.80)	1.48 (0.92 to 2.39)
Medium	1.87 (1.16 to 3.00)*	2.25 (1.49 to 3.39)***	3.42 (2.07 to 5.65)***
High	3.94 (2.48 to 6.25)***	5.58 (3.72 to 8.36)***	10.51 (6.26 to 17.65)***

[a]Adjusted for age, education, marital status, drinking, smoking, exercises, BMI, working hours, days off, shift work and VDT work

HNM higher level of non-manual workers, *LNM* lower level of non-manual workers, *E/R* effort–reward ratio, *OC* over commitment

*$p<0.05$, **$p<0.01$, ***$p<0.001$

increased vulnerability. Further research is needed to investigate the synergistic interaction effect between employment level and exposures to an adverse psychosocial environment on worker's health.

Furthermore, with respect to the mediation hypothesis, several studies have reported that the higher prevalence of high job strain or low job control among the lower social position explains part of the risk for cardiovascular disease [1, 42, 43]. However, there were few reports showing that adverse psychosocial environment, assessed by the ERI, mediated the inverse association of socio-economic status with health status of workers. Sekine et al. [6] revealed that uneven distribution of low job control might mediate the association of low employment grade with insomnia among Japanese male workers. In our study, exposure to high job strain was likely to be experienced more frequently among manual workers. And the results of multivariate analyses showed that the odds ratio of manual workers was attenuated after adjusted for job strain. These may indicate that the uneven distribution of exposure to job strain affects the difference in employment level and insomnia. In contrast, exposure to E/R or OC was not likely to be experienced more frequently among workers of lower employment level. And the odds ratio of manual workers was attenuated only slightly after adjusted for E/R, and enhanced after adjusted for OC. Because findings on ERI are scarce, further research is needed to investigate the mediation hypothesis.

Soldatos et al. [44] reported the results of an epidemiological study on insomnia assessed by the AIS in ten countries. The prevalence of insomnia in Japanese participants (men=50.9 %) was 28.5 %. Because most previous studies have indicated that the prevalence of insomnia

Fig. 1 Multivariate-adjusted odds ratio of contribution of employment level and job strain on insomnia

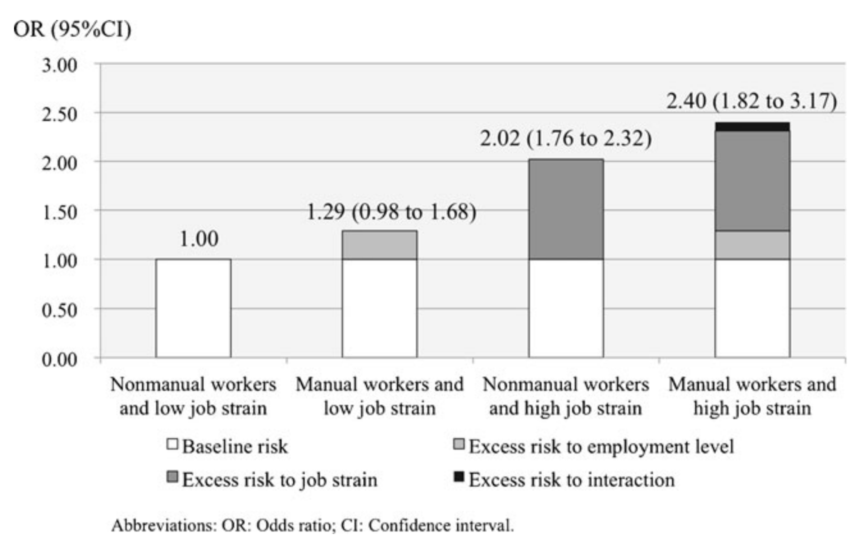
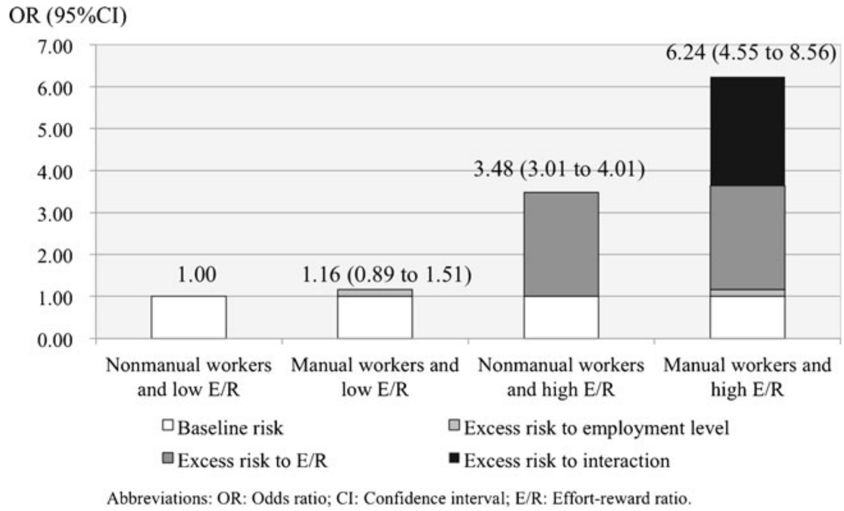


