bias. The response rate of one company was low at 47%. However, whether or not the company's data were reviewed did not affect the statistical result. In addition to this, differences among the companies did not affect the results. Third, for the cross-sectional design we did not investigate circumstantial changes in each company that might influence sickness absence, e.g. downsizing or expansion of the organization (Vahtera et al. 2004b; Westerlund et al. 2004). Additionally, all the companies were involved in manufacturing and had relatively big capital.

We studied the influence of job demand/control model as psychosocial work characteristics on sickness absence for the first time in Japan with the data from a large number of respondents working for multiple Japanese institutions. Both low job control and low support at the worksite were associated with a high frequency of more than 6 days of accumulated sick leaves during the previous year. Assessment of job demand/control by JCQ or GJSQ did not change the result much. Besides, we found the lowest sickness absence rate in male managers and the highest in laborers. Therefore, job control, support at the worksite and occupational status are also important psychosocial factors of occupational health in Japan that should be considered to promote workers' and workplace health. The future direction of our study will be to elucidate the relationship between job demand/control and sick leaves including both short and long leaves by using the accurate attendance records preserved at Japanese workplaces, as compared with the corresponding European data.

Appendix

The Japan Work Stress and Health Cohort Study Group

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Reference

Haratani T, Kawakami N, Araki S (1993) Reliability and validity of the Japanese version of NIOSH genetic job stress questionnaire. Jpn J Ind Health 35(Suppl):S214 (in Japanese)

Haratani T, Kawakami N, Araki S, Hurrell JJ Jr, Sauter SL, Swanson NG (1996) Psychometric properties and stability of the Japanese version of the NIOSH job stress questionnaire. In: Twenty-fifth international congress on occupational health. Book of Abstracts, Part 2, 393 pp

International Labour Office Staff (1991) International Standard Classification of Occupations (ISCO-88). International Labour Office Staff, Geneva

Kawakami N, Haratani T (1999) Epidemiology of job stress and health in Japan: review of current evidence and future direction. Ind Health 37:174–186

Kawakami N, Kobayashi F, Araki S, Haratani T, Furui H (1995) Assessment of job stress dimensions based on the job demands-control model of employees of telecommunication and electric power companies in Japan: reliability and validity of the Japanese version of job content questionnaire. Int J Behav Med 2:358–375

Kawakami N, Haratani T, Kobayashi F, Ishizaki M, Hayashi T, Fujita O, Aizawa Y, Miyazaki S, Hiro H, Masumoto T, Hashimoto S, Araki S (2004) Occupational class and exposure to job stressors among employed men and women in Japan. J Epidemiol 14:204–211

Kivimäki M, Head J, Ferrie JE, Shipley MJ, Vahtera J, Marmot MG (2003) Sickness absence as a global measure of health: evidence from mortality in the Whitehall II prospective cohort study. BMJ 327:364–368

Marmot M, Feeney A, Shipley M, North F, Syme SL (1995) Sickness absence as a measure of health status and functioning: from the UK Whitehall II study. J Epidemiol Community Health 49:124–130

Martikainen P, Ishizaki M, Marmot MG, Nakagawa H, Kagamimori S (2001) Socioeconomic differences in behavioural and biological risk factors: a comparison of a Japanese and an English cohort of employed men. Int J Epidemiol 30:833–838

Melchior M, Niedhammer I, Berkman LF, Goldberg M (2003) Do psychosocial work factors and social relations exert independent effects on sickness absence? A six year prospective study of the GAZEL cohort. J Epidemiol Community Health 57:285–293

Ministry of Health Labour and Welfare (2004) White paper on the labor economy total contents. Gyosei Corporation, Tokyo (in Japanese)

Moreau M, Valente F, Mak R, Pelfrene E, de Smet P, De Backer G, Kornitzer M (2004) Occupational stress and incidence of sick leave in the Belgian workforce: the Belstress study. J Epidemiol Community Health 58:507–516

Morikawa Y, Martikainen P, Head J, Marmot M, Ishizaki M, Nakagawa H (2004) A comparison of socio-economic differences in long-term sickness absence in a Japanese cohort and a British cohort of employed men. Eur J Public Health 14:413–416

Muto T, Sumiyoshi Y, Sawada S, Momotani H, Itoh I, Fukuda H, Taira M, Kawagoe S, Watanabe G, Minowa H, Takeda S (1999) Sickness absence due to mental disorders in Japanese workforce. Ind Health 37:243–252

Nakata A, Haratani T, Yakahashi M, Kawakami N, Arito H, Kobayashi F, Araki S (2004) Job stress, social support, and prevalence of insomnia in a population of Japanese daytime workers. Soc Sci Med 59:1719–1730

Nasermoaddeli A, Sekine M, Hamanishi S, Kagamimori S (2003) Associations of sense of coherence with sickness absence and reported symptoms of illness in Japanese civil servants. J Occup Health 45:231–233

Niedhammer I, Bugel I, Goldberg M, Leclerc A, Guéguen A (1998) Psychosocial factors at work and sickness absence in the Gazel cohort: a prospective study. Occup Environ Med 55:735–741

North F, Syme SL, Feeney A, Head J, Shipley MJ, Marmot MG (1993) Explaining socioeconomic differences in sickness absence: the Whitehall II study. BMJ 306:361–366
North FM, Syme SL, Feeney A, Shipley M, Marmot M (1996) Psychosocial work environment and sickness absence among British civil servants: the Whitehall II study. Am J Public Health 86:332–340
Ogura K et al (1998) Surveillance study on sick leave system. Investigation research report no. 105. The Japan Institute of Labour, Tokyo (in Japanese)
Organisation for Economic Co-operation and Development (1991) Absence from work reported in labour force surveys. The OECD Employment Outlook, OECD, France, chapt. 6, pp 177–197
Searle SJ (2003) Sickness absence. In: Waldron HA, Edling C (eds) Occupational health practice, chapt. 8, 4th edn. Arnold, London, pp 112–125
Shimizu T, Nagashima S, Mizoue T, Higashi T, Nagata S (2003) A psychosocial-approached health promotion program at a Japanese worksite. J UOEH 25:23–34
Shimizu T, Horie S, Nagata S, Marui E (2004) Relationship between self-reported low productivity and overtime working. Occup Med 54:52–54
Smulders PGM, Nijhuis FJN (1999) The job demands-job control model and absence behaviour: results of a 3-year longitudinal study. Work Stress 13:115–131
Takao S, Kawakami N, Ohtsu T, the Japan Work Stress, Health Cohort Study Group (2003) Occupational class and physical activity among Japanese employees. Soc Sci Med 57:2281–2289
Vahtera J, Kivimäki M, Pentti J, Theorell T (2000) Effect of change in the psychosocial work environment on sickness absence: a seven year follow up of initially healthy employees. J Epidemiol Community Health 54:484–493
Vahtera J, Kivimäki M, Pentti J (2001) The role of extended weekends in sickness absenteeism. Occup Environ Med 58:818–822
Vahtera J, Pentti J, Kivimäki M (2004a) Sickness absence as a predictor of mortality among male and female employees. J Epidemiol Community Health 58:321–326
Vahtera J, Kivimäki M, Pentti J, Linna A, Virtanen M, Virtanen P, Ferrie JE (2004b) Organisational downsizing, sickness absence, and mortality: 10-town prospective cohort study. BMJ 328:555–558
Vahtera J, Pentti J, Kivimäki M (2005) Sickness absence as a predictor of mortality among male and female employees. J Epidemiol Community Health 58:321–326
Voss M, Floderus B, Diderichsen F (2001) Physical, psychosocial, and organizational factors relative to sickness absence: a study based on Sweden Post. Occup Environ Med 58:178–184
Westerlund H, Ferrie J, Hagberg J, Jeding K, Oxenstiema G, Theorell T (2004) Workplace expansion, long-term sickness absence, and hospital admission. Lancet 363:1193–1197

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Psychosocial job characteristics and risk of mortality in a Japanese community-based working population: The Jichi Medical School Cohort Study

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Abstract

We prospectively investigated the association between psychosocial job characteristics according to the job demand–control model and the risk of mortality in a Japanese community-based working population. A baseline examination conducted from 1992 to 1995 determined the socioeconomic, behavioural, and biological risks in addition to the psychosocial job characteristics of 3178 male and 3331 female workers aged 65 and under and free from cancer and cardiovascular diseases. During the 9-year follow-up study, 157 men and 64 women died. In the follow-up, the results of Cox proportional hazards regression analysis revealed that men with concurrent high job demands and high job control (an active job) had the lowest risk of mortality from all causes. Compared with the low demand and high control job category, the multivariate relative risk of an active job was 0.53 (95% confidence interval: 0.31, 0.89). This finding appeared largely attributable to a reduction in cancer mortality. Job characteristics were not associated with cardiovascular diseases or external causes of mortality. For women, no significant associations were observed. The findings suggest that an active job has a beneficial effect on the health of Japanese male workers. Investigating of the effect of psychosocial job characteristics on cancer might therefore provide valuable insights into the health of workers.

Keywords: Cardiovascular diseases; Cohort studies: Mortality; Neoplasms; Stress; Psychological; Workplace; Japan

Introduction

The job demand–control model is currently the most prevalent job stress model (Karasek & Theorell, 1990). The model posits that workers who face high psychological demands and have little control over their work (i.e., job strain) are at greater risk of becoming ill. Many prospective studies have supported this hypothesis using cardiovascular disease outcomes (Alfredsson, Spetz, & Theorell, 1985; Alterman, Shekelle, Vernon, & Burau, 1994; Bosma, Peter, Siegrist, & Marmot, 1998; de Bacquer et al., 2005; Haan, 1988; Karasek,

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Baker, Marxer, Ahlbom, & Theorell, 1981; Kivimäki et al., 2002; Kuper & Marmot, 2003; Steenland, Johnson, & Nowlin, 1997), although some have failed to do so (Eaker, Sullivan, Kelly Hayes, D'Agostino, & Benjamin, 2004; Lee, Colditz, Berkman, & Kawachi, 2002; Reed, LaCroix, Karasek, Miller, & MacLean, 1989; Suadicani, Hein, & Gyntelberg, 1993). However, very few studies have examined the outcome of all-cause mortality, and those that have, produced conflicting results. For example, a higher relative mortality risk was found among elderly men exposed to job strain (Falk, Hanson, Isacsson, & Östergren, 1992). Another study revealed null associations between job strain and mortality (Eaker et al., 2004), while a further two showed that low job control but not job strain was associated with mortality (Amick