of short-term sick leave [2, 18]. Furthermore, reports from these studies indicated that the association was observed only among limited groups of employees, i.e., male employees with low levels of employment [18] and female employees [2].

Moreover, from a methodological viewpoint, most previous longitudinal studies [1, 2, 18, 26, 16] did not consider sick leave at the baseline, which might have resulted in a limited interpretation of the findings: if subjects with greater sick leave days reported high job stress at the baseline, an apparent association would be expected between baseline job strain and sick leave at the follow-up. The relationship between job strain and sick leave has been examined in only one study in which controls were established for sick leave at the baseline [19]. However, this study did not reveal any significant association between job strain and sick leave because the job demand was negatively associated with sick-leave absences. Thus, there is still limited evidence in longitudinal studies for an association between the job demand–control (–support) model and sick leave.

It is generally accepted that Japanese employees take fewer sick leave days than their western counterparts. For instance, Japanese companies have reported that 2.8% [14] of male employees took 7 days or longer sick leave per year, while 14.5% of the male workers in the UK Whitehall II study took an equivalent amount [25]. In a previous study the employees ($n = 1{,}183$) at the baseline who took 7 days or longer sick leave in a year was 6.2% for males and 8.6% for females. Japanese employees appear to have greater commitment to their jobs and companies [12]. Moreover, it is suggested that Japanese ethics may discourage employees from taking sick leave even when they are ill [15]. The characteristics of the Japanese labor market may account for the differences between job strain and sick leave that are reported in western countries.

Several studies in Japan have explored the effects of mental health-promotion programs [22, 23] and related improvements in the working environment [9]. These studies indicate that such psychosocial interventions may have a positive effect on sick leave patterns related to job stress and lack of social support received at the worksite. However, to date, no epidemiological evidence is available on the association between job strain and sick leave in Japan. Most previous studies on the association between job stressors and sick leave, except the one from Singapore [27], were conducted in western countries, such as the EU, the UK, and the US. It is important to investigate whether or not the association between the job demand–control (–support) model and sick leave can be generalized to non-western working populations.

The purpose of this study was to determine whether job strain and social worksite support for Japanese employees at the baseline can predict how sick leave will be used. At the baseline, only subjects without a history of taking sick leave were used in the study; this restriction was used to obtain a clearer effect of job strain on taking sick leave. In previous studies [1, 2, 16], a worksite social-support scale was established by combining the support from supervisor and co-worker. In this study, to determine differences in the outcome, the effects of support from supervisors and co-workers were examined separately.

Methods

Study subjects

In 1997, a baseline questionnaire was given to 2,625 employees of an electronics firm in Gifu Prefecture, Japan, whose age ranged from 18 to 60. A total of 2,364 (90%) employees (1,902 males and 462 females) returned the questionnaire. Of these, 2,035 employees (1,688 males and 347 females) completed all of the relevant questions in the baseline questionnaire, and these subjects were followed-up. In 1999, follow-up studies were conducted and complete responses obtained from 1,183 subjects (997 males and 186 females) (follow-up rate 58%).

Among the follow-up individuals, 448 males and 81 females reported that they had not used sick leave in the year preceding the baseline (45 and 44%, respectively). The analyses were restricted to those subjects who had not reported the use of sick leave at the baseline in order to test strictly the relationship between job strain and the use of sick leave.

The characteristics of the male/female subjects were as follows: the average age (standard deviation) was 33.5/31.7 (9.8/7.6) years, and 41.7/16.0% of the subjects had completed more than 12 years of education. The male/female employee were categorized into three occupations: managers (13.2/0.0%), white-collar workers (professionals, technicians, clerks, and service workers) (43.8/59.3%), and blue-collar workers (mechanics, laborers and unspecified) (43.1/40.7%).

Measures

Self-administered questionnaires were used for data collection in 1997 and 1999. The questionnaire asked for information on socio-demographic variables, occupations, health-related behavior, and sick leave and included a Japanese version of the Job Content Questionnaire (JCQ).

The JCQ was designed to measure work environment characteristics based on the demand–control–support model [5–7]. The Japanese version of the JCQ has been validated and tested for reliability [8]. The questionnaire consists of scales of job demand (five items), job control (nine items), supervisory support (four items), and co-worker support (four items); Likert-scale response options from 1 (completely disagree) to 4 (completely agree) were used. Cronbach's alpha coefficients among the study subjects were 0.66 for job demand, 0.84 for job control, 0.85 for supervisor support, and 0.73 for co-worker support. Job demand, job control, and worksite social support at the baseline were calculated by summing the scores according to the JCQ guideline [7] and dividing the results into tertile. As an indicator of job strain, the ratio of job demand to job control was also calculated and divided into tertile.

Sick leave absences were measured by self-reporting as the total for the year preceding the baseline and the follow-up. The average number (standard deviation) of days used for sick leave was 2.3 (9.0) at the baseline ($n=1,688$) and 2.7 (16.5) at the follow-up ($n=997$) for males and 3.8 (20.0) at the baseline ($n=347$) and 2.5 (3.9) at the follow-up ($n=186$) for females. Considering the small number of sick leave days, this study sample was divided into two groups based on the sick leave days for the past year at follow-up: 5 days or longer ($n=33$) and 0–4 days ($n=496$).

Health-related behavior included the number of cigarettes smoked daily and the amount of alcohol consumed weekly. The number of cups was estimated from the amount and type of alcohol consumed: one cup was equal to 350 ml of beer, 120 ml of wine, or 40 ml of whisky.

Table 1 The association between studied variables at baseline (1997) and sickness absence (5 days or longer per year) at follow-up (1999) among employed Japanese males ($n=448$) and females ($n=81$) who had no sickness absence at baseline

Variable	Sickness absence of 5 days or longer					
	N	*n*	%	Crude OR	95%CI	
					Lower	Upper
Job demand						
Low	168	7	4.17	1.00		
Medium	191	10	5.24	1.27	0.47	3.42
High	170	16	9.41	2.39	0.96	5.97
Job control						
Low	172	13	7.56	1.00		
Medium	192	10	5.21	0.67	0.29	1.57
High	165	10	6.06	0.79	0.34	1.85
Job strain (job demand/control ratio)						
Low	176	6	3.41	1.00		
Medium	176	13	7.39	2.26	0.84	6.09
High	177	14	7.91	2.43	0.91	6.49
Supervisor support						
Low	162	10	6.17	1.00		
Medium	79	5	6.33	1.03	0.34	3.11
High	288	18	6.25	1.01	0.46	2.25
Co-worker support						
Low	118	9	7.63	1.00		
Medium	165	6	3.64	0.46	0.16	1.32
High	246	18	7.32	0.96	0.42	2.20
Gender						
Male	448	31	6.92	1.00		
Female	81	2	2.47	0.34	0.08	1.45
Age						
29 years or less	215	13	6.05	1.00		
30–39 years	189	14	7.41	1.24	0.57	2.72
More than 40 years	125	6	4.80	0.78	0.29	2.12
Education						
12 years or less	329	16	4.86	1.00		
More than 12 years	200	17	8.50	1.82	0.90	3.68
Occupation						
Managers	59	6	10.17	1.00		
White collar	244	13	5.33	0.50	0.18	1.37
Blue collar	226	14	6.19	0.58	0.21	1.59
Smoking						
Non-smoker	303	16	5.28	1.00		
1–14 per day	57	1	1.75	0.32	0.04	2.47
15 or more per day	169	16	9.47	1.88	0.91	3.85
Drinking						
None	102	7	6.86	1.00		
one cup	233	11	4.72	0.67	0.25	1.79
two cups or more	194	15	7.73	1.14	0.45	2.89

The variables were classified into tertiles except for gender, education, and occupation

Statistical analysis

The odds ratios (ORs) and 95% confidence intervals (95% CIs) of using 5 days or longer sick leave for the year preceding the follow-up were calculated with a simple logistic regression analysis and showed crude odds ratio for all variables (Table 1). Confounding factors included gender, age (categorized = < 29 years, 30–39 years, = > 40 years), education completed (categorized = < 12 years and > 12 years), occupation, daily tobacco consumption (categorized non-smoker, 1–14 per day, = > 15 per day), and weekly alcohol consumption (categorized non-drinker, one cup per week, = > two cups per week). These variables affect health outcomes and were treated as confounding factors in previous studies on sick leave related to job strain [18, 26, 2, 21]. Job strain, supervisory support, and co-worker support were entered by force in a multiple logistic regression model using sick leave as a dependent variable, and any trend in the pattern was determined (Table 2). Analyses were conducted by using SPSS 11.0J [24].

Results

The crude ORs and 95% CIs for sick leave in the follow-up study are shown in Table 1 according to the studied variables at the baseline. A medium or high level of job strain, in comparison with a low level of job strain, at the baseline was marginally and significantly associated with increased risk of being absent for 5 days or longer during the previous year, as determined by the follow-up study. A high level of job demand was also marginally and significantly associated with increased risk. Subjects with high job control or high worksite support at the baseline were less likely to have taken sick leave as reported in the follow-up study, but the associations were

Table 2 The association between pyschosocial job characteristics at baseline (1997) and sickness absence (5 days or longer per year) at follow-up (1999) among employed Japanese males ($n = 448$) and females ($n = 81$) by logistic regression analysis, including the results for the confouding factors

Variable	Sickness absence of 5 days or longer ($n = 33$)			
	Adjusted OR	95%Cl		p value for trend
		Lower	Upper	
Job strain (job demand/control ratio)				
Low	1.00			
Medium	2.11	0.74	5.98	
High	3.02	1.00	9.16	< 0.05
Supervisor support				
Low	1.00			
Medium	1.02	0.32	3.28	
High	1.00	0.41	2.47	n.s.
Co-worker support				
Low	1.00			
Medium	0.42	0.14	1.30	
High	0.84	0.33	2.16	n.s.
Gender				
Male	1.00			
Female	0.45	0.09	2.20	
Age				
29 years or less	1.00			
30–39 years	1.07	0.42	2.70	
More than 40 years	0.35	0.07	1.71	
Education				
12 years or less	1.00			
More than 12 years	1.88	0.68	5.18	
Occupation				
Managers	1.00			
White collar	0.22	0.05	1.00	
Blue collar	0.29	0.05	1.67	
Smoking				
Non-smoker	1.00			
1–14 per day	0.35	0.04	2.84	
15 or more per day	1.94	0.85	4.45	
Drinking				
None	1.00			
one cup	0.41	0.14	1.23	
Two cups or more	0.68	0.23	1.95	

not statistically significant. There were no significant differences in gender, age, occupation, and weekly alcohol consumption between the two groups, one that took 0–4 sick days and the other that took 5 days or longer. However, in the group that look 5 days or longer sick leave, the daily tobacco consumption and higher level of education completed were marginally and significantly higher.

The multiple logistic regression analysis indicated that individuals exposed to high strain at the baseline were three times more likely to have taken 5 days or longer sick leave after adjusting for gender, age, education completed, occupation, daily tobacco consumption, and weekly alcohol consumption (Table2), and, in addition, the risk increased significantly along with increasing levels of job strain ($p < 0.05$). Worksite social support was not associated with a reduction in the risk of sick leave. The logistic regression model with job demand and job control, in place of job strain (demand/control ratio), as independent variables provided no significant associations (OR 1.22; 95%CI 0.43–3.48 and OR 2.00; 95%CI 0.75–5.36 for medium and high demands, respectively; OR 0.62; 95%CI 0.24–1.59 and OR 0.44; 95%CI 0.14–1.39 for medium and high controls, respectively). The trend in the risk of 5 days or longer sick leave was not significant when considering job demand or job control.

The different figures may appear with a different dichotomization of the number of sick leave days. Analyses were repeated with different dichotomizations (Table 3). Similar association was shown with the dichotomization of 4 days or longer, and the dose–response relationship was supported. Higher strain was associated with sick leave of six or more days and seven or more days, but the associations were not statistically significant.

Discussion

After adjusting for gender, age, education, occupation, and health-related behavior, a high level of job strain was found to be associated with an increased risk of sick leave in the follow-up study of Japanese employees who had not taken sick leave at the baseline. The present study demonstrated a prospective association between job strain and sick leave.

In the present study, the total number of sick leave days taken in the previous year was counted and the data divided into two groups, one of 5 days or longer and the other of less than 5 days. The findings here are compatible with earlier studies that focused on short-term spells of sick leave. Bourbonnais and Mondor [2] found that female employees with high demand and low control over their jobs were quite likely to take more short-term sick leave (incidence ratio 1.20). North et al. [18] found that men who reported high job demand and low job control took 10–20% more sick leave for short-term periods. Kristensen [11] indicated that absences due to sickness were not a simple indication of the adverse health effects of job stressors but, rather, could be determined individually by integrating several relevant factors, such as work environment characteristics, an employee's personal perception of his health status, and his coping possibilities. Kivimaki et al. [10] suggested that short-term sick leave indicates employees have coped with job stress. If Kivimaki's results could be applied to our sample, it might be concluded that subjects who were exposed to high job strain developed coping behavior.

Although the trends were as expected, the individual variables of job demand and job control were not significantly associated with increased risk of taking sick leave. In agreement with Karasek's theory, the combination of high job demand and low job control may be the best predictor of health outcome. With regard to job demand, low-scale reliability of the variable may result in an underestimation of the associations.

Co-worker support resulted in a reduction in the risk of sick leave, and, in this study, supervisory support was not associated with sick leave. As reported elsewhere, Japanese employees' behaviors for sick leave in relation to their colleagues may be unique [15]. Japanese employees may not use sick leave, even when they are sick, because they do not want to inconvenience their co-workers or supervisors. On the other hand, a conscientious

Table 3 The association between pyschosocial job characteristics at baseline (199 7) and sickness absence (4, 6, and 7 days or longer per year) at follow-up (1999) among employed Japanese males ($n = 488$) and females ($n = 81$) by logistic regression analysis, adjusted by gender, age, education, occupation, smoking, and drinking

Variable	Sickness absence of 4 days or longer a year ($n = 41$)			Sickness absence of 6 days or longer a year ($n = 25$)			Sickness absence of 7 days or longer a year ($n = 20$)		
	Adjusted OR*	95%CI		Adjusted OR*	95%CI		Adjusted OR*	95%CI	
		Lower	Upper		Lower	Upper		Lower	Upper
Job strain (job demand/control ratio)									
Low	1.00			1.00			1.00		
Medium	1.86	0.70	4.97	1.96	0.62	6.19	2.27	0.63	8.17
High	3.27	1.20	8.96	2.64	0.76	9.16	2.51	0.60	10.51
p for trend	$p < 0.05$			n.s.			n.s.		

* Odds ratio was adjusted for gender, age, education, occupation, smoking, and drinking

supervisor would advise an employee to take sick leave when ill. Associations between worksite support and the use of sick leave, because of its complexity, may require further study. A comparative study examining supervisory and co-worker supports separately might produce valuable insights.

Job strain was significantly associated with the number of sick days taken: 4 days or longer and 5 days or longer, and the dose–response relationship was supported. Similar associations were found when we used different outcomes of more frequent sick leave (6 days or longer); however, the associations were insignificant and the dose–response relationship became unclear. The reason considered was that the power was insufficient to detect the association, because the number of subjects who had much more frequent sick leave was small.

The present study had several limitations. The retrospective power analyses suggested that the number of the participants to contrast the differences between the risk and non-risk groups by 80% power was more than 400 in one group. Probably, observed negative findings reflected lack of study power. The follow-up rate of the study sample was relatively low (58%). Compared to the non-respondents at the follow-up study, the respondents had some significant differences on the variables at the baseline: the rate of males was higher, the education level, and job control were lower. This finding could not explain whether the relationship between job strain and the use of sick leave might either be overestimated or underestimated because the information on non-respondents, including the reasons for their leaving the company, was insufficient. In addition, the measures of work environment characteristics and the data on sick leave were based on self-report. Self-reporting of sick leave may be valid [4], but the present study should be replicated using more objective information. Furthermore, no effort was made to distinguish between the frequency of sick leave and its duration. Finally, no adjustments were made for baseline health status and personality, which could potentially confound the association [27, 17, 20, 13].

In spite of these limitations, the present study indicates that a high level of job strain may be associated with an increased risk of sick leave among Japanese employees who take sick leave less frequently than their counterparts in western countries, although further study may be required.

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ORIGINAL ARTICLE

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Exposure to particles and nitrogen dioxide among taxi, bus and lorry drivers

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Abstract *Aim*: The aims of this study have been to investigate the occurrence of systematic differences in the personal exposure to motor exhaust between different groups of taxi, bus and lorry drivers, and to study if these are influenced by the choice of exposure indicator. *Methods*: We used one indicator of the gaseous phase, nitrogen dioxide (NO_2), and one of the particle phase (measured by DataRAM), of the exhausts. A total of 121 drivers were included in the study: 39 taxi drivers, 42 bus drivers and 40 lorry drivers. Personal measurements were performed during one working day. Nitrogen dioxide was measured with passive diffusive samplers and particles with Data-RAM, a logging instrument using nephelometric monitoring. The instrument measures particles between 0.1 and 10 μm in size. *Results*: The average exposure to NO_2 for lorry drivers was 68 $\mu g/m^3$; for bus drivers 60 $\mu g/m^3$ and for taxi drivers 48 $\mu g/m^3$. For particles the exposure was 57 $\mu g/m^3$ for lorry drivers, 44 $\mu g/m^3$ for bus drivers and 26 $\mu g/m^3$ for taxi drivers. The result remained unchanged when exposures were adjusted for variation in urban background levels of NO_2 and particulate matter with an aerodynamic diameter < 10 μm (PM_{10}). *Conclusion*: Lorry drivers experienced the highest exposure and taxi drivers the lowest with bus drivers in an intermediate position, regardless of whether NO_2 or particles were used as exposure indicator. The levels of both NO_2 and particles were higher for bus drivers in the city than for them driving in the suburbs. Using diesel or petrol as a fuel for taxis had no influence on the exposure for the drivers, indicating that the taxi drivers' exposure mainly depends on exhaust from surrounding traffic.

Keywords Occupational exposure · Motor exhaust · Diesel exhaust · Petrol exhaust · Professional drivers

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Introduction

Previous studies have indicated an increased risk of lung cancer (Bofetta et al. 1997) and myocardial infarction among professional drivers (Tüchsen 2000). The International Agency for Research on Cancer classified diesel exhaust as *probably carcinogenic* to humans and petrol exhaust as *possibly carcinogenic* to humans (IARC 1989).

A previous epidemiological study reported an increased risk of lung cancer among Swedish short-distance lorry drivers but not among bus drivers, while the risk among taxi drivers was slightly increased and of borderline significance (Jakobsson et al. 1997). The difference in lung cancer risk between drivers driving different vehicles led us to investigate if there are differences in exposure between groups of drivers. There are some earlier investigations of motor exhaust exposure among professional drivers (Guillemin et al. 1992, Zagury et al. 2000, Son et al. 2004) but we have found no earlier reports regarding the personal exposure to motor exhaust specific for vehicle type.

The aims of this study were to investigate the occurrence of systematic differences in the personal exposure to motor exhaust between different groups of taxi, bus, and lorry drivers, and to study if these are influenced by the choice of exposure indicator. We used one indicator of the gaseous phase, nitrogen dioxide, and one of the particle phase (measured by DataRAM), of the exhausts. A third aim was to investigate if there are differences in the exposure among drivers in the city and suburban areas of Stockholm. We could segregate city and rural driving for bus and lorry drivers, but this was not possible in the case of taxi drivers.

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Relationship between Two Job Stress Models and Coronary Risk Factors among Japanese Part-Time Female Employees of a Retail Company

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Abstract: Relationship between Two Job Stress Models and Coronary Risk Factors among Japanese Part-Time Female Employees of a Retail Company: Yuka KOBAYASHI, *et al.* Department of Hygiene and Preventive Medicine, Okayama University Graduate School of Medicine and Dentistry—The objective of this study was to explore the associations between two major job stress models (job strain and effort-reward imbalance) and coronary heart disease (CHD) risk factors (blood pressure; total, high- (HDL) and low-density lipoprotein (LDL) cholesterol; and triglycerides) in Japanese part-time female employees of a retail company. The study population was either 35 yr old or between 40 and 63 yr old. Data collection was carried out in 2002; a total of 1,401 subjects participated in a medical examination and completed a questionnaire. After adjusting for other covariates (age, relative weight, tobacco use, alcohol consumption, lack of exercise, education, marital status, history of child bearing, medical treatment for disease, and occupation), a significant association was found between the effort-reward imbalance, a "high-cost and low-gain" condition at work, and a high prevalence of low HDL cholesterol (Odds ratio = 4.4). A weak but unexpected association was found between job strain and low prevalence of low HDL cholesterol. In explanatory analysis with individual components of the two models, associations were evident between high extrinsic effort and high prevalence of low HDL cholesterol and low prevalence of high triglyceride, high job control and low prevalence of high systolic blood pressure, and high job demands and low prevalence of high systolic and diastolic blood pressure. In this cross-sectional study of Japanese part-time working women, a significant association was found between effort-reward imbalance and unfavorable HDL cholesterol profiles. The findings did not support the hypothesis that job strain is associated with CHD risk factors.
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Key words: Job strain, Effort-reward imbalance, Coronary risk factors, Part-time workers, Women, Japan

In the past two decades, a cumulative body of results has been reported showing an association between job strain defined in Karasek's job strain model[1)] and coronary heart disease (CHD)[2–4)] and its risk factors[5–17)]. A high level of job strain, that is, a combination of high level of job demands and low level of job control, has been found to be associated with physiological CHD risk factors, such as high blood pressure in men[5–10)] and women[11)], high serum total cholesterol in men[9–12)] and women[9)], low high-density lipoprotein (HDL) cholesterol in men and women[11)], and high triglycerides in men[8)]. In addition, social support at work appears to reduce the effects of job strain on CHD risk factors, such as high blood pressure in women[18)] and high serum total cholesterol in men[9)]. However, previous studies have reported no clear association between job strain and high blood pressure in men[11, 14, 15, 19, 20)] and women[6, 7, 9, 15, 17, 20)], high serum total cholesterol in men[5, 8, 13, 14, 20)] and women[12, 13, 17, 20)], low HDL cholesterol in men[8, 11–13, 15, 20)] and women[12, 13, 15, 17, 20)], and high triglycerides in men[15, 20)] and women[15, 17, 20)].

Another more recently developed job stress model is the effort-reward imbalance model[21)]. This model supposes that the source of stress in the workplace results from imbalance between individual recognition of extrinsic effort (e.g., high workload) and the extrinsic

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reward (e.g., money, esteem, and occupational status control), focusing on the negative trade-off between experienced costs and gains at work. However, this model has been studied much less than the job strain model, which shows that effort-reward imbalance also predicts CHD[22–24]. A significant association between effort-reward imbalance and high blood pressure, high serum total cholesterol, and high total / HDL cholesterol has been observed in men[25].

Information on women is sparse and inconsistent when compared to the data from studies of men[6, 9, 11–13, 15, 17, 20] with regard to the job strain model[6, 9, 11–13, 15, 17, 20], effort-reward imbalance model[25], and a combination of both[23]. These differences might be attributable to difficulties in finding associations owing to the protective function of female reproductive hormones and contamination of data from domestic work and job stress. Another important factor related to job stress is whether an individual is employed full- or part-time. Recently, the number of part-time working women has been increasing in Japan[26]; it has grown by approximately 1.4 times in the last decade. The results of studies in western countries indicate that part-time workers have lower levels of perceived job stress than full-time workers[27]. The low levels of job stress among part-time employees might be attributable to limited exposure to job stressors; however, a Japanese study showed lower levels of decision latitude in female temporary employees than permanent employees[28]. Furthermore, part-time employees experience more job insecurity and poorer prospects for promotion than full-timers. Although such differences in job stress are generally attributed to working conditions, it appears that the association between job stress and CHD risk factors in part-time employees has never been examined.

The questionnaires used for the job strain and effort-reward imbalance models are similar (i.e., job demands and extrinsic effort); however, the job strain model focuses more on task-oriented characteristics, while the effort-reward imbalance model deals with the broader occupational environment. Furthermore, the questionnaires show that the job strain scale makes use of objective job characteristics[29], while the effort-reward imbalance questionnaire measures the emotional aspects induced by stressful situations (see the Methods section). Thus, associations with biological CHD risk factors, if any, might be different between the two stress measures. Furthermore, application of the two stress models might provide more comprehensive features of the association between psychosocial job stress and coronary risks.

The objective of this study was to explore the associations between psychosocial work environments and CHD risk factors in a population of Japanese part-time female employees. Japanese retail companies hire many part-time females, and we used a large database of retailers. The two stress models and biological CHD risk factors were measured simultaneously.

Subjects and Methods

Subjects

The study population was recruited from a retail business in Miyagi Prefecture, Japan. A total of 5,635 employees were engaged in processing, sales, and the delivery of dairy goods, and about 80 percent of them were part-time employees. The target population included 3,510 female employees who worked four hours daily, 20 hours weekly, five days a week. They were selected from all part-time females (n=4,104), and the majority worked four-hour shifts.

A cross-sectional survey was carried out between July and December 2002 using a mailed questionnaire on demographic variables and the psychosocial work environment. Each employee was asked to complete the questionnaire. They also underwent an annual medical examination, which included a physical examination to determine blood pressure and blood tests. Blood samples were collected from participants aged 35 yr and from those aged 40 yr or above (n=2,798), according to the Industrial Safety and Health Law and related regulations. One thousand four hundred one participants completed both the questionnaire and medical examination, including the blood test (participation rate: 50%).

The study design and procedures were reviewed and approved by the Human Ethics Committee for Epidemiological Research at the Okayama University Graduate School of Medicine and Dentistry, Japan.

Procedures

CHD risk factors

The biological risk factors for CHD were measured as a part of the medical examination. The examination included measurements of blood pressure and serum lipids from blood samples, and took place during working hours (09:30 to 16:00).

The subject was seated, and then blood pressure was measured on the right arm once or twice by trained nurses. Measurements were obtained with a sphygmomanometer. The point at which the Korotkoff sounds disappeared (Swan's point 5) was recorded as the diastolic blood pressure. High systolic blood pressure was defined as 140 mmHg or greater and high diastolic blood pressure was defined as 90 mmHg or greater, according to the guidelines of The Japanese Society of Hypertension[30].

Serum total cholesterol, HDL cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides were measured from the blood samples using high performance liquid chromatography. High serum total cholesterol was defined as 220 mg/d*l* or greater; low HDL cholesterol as under 40 mg/d*l*; high LDL cholesterol as 140 mg/d*l* or greater; and high triglycerides as 150 mg/d*l* or greater, according to the guidelines of the Japan Atherosclerosis

Society[31].

Psychosocial job stressors

Psychosocial job stressors were measured according to two major job stress models, the job strain[1] or demand-control-support model[4] and the effort-reward imbalance model[21]. The job strain model was measured using the Japanese version of the Job Content Questionnaire (JCQ), which contains 22 Likert-scaled items[32, 33]. Job strain score reflects a relatively objective work environment[29]. A scale of 1 to 4 was used to measure job strain. There were 5 items measuring "job demands" such as "working very fast"; nine items composed of two subscales for "job control": "skill discretion" with 6 items such as "opportunity to develop abilities", and "decision authority" with 3 items such as "allowed to make decisions"; four items for "supervisor support" such as "the supervisor pays attention to me"; and 4 items on "coworker support" such as "coworkers take an interest in me". The questions were designed to seek information about the existence of stressors in the workplace. A 4-point scale ranging from *strongly disagree* to *strongly agree* was developed, and the scores ranged from 12 to 48 for job demands, 24 to 96 for job control, 4 to 16 for supervisor support, and 4 to 16 for coworker support. The reliability coefficients of each subscale were job demands: 0.65, job control: 0.72, supervisor support: 0.90, and coworker support: 0.77. The quotient of job demands to job control was used as an indicator of "job strain" according to previous studies[19], and ranged from 0.1 to 2.0. The subjects were grouped into one of three strata for each psychosocial job stressor (low, medium or high) based on tertiles defined according to the distribution of scores: 15–31, 32–35, and 36 or greater, respectively, for job demands; 24–58, 59–66, and 67 or greater, respectively, for job control; 4–9, 10–11, and 12 or greater, respectively, for supervisor support; 4–10, 11, and 12 or greater, respectively, for coworker support; and 0.28–0.51, 0.51–0.61, and 0.61 or greater, respectively, for the job strain index.

The effort-reward imbalance model was measured using the Japanese version of the effort-reward imbalance questionnaire, which contains 17 Likert-scaled items[21, 34]. Two categories were used to measure these items. One was "extrinsic effort", which had 6 items such as "I am under constant time pressure due to my heavy work load", the other was "extrinsic reward", which had 11 items composed of three subscales. The subscales were as follows: "job promotion and salary" with 4 items such as "My job promotion prospects are poor"; "esteem" with 5 items such as "I receive the respect I deserve from my supervisors"; and "job instability" with 2 items such as "My job security is poor". The extrinsic effort and extrinsic reward categories were designed to seek information from respondents about the existence of stressful environmental conditions. If they *agree*, they are then asked to indicate the level of distress on a 4-point scale ranging from *very distressed* to *not at all distressed.* The total score used to measure these elements ranged from 6 to 30 for extrinsic effort and from 11 to 55 for extrinsic reward. The reliability coefficients of each subscale were 0.80 and 0.84 for extrinsic effort and extrinsic reward, respectively. The effort-reward imbalance index was calculated using the following formula, which ranged from 0.2 to 5:

$$\text{extrinsic effort} \times 11/((66-\text{extrinsic reward}) \times 0.5454)$$ [35]

An effort-reward imbalance index was used to indicate "high-cost and low-gain", which reflects a subjective work environment. The subjects were grouped into one of three strata for each psychosocial job stressor (low, medium or high) based on tertiles defined according to the distribution of scores: 6–10, 11–14, and 15 or greater, respectively, for extrinsic effort; 11–14, 15–20, and 21 or greater, respectively, for extrinsic reward; and 0.20–0.37, 0.37–0.56, and 0.56 or greater, respectively, for the effort-reward imbalance index.

Covariates

Subjects were divided into three age groups according to age, 35 and 40–44, 45–49, and 50–63 yr old, and three occupational categories were used, laborers, clerks, or others. Other covariates included relative weight, health-related behaviors, and demographic variables. Height and weight were measured by trained nurses during the medical examination. The degree of relative weight was calculated as the relative excess in weight to a standard weight based on height ($22 \times \text{height (m)}^2$). Relative weight was divided into three categories: less than −10%, between −10 and 10%, and greater than 10%.

Health-related behaviors included tobacco use, alcohol consumption, and lack of exercise, and were self-reported. Tobacco use was determined according to whether individuals classified themselves as a current smoker, ex-smoker, or non-smoker; they were further divided into current or non-smokers. Alcohol consumption was determined according to how individuals classified their alcohol use: that is, daily, occasional, or rare; they were further divided into drinkers (those who answered "daily" or "occasional") and non-drinkers (those who answered "rare"). Frequency of exercise was determined by individual answers as follows: "more than once weekly", "sometimes", and "rarely"; subjects were then divided into one of two groups, "once weekly" or "less than once weekly"; the latter was defined as a lack of exercise.

Educational level was determined by years of school completed, and subjects were divided into two groups, 12 yr or less of schooling or more than 12 yr. Two categories were used for marital status, currently married or not married. Subjects also indicated whether or not they had children and whether they were being treated for CHD-related diseases, such as hypertension, hyperlipidemia, angina pectoris, myocardial infarction, and diabetes.

Statistical analysis

First, associations of psychosocial job stressors and tobacco use, alcohol consumption, lack of exercise, and relative weight were examined by the χ^2 test. Next, the associations between psychosocial job stressors and CHD risk factors were examined by multiple logistic regressions. Four psychosocial job stressors (job strain, supervisor support, coworker support, or effort-reward imbalance) were entered into the model to predict each CHD risk factor (the prevalence of high systolic/diastolic blood pressure, high total cholesterol, low HDL cholesterol, high LDL cholesterol, and high triglycerides), while controlling all covariates (age, tobacco use, alcohol consumption, lack of exercise, education, marital status, child bearing history, and medical treatment for disease) and occupation. As explanatory analyses, similar multiple logistic regression of each CHD risk factor were conducted with regards to job demands, job control, extrinsic effort, extrinsic reward, supervisor support, and coworker support, while controlling all covariates. All associations were inferred with an α level of 0.05. These were performed using SPSS computer program, version 11 (Chicago, IL, U.S.A.).

Results

The characteristics of the subjects are presented in Table 1. Compared with the excluded subjects, the number of clerical and married employees was higher (5 vs. 8%, χ^2=13.4; p=0.001, and 96 vs. 98%, χ^2=5.8; p= 0.016, respectively) among those analyzed. There were no differences between the analyzed and excluded subjects with regards to the other studied variables.

The associations of job stressors and tobacco use,

Table 1. Characteristics of the study sample

Variables	n	(%)
Sociodemographic data and health-related behaviors		
Age (years)		
35 or 40–44	337	(24.1)
45–49	465	(33.2)
50–63	599	(42.8)
Relative weight (relative excess in weight, see text)		
<–10%	209	(14.9)
–10–10%	776	(55.4)
10%<	416	(29.7)
Tabaccouse		
Current smoker	182	(13.0)
Never or ex-smoker	1219	(87.0)
Alcohol consumption		
Daily or sometimes	634	(45.3)
Rarely	767	(54.7)
Exercise		
Once weekly	346	(24.7)
Less than once weekly	1055	(75.3)
Education		
12 years or less	1015	(72.4)
More than 12 years	386	(27.6)
Marital status		
Married	1369	(97.7)
Not married	32	(2.3)
Childbearing		
Yes	768	(54.8)
No	633	(45.2)
Being treated for diseases[a)]		
Yes	135	(9.6)
No	1266	(90.4)

(continued on next page)

(continued)
Table 1. Characteristics of the study sample

Variables	n	(%)
Occupation		
Production line workers	1241	(88.6)
Clerks	116	(8.3)
Others	44	(3.1)
Psychosocial job stressors (scores in the parentheses)		
Job strain (Job demands/Job control ratio)		
Low (.28–.51)	375	(26.8)
Medium (.51–.61)	489	(34.9)
High (.61–1.62)	537	(38.3)
Supervisor support		
High (12–16)	671	(47.9)
Medium (10–11)	305	(21.8)
Low (4–9)	425	(30.3)
Coworker support		
High (12–16)	726	(51.8)
Medium (11)	371	(26.5)
Low (4–10)	304	(21.7)
Effort-reward imbalance		
Low (.20–.37)	479	(34.2)
Medium (.37–.56)	460	(32.8)
High (.56–2.08)	462	(33.0)
CHD risk factors		
High systolic blood pressure (≥140 mmHg)	149	(10.6)
High diastolic blood pressure (≥90 mmHg)	136	(9.7)
High total cholesterol (≥220 mg/d*l*)	452	(32.3)
Low HDL cholesterol (<40mg/d*l*)	40	(2.9)
High LDL cholesterol (≥140 mg/d*l*)	434	(31.0)
High triglycerides (≥150 mg/d*l*)	175	(12.5)

a)"diseases" comprises hypertension, hyperlipidemia, angina pectoris, myocardial infarction, and diabetes.

alcohol consumption, lack of exercise, and relative weight are shown in Table 2. In our subjects, there were no statistically significant associations, although those who reported low coworker support tended to exercise less frequently (χ^2=5.6, p<0.10).

When four psychosocial job stressors and all other covariates were simultaneously entered into the multiple logistic regression model (Table 3), part-time women exposed to the highest effort-reward imbalance were four times as likely to be associated with high prevalence of low HDL cholesterol compared with those with the lowest effort-reward imbalance. On the other hand, although the association was weaker, the high job strain group had a significantly lower odds ratio (OR) of high prevalence of low HDL cholesterol. Associations between social support and CHD risk factors were apparent, but not statistically significant. Age and relative weight were significantly associated with all CHD risk factors except for HDL cholesterol; tobacco use was inversely associated with high prevalence of high total cholesterol; alcohol consumption was inversely associated with high prevalence of high total and LDL cholesterol; and lack of exercise was significantly associated with high prevalence of high systolic blood pressure. Additional controlling for occupation did not change the results.

Explanatory logistic regression analyses using job demands, job control, extrinsic effort, extrinsic reward, supervisor support, and coworker support as independent variables showed that high extrinsic effort was associated with high prevalence of low HDL cholesterol (OR =2.92, 95% confidence interval (CI)=1.04–8.19 for the medium group; OR=4.23, 95%CI=1.34–13.38 for the high group), and low prevalence of high triglycerides (OR=0.83, 95% CI=0.55–1.26 for the medium group; OR=0.46, 95% CI=0.27–0.78 for the high group). As expected, high job control was associated with low prevalence of high systolic blood pressure (OR=0.75, 95% CI=0.48–1.15 for the medium group; OR=0.43, 95% CI=0.26–0.71 for the

Table 2. Association of psychosocial job stressors with health-related behaviors (tobacco use, alcohol consumption, and lack of exercise) and relative weight status among part-time working women[a)]

Job stressor (Range of scores)	Current smoker n	Current smoker (%)	Drinker (daily or sometimes) n	Drinker (daily or sometimes) (%)	Lack of exercise (Less than once weekly) n	Lack of exercise (Less than once weekly) (%)	Relative weight[b)] <−10% n	<−10% (%)	−10–10% n	−10–10% (%)	10%< n	10%< (%)
Job strain (Job demands/Job control ratio)												
Low (.28–.51)	46	(12.3)	173	(46.1)	292	(77.9)	51	(13.6)	205	(54.7)	119	(31.7)
Medium (.51–.61)	69	(14.1)	218	(44.6)	356	(72.8)	75	(15.3)	283	(57.9)	131	(26.8)
High (.61–1.62)	67	(12.5)	243	(45.3)	407	(75.8)	83	(15.5)	288	(53.6)	166	(30.9)
Supervisor support												
High (12–16)	90	(13.4)	295	(44.0)	513	(76.5)	110	(16.4)	366	(54.5)	195	(29.1)
Medium (10–11)	37	(12.1)	147	(48.2)	232	(76.1)	45	(14.8)	164	(53.8)	96	(31.5)
Low (4–9)	55	(12.9)	192	(45.2)	310	(72.9)	54	(12.7)	246	(57.9)	125	(29.4)
Coworker support												
High (12–16)	92	(12.7)	321	(44.2)	549	(75.6)	118	(16.3)	393	(54.1)	215	(29.6)
Medium (11)	47	(12.7)	164	(44.2)	265	(71.4)	55	(14.8)	211	(56.9)	105	(28.3)
Low (4–10)	43	(14.1)	149	(49.0)	241	(79.3)	36	(11.8)	172	(56.6)	96	(31.6)
Effort–reward imbalance												
Low (.20–.37)	60	(12.5)	213	(44.5)	360	(75.2)	81	(16.9)	256	(53.4)	142	(29.6)
Medium (.37–.56)	62	(13.5)	211	(45.9)	359	(78.0)	67	(14.6)	269	(58.5)	124	(27.0)
High (.56–2.08)	60	(13.0)	210	(45.5)	336	(72.7)	61	(13.2)	251	(54.3)	150	(32.5)

a) No significant association was observed between job stressors and health-related behaviors (tobacco use, alcohol consumption, or lack of exercise) or relative weight status in crude or age-adjusted analysis (χ^2 test or multiple logistic regression, respectively, p>0.05).
b) Relative excess (%) in weight. See text.

high group), but unexpectedly high job demands were associated with low prevalence of high systolic blood pressure (OR=0.60, 95% CI=0.37–0.96 for the medium group; OR=0.71, 95% CI=0.44–1.16 for the high group) and low prevalence of high diastolic blood pressure (OR=0.45, 95% CI=0.27–0.76 for the medium group; OR=0.86, 95% CI=0.53–1.41 for the high group). Although not statistically significant, job demands showed a tendency to be associated with low prevalence of low HDL cholesterol (OR=0.92, 95% CI=0.36–2.36 for the medium group; OR=0.80, 95% CI=0.31–2.06 for the high group). Low coworker support was significantly associated with high prevalence of low HDL cholesterol (OR=2.21, 95% CI=1.03–4.76 for the medium group; OR=1.35, 95% CI=0.55–3.30 for the low group).

Discussion

Multivariate logistic regression analyses revealed a significant association between effort-reward imbalance and high prevalence of low HDL cholesterol in female part-time employees of a retail business, after adjusting for relevant confounding factors (age, relative weight, tobacco use, alcohol consumption, lack of exercise, education, marital status, child bearing, medical treatment of disease, and occupation). On the other hand, high job strain was associated with low prevalence of low HDL cholesterol. Explanatory analyses showed expected findings with regards to job control and support components, whereas demand components, extrinsic effort, and particularly, job demands had inverse associations with CHD risk factors. The associations between covariates and CHD risk factors were mostly as expected.

Effort-reward imbalance was associated with a large proportion of individuals with low HDL cholesterol. On the other hand, as in previous studies with inconsistent results ranging from a significantly adverse association[11)] to almost no association[12, 13, 15, 17, 20)] in women, this study showed high HDL cholesterol in the part-time workers exposed to job strain. These results might have been caused by differences in the aspects measured by both models. Emotional reactions to unpleasant situations might be an important variable in biochemical correlation studies of cholesterol[36)], and lipid elevation appears to be more affected by perceived stress than objective stress[37)]. The job strain model might be related more to objective measures of stressors than other questionnaires[29)]; the subjects are questioned about their job characteristics, not about their feelings concerning stress. In contrast, the effort-reward questionnaire approaches more

Table 3. Associations between psychosocial job stressors and CHD risk factors among part-time working women: Results of fully adjusted multiple logistic regression analysis

Variables	High systolic blood pressure			High diastolic blood pressure			High total cholesterol			Low HDL cholesterol			High LDL cholesterol			High triglycerides		
		95%CI[a]			95%CI			95%CI			95%CI			95%CI			95%CI	
	Odds ratio	Lower	Upper	Odds ratio	Lower	Upper	Odds ratio	Lower	Upper	Odds ratio	Lower	Upper	Odds ratio	Lower	Upper	Odds ratio	Lower	Upper
Job strain (Job demand/Job control ratio)																		
Low (.28–.51)	1.00			1.00			1.00			1.00			1.00			1.00		
Medium (.51–.61)	0.78	0.49	1.26	0.79	0.48	1.28	1.01	0.74	1.38	0.71	0.32	1.58	1.03	0.75	1.41	0.90	0.58	1.39
High (.61–1.62)	1.12	0.71	1.77	1.02	0.64	1.64	1.02	0.75	1.40	0.40*	0.17	0.97	1.07	0.78	1.47	1.10	0.72	1.69
Supervisor support																		
High (12–16)	1.00			1.00			1.00			1.00			1.00			1.00		
Medium (10–11)	0.85	0.51	1.40	1.14	0.70	1.87	1.13	0.82	1.55	0.89	0.35	2.26	1.06	0.77	1.47	1.14	0.74	1.77
Low (4–9)	1.37	0.88	2.13	1.16	0.72	1.87	1.18	0.87	1.60	1.27	0.56	2.88	1.27	0.94	1.73	1.25	0.82	1.90
Coworker support																		
High (12–16)	1.00			1.00			1.00			1.00			1.00			1.00		
Medium (11)	1.38	0.91	2.09	1.06	0.68	1.65	1.09	0.82	1.44	2.14	1.00	4.58	1.07	0.81	1.43	1.24	0.83	1.85
Low (4–10)	0.96	0.59	1.57	0.98	0.60	1.62	1.04	0.75	1.44	1.29	0.54	3.08	0.93	0.67	1.30	1.44	0.94	2.22
Effort-reward imbalance																		
Low (.20–.37)	1.00			1.00			1.00			1.00			1.00			1.00		
Medium (.37–.56)	0.98	0.63	1.52	1.18	0.75	1.87	1.15	0.86	1.54	2.00	0.72	5.55	1.14	0.85	1.54	1.04	0.70	1.54
High (.56–2.08)	0.88	0.55	1.40	0.92	0.56	1.51	0.87	0.63	1.19	4.37**	1.63	11.73	0.88	0.64	1.21	0.63	0.41	0.99
Age (year)																		
35 or 40–44	1.00				1.00			1.00			1.00			1.00			1.00	
45–49	1.82	0.96	3.43	1.46	0.76	2.80	1.58*	1.09	2.28	0.80	0.34	1.93	1.59*	1.09	2.32	1.24	0.75	2.07
50–63	2.87**	1.46	5.64	2.52**	1.26	5.04	3.31**	2.20	4.98	0.44	0.15	1.34	2.90**	1.91	4.40	1.67	0.95	2.93
Relative weight (relative excess in weight)																		
<–10%	1.00			1.00			1.00			1.00			1.00			1.00		
–10–10%	1.79	0.89	3.58	1.54	0.77	3.11	1.93**	1.30	2.88	0.69	0.24	1.99	2.84**	1.80	4.48	2.19*	1.10	4.34
10%<	2.76**	1.36	5.60	2.56**	1.25	5.22	2.21**	1.44	3.37	2.09	0.74	5.94	4.73**	2.94	7.61	4.78**	2.39	9.56
Tobacco use (current smoker)	0.77	0.41	1.43	0.69	0.35	1.35	0.62*	0.41	0.94	1.35	0.54	3.36	0.84	0.56	1.25	1.61	1.00	2.59
Alcohol consumption (drinker)	1.02	0.71	1.48	1.26	0.86	1.84	0.77*	0.60	0.98	0.80	0.40	1.59	0.70**	0.54	0.89	1.00	0.71	1.41
Lack of exercise (less than once weekly)																		
	1.71*	1.08	2.69	1.41	0.90	2.22	0.80	0.61	1.06	1.68	0.71	3.95	0.94	0.71	1.25	0.84	0.58	1.23
Education (more than 12 yr)	0.83	0.54	1.27	0.85	0.55	1.33	0.99	0.75	1.29	1.04	0.48	2.21	1.08	0.82	1.42	0.77	0.52	1.15
Marital status (not married)	0.61	0.17	2.18	1.12	0.36	3.47	1.33	0.61	2.90	0.00	0.00	7×10^{11}	1.26	0.57	2.75	1.24	0.44	3.49
Child bearing (yes)	0.87	0.55	1.38	0.85	0.52	1.37	1.06	0.78	1.44	0.62	0.26	1.52	0.89	0.65	1.21	1.11	0.72	1.70
Being treated for diseases (yes)	2.64**	1.67	4.18	3.21**	2.03	5.08	2.08**	1.41	3.05	0.36	0.08	1.60	1.33	0.91	1.96	2.37**	1.51	3.71

*: p<.05, **: p<.01, all variables were simultaneously entered in the model.
a) CI=Confidence Interval

cognitive levels of perceived job stress, and in this questionnaire the subjects are asked how they feel distressed.

The two stress models might provide an additional explanation for the results on lipid profiles. Previous investigations of occupational instability and job insecurity have frequently demonstrated increased total cholesterol levels[38, 39] and, to a lesser extent, high blood pressure levels[40]. Thus, perceived threat of job loss or poor job prospects could be a sensitive predictor of lipid deterioration, which might have been replicated in the effort-reward imbalance analysis. However, prevalence of low HDL cholesterol was very low; although relevant confounders were adjusted for in this study, the subjects with low HDL cholesterol may be a special group characterized by factors other than effort-reward imbalance, such as poor health practices or lifestyles. Further studies are necessary to explore the association between effort-reward imbalance and poor HDL cholesterol profiles.

The explanatory analysis revealed that the unexpected findings with regards to job strain appeared to be primarily attributable to the job demands component. The majority of recent evidence on job strain and CHD has not been able to confirm the full model, that is, the combination with high demands and low control[41]. Most recent studies have predicted an association between low control and CHD risk, whereas high demands were associated with decreased CHD risk. A demanding situation might not necessarily lead to adverse consequences in the current working world. This proposition might apply to Siegrist's effort component[21] to some extent (i.e., the unexpected observed association with triglycerides), and it requires more study. As expected, however, part-time women with high job control had low prevalence of high systolic blood pressure. Extrinsic effort was also associated with unfavorable HDL profiles, but the combination of high extrinsic effort and low extrinsic reward showed a clearer association, as postulated by the model[21].

Many tests showed no statistically significant associations, not only in our main hypothesis between job stressors and biological CHD risk factors but also in the associations between job stressors and health-related behaviors, which are possible mediators through which job stressors lead to biological CHD risk factors. These findings might be related to the specific characteristics of the sample studied. Part-time workers in retail businesses, such as the one studied here, consist of a central work force. While career development is limited, employees do not face a severe threat of job loss. In addition, exposure to adverse conditions is limited because of the limited working hours. Thus, it should be taken into account that the sample did not necessarily represent part-time employees who hypothetically experience harsh working conditions in terms of low occupational rewards.

The following limitations of the present study need to be discussed. First, because of the cross-sectional design of the study, a causal relationship was not determined by these results. Another shortcoming due to the study design is related to the employees' response to psychosocial job characteristics. Most employees have an annual physical checkup and were aware of their health status. Those who were aware that their health status was poor might have let their health situation be affected by external work conditions. More definite evidence would be obtained from a longitudinal study[24].

The low response rate might also have limited the validity of this study. The study population was slightly over-representative of clerical and married workers in the target population. However, there were no differences in independent and dependent indices (job stressors and CHD risk factor levels) as well as other demographic/behavioral variables between the analyzed and excluded workers. Thus, it was unlikely that the selection had a large effect on the results.

Third, blood pressure data were obtained by casual blood pressure measurements. Casual blood pressure measurements are less sensitive than ambulatory blood pressure monitoring in determining an association between psychosocial job characteristics and blood pressure[42–44]. In addition, serum samples were not collected after fasting in the present study, which might have resulted in measurement errors for serum lipids. Therefore, it is possible that the associations among psychosocial job stressors and CHD risk factors were underestimated in this study.

Fourth, not much consideration was given in this study to the following confounding factors. In this study sample, most workers carried domestic burdens as housekeepers, child care providers, or elderly care providers. Such domestic burdens might have affected the physiological data and shown a relationship with job stress. This study did not measure physical activity at work to adjust for other factors, which limits our interpretation of the unexpected associations of extrinsic effort and job strain with CHD risk factors. It is clear that there are other important possibly confounding factors, which were not included in the present analysis, such as family income, menstruation, dietary pattern, and sedentary lifestyle.

Finally, problems might have resulted due to multiple testing. In this study, the associations between multiple indicators were tested: four to six at once with regards to job stressors and six CHD risk factors. This possibly would increase the α error. Some subtle associations might have been observed as statistically significant.

Our findings did not fully support the hypothesis that an adverse psychosocial work environment is associated with unfavorable CHD risk factors. However, this does not mean that the association is not worthy of further study. Rather, our trial should be replicated using a larger employee sample engaged in contingent work characterized by low-wages and poor work prospects and performed mainly by women.

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Young Investigator Award Winner's Special Article

Psychosocial Factors and Health: Community and Workplace Study

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The effects of psychosocial factors on health have drawn growing attention. An important prerequisite for epidemiologic studies is that instruments to measure psychosocial factors be reliable and valid based on psychometric properties. The introduction of occupational stress models has made breakthroughs in conceptualizing real-life complex phenomena in the workplace. This article describes some trials that explore the associations between psychosocial factors and health in the community and workplace. Scales for measuring social support and psychosocial job characteristics were developed, and their validation was pursued. Findings suggest that adverse social relationships and job characteristics measured by these instruments are associated with ill health. To strengthen the validities of the measurements and to provide strong causal evidence between psychosocial factors and health, more prospective studies and interventional approaches are needed.
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Key words: psychosocial factors, measurement, Social Support, Stress, intervention.

Whether psychosocial factors affect health has drawn growing attention in current epidemiologic research. Through the use of psychometric techniques, improvements have been seen in the validity and reliability of the questionnaire-based instruments used to measure psychosocial factors.[1] However, studies on the use of validated psychosocial questionnaires are scarce in Japanese populations. Some trials to fill knowledge gaps in the community and workplace are described in this article. The primary objective of the trials was to see the extent to which psychosocial factors are related to health risks. The validation of the measurement instruments was also pursued during the study.

The Jichi Medical School (JMS) Cohort study

The JMS Cohort study is a prospective study that explores the risk factors of cardiovascular diseases among Japanese community residents.[2] The baseline data were collected between 1992 and 1995. Ultimately, 12,490 Japanese from 12 communities located across Japan participated. The overall response rate was 65.4%. The examined cardiovascular risk factors in the JMS Cohort study included traditional risk factors, such as behavioral factors (cigarette smoking, alcohol consumption, physical activity, and dietary patterns) and anthropometric / biological factors (body weight, height, blood pressure, blood glucose, serum lipids, and electrical cardiogram). The newly emerged risk factors, such as high-sensitivity C-reactive protein, coagulation factors, lipoprotein (a), and serum insulin, were also measured at baseline. Another unique objective of the JMS Cohort study was to investigate the health effects of psychosocial factors, which included social relationships of the individuals, type A behavior, and psychosocial job characteristics.

Development of a social support scale

For a better understanding of social relationships and health, it is desirable to consider three aspects of social relationships: (1) their existence and number, (2) aspects of the network structure, and (3) functional content and quality of the relationships. Measures

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of the existence and number of social relationships or contacts, such as information on whether individuals are married, live alone, or belong to organizations, are relatively objective, reliable, and easy to obtain. Although more complicated, social network measurements or analyses in terms of size, density, and reciprocity are informative. However, current evidence postulates that the most sensible measure to tap the beneficial effects of social relationships is the function and quality of those relationships.[3]

We developed a 28-item instrument that measures the perceived availability of social support from a spouse, family, and friends for community residents involved in the JMS Cohort study.[4, 5] The internal consistencies were high, and both factorial and cross validities have been confirmed. In the cross-sectional analysis of 222 men and 417 women, perceived social support was shown to be generally associated with favorable health-related behavior.[6] Among men, the support of friends was positively associated with the frequency of alcohol drinking; on the other hand, strong spousal support was related to reduced alcohol drinking, and enhanced family support was related to a reduction in smoking. Among women, family support was positively associated with the frequency of consuming Japanese food.

Measurement of occupational stress

Stress is too vague a word to be informative in epidemiologic studies. For example, study participants are sometimes asked whether or not they experience occupational stress. The content may differ according to the individual. One person might perceive occupational stress as a result of time pressure, while another might suffer from a conflict in a personal relationship with a supervisor or colleague. Even if the exposure detected by the answer to such a question predicted a health outcome, it would be impossible to intervene because the precise nature of the stressor would be unknown. There have been improvements in the measurement of occupational stress, moving away from the generic idea of stress towards the combination of a few definite concepts based on theories. The introduction of stress models has made breakthroughs in occupational stress research and practices possible.

The job demand-control model is currently the most prevalent occupational stress model.[7] The model posits that workers with a combination of high psychological job demands and low control over a job (i.e., job strain) have a risk of developing an illness.[8] Although the combined effect of the demand and control components is of central interest in this model, its individual components may also predict a stress-related health outcome. To investigate the effects of adverse psychosocial job characteristics on cardiovascular diseases among Japanese workers, the JMS Cohort study adopted the MONICA version of the demand-control questionnaire, which was translated by Professor Uehata and his group.[9] The internal consistency was acceptable for the job demands scale ($\alpha = 0.69$) but slightly low for the job control scale ($\alpha = 0.65$) in this cohort.

Psychosocial job characteristics and cardiovascular diseases

Nearly 7,000 male and female workers in the JMS Cohort study were subjected to the analysis to investigate the extent to which psychosocial job characteristics by the demand-control model are related to cardiovascular risk factors. The working population was relatively older and healthier than the norm due to the recruitment method.[2] Many of the individuals supposed to have long careers. In addition, the study population included large number of workers engaged in farming, forestry, and fisheries.

With a few exceptions, adverse job characteristics were related to unfavorable health behavior.[10] High psychological demands were associated with heavy smoking, high prevalence of alcohol consumption, and high degrees of work-related physical activity. Low job control was associated with lower consumption of vegetables, a smaller number of cigarettes smoked, and a low level of work-related physical activity. Job strain, a combined measure obtained from the ratio of demands to control, was associated with lower vegetable consumption, low prevalence of smoking, and high prevalence of current alcohol consumption.

In men, a multiple logistic regression model revealed that job strain was significantly related to hypertension (odds ratio, 1.2; 95% confidence interval: 1.1-1.3), after adjusting for age, employment status (white-collar versus blue-collar), marital status, family history of hypertension, cigarette smoking, alcohol consumption, physical activity, and body mass index.[11] This study also replicated the findings often cited in studies in Western countries, i.e., that the effects of the adverse job characteristics were stronger among workers in the lower socioeconomic strata.[12] Significantly greater risks were observed among employees in subordinate positions, blue-collar jobs and the less-educated, than among those in the respective counterparts.

Higher psychological job demands were associated with a higher total cholesterol level, with an adjusted difference from the top to bottom tertile of 3.3 mg/dL ($F = 3.03$; $p = 0.048$). Higher job demands were also significantly associated with the total/HDL cholesterol ratio ($F = 3.94$; $p = 0.020$).[13] However, the magnitude of the observed effect, up to a 3% average difference of the total cholesterol levels, may not be clinically meaningful.

Studies from Western industrialized societies have demonstrated that the job demand-control model predicts cardiovascular diseases, in particular, ischemic heart disease. In Japan, stroke is an important heavy burden on the public. Based on the ongoing data from the JMS Cohort study, we examined the extent to which psychosocial job characteristics are related to the risk of stroke (Unpublished data). The participants were followed 8 years on average until March 2002 using systematic surveillance. Incidence cases were identified according to criteria established by the Japan Ministry of Health and Welfare. Cox proportional hazards regression analysis was used for multivariate analyses.

Among the participants who had been free from stroke at baseline, 97 cases were identified during the follow-up. Workers exposed to job strain (concurrent high job demands and low job control) had the highest risk of stroke. Compared with workers in low strain jobs (low job demands and high job control), the age- and sex-adjusted relative risk of stroke was a hazard ratio = 1.4 (95% confidence interval: 0.7-2.7); the point estimate is compatible with recent Western reports on the relative risk of adverse job strain on ischemic heart disease or cardiovascular death.[14] The adjustment for socioeconomic status, behavioral, and biological risk factors slightly reduced the risk. These statistically insignificant findings may be attributable to the small number of outcome events, possibly due to survivor bias or insufficient follow-up periods, and the relatively low scale reliability.

The findings suggest that psychosocial job characteristics defined by the job demand-control model predict cardiovascular diseases among Japanese workers. However, the inconclusive findings to date warrant further investigation.

A new occupational stress model

Another more recently developed occupational stress model is the effort-reward imbalance (ERI) model.[15] This model postulates that the source of stress at the workplace results from an imbalance between an individual's recognition of his extrinsic effort (e.g., high workload) and the extrinsic reward (e.g., money, esteem, and occupational status control), with a focus on a negative trade-off between experienced costs and gains at work. In the current labor market, socioeconomic factors beyond an individual's ability to change them have the potential to produce a significant amount of stress. That is, economic recession and globalization have lead to organizational restructuring, which includes downsizing. Job insecurity has been identified as a serious health risk. Thus, the ERI model is expected to capture the current occupational stress most sensitively. Although this model has been studied much less than the job demand-control model, evidence showing that ERI predicts cardiovascular diseases has been accumulating.[7]

The Japanese version of the ERI questionnaire was developed through a back-translation process.[16] The reliability was acceptable for various Japanese working populations, and the validity has been confirmed in several investigations at workplaces.

The responsiveness of the stress measures was demonstrated in a real case of company restructuring.[17] For the employees who had been affected by restructuring of their company due to economic hardship, two consecutive questionnaire surveys were conducted over a specific period. A total of 544 full-time employees responded to both surveys. Changes in the summary measures from the ERI model component were evaluated. The summary measures showed significant psychological deterioration in the total study population. The deterioration was prevalent in those employees who had presumably experienced the effects of stressful organizational changes related to the restructuring; potentially stronger effects of multiple organizational changes on employees were indicated.

The complementary roles of the effort-reward imbalance and the job demand-control models have been clarified; the two models identify different aspects of occupational stress and that the health effects are independent of each other.[18] A cross-sectional analysis was conducted to examine these associations in 190 male and female workers of a small Japanese plant with economic hardship. Workers were engaged in two types of jobs – direct assembly line and indirect support tasks –; the latter was threatened by job loss because of downsizing. Independent variables were measured by the Japanese versions of the demand-control and ERI questionnaires. The Center for Epidemiologic Studies Depression Scale was used to assess depressive symptomatology. Workers with indirect supportive tasks (target for downsizing) were more likely to have depressive symptoms than assembly line workers. Job strain, a combination of high demand and low control at work, was more frequent among the assembly line workers, while the combination of high effort and low reward was more frequent among the workers with indirect supportive tasks. After adjusting for work environmental factors, low control and ERI were independently related to depressive symptoms (odds ratios 4.7 and 4.1, respectively).

Other than the above-mentioned studies, the criterion validity was tested in terms of the associations with psychological and physiological health outcome; the ERI stress indices were associated with several psycho-physiological and behavioral health outcomes. The discriminant validity was discussed in terms of the stress prevalence in various socioeconomic strata.[19]

Intervention

Although not based on specific stress models, our trial provided a suggestive evidence that providing supervisors with appropriate information with regard to mental health at the workplace, including occupational stress models, has a positive effect on employee psychological well-being.[20]

A single-session supervisory education program was developed in conjunction with the Japanese national guidelines for the promotion of employee mental health. A total of 267 voluntary supervisors in a prefectural office were presented with comprehensive information on the role they are to fulfill to promote mental health in the workplace. A total of 864 office employees were evaluated to determine whether education had had an effect on their psychological distress. Three months after the education, the levels of psychological distress improved among employees in the departments in which more than one-third of the supervisors attended an educational session; these findings were compared to those from departments with lower attendance rates of the supervisors. The positive effect of education was supported by statistically significant interaction between time and the category of the department; adjustments were made for the confounders.

Conclusions

Evidence from communities and workplaces suggests that psychosocial factors affect health among Japanese populations. Accurate measurements of psychosocial factors are a crucial prerequisite to obtain rigorous evidence. Prospective and interventional studies are necessary for more definitive conclusions. Well-defined occupational stress models serve as useful tools for