Fig. 2 Multivariate-adjusted odds ratio of contribution of employment level and effort–reward strain on insomnia

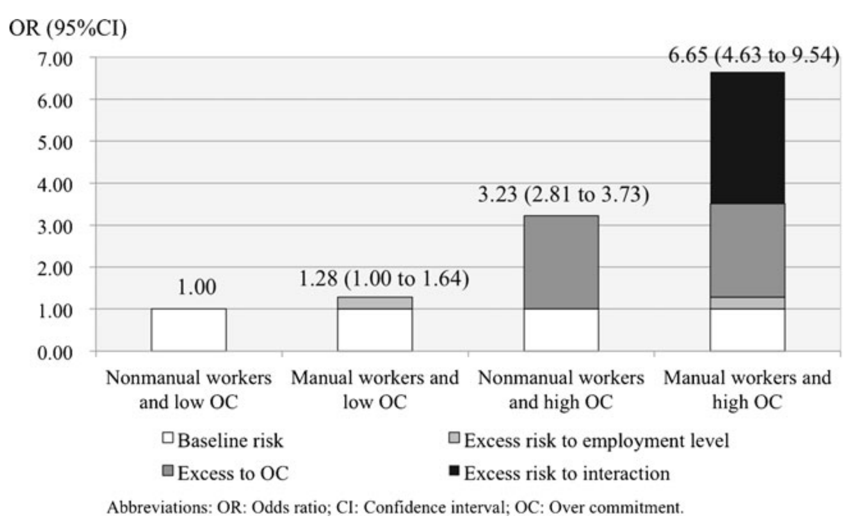


among women was generally higher than among men [18, 45], the prevalence of insomnia in our research was slightly lower than that of Soldatos. Sekine et al. [6] reported that the prevalence of insomnia, assessed by the Pittsburgh Sleep Quality Index, in male employees in local government in Japan was 21.2 %. While we assessed insomnia using the AIS, our results are similar to those obtained by Sekine.

One previous study among employees in local government in Japan reported that there was a significant grade difference in sleep among men, but not among women [6]. Another by Martikainen et al. [2] compared the pattern of socioeconomic inequalities in physical functioning and perceived health among male and female public sector employees in Britain, Finland, and Japan. Their results showed that there are SES inequalities in perceived health and physical functioning among men and women in Britain and Finland, and among men in Japan. However, the pattern of ill health was less consistent and smaller among Japanese women. In this study, while data on female participants are not shown, we found no significant association between employment level and insomnia. In addition, there is some evidence that the association of SES with health among women is not as strong when women are classified by their own occupation rather than the occupation of the head of their household [46]. Thus, it might be appropriate that the occupation of the head of the household or total household income be used when investigating health inequalities in women.

Several limitations should be considered in the interpretation of our results. First, because our study was a cross-sectional study, the causal nature of the association between insomnia and employment level and psychosocial work environments cannot be determined. Second, variables that could be analyzed were limited. For example, information on history of mental health problems and the use of psychiatric drugs was not available. These factors could affect the sleep state of workers [47, 48], and could have been important putative confounding factors. Third, because the response rate of our study was rather low, our study could

Fig. 3 Multivariate-adjusted odds ratio of contribution of employment grade and overcommitment on insomnia



not completely eliminate sampling bias. We were unable to obtain data on non-responders and compare the prevalence of insomnia, employment level, psychosocial work environment, and other characteristics between the responders and non-responders. In addition, those who perceived a large amount of stress might not have answered the questionnaire, and those who perceived very low stress might have had no interest in the stress and sleep questionnaire. However, because the overall prevalence of insomnia in our study did not differ from those in prior studies [6, 44], we believe that either the presence or absence of insomnia was minimally affected by the study population. Fourth, the measurement of insomnia was based on self-assessment. Moreover, while the AIS was employed for describing between-country differences in both prevalence and type of sleep disorders[44], the Japanese version has not yet been validated. The prevalence of insomnia is different according to definitions; the prevalence in self-assessments is higher than those diagnosed clinically based on the DSM-IV classification [18]. Fifth, our research was conducted during April 2003 to March 2004. Since sleep habits could be influenced by seasonal factors [49], our results might also have been affected. Finally, participants in this study were working civil servants, which may make it difficult to generalize the results of this study.

In summary, we found SES inequality in insomnia in Japanese male workers, and that supra-additive interactions existed between employment level and adverse psychosocial work environment, assessed by the ERI ('effort-reward ratio' and 'over commitment'). However, no supra-additive interaction existed between employment level and DCM. Our findings suggested that lower level workers are more vulnerable to adverse psychosocial work environment than those at a higher level. Even if we recognize health inequalities between employment levels, it is difficult to remove SES inequality from occupational settings. However, we can improve harmful circumstances that are caused by SES inequality. First, we need to monitor psychosocial work circumstances regularly, and next we have to redesign working conditions based on monitored data. Thus, appropriate measures, such as monitoring stress and redesigning work conditions, should be taken to alleviate occupational stress, especially among lower grade workers.

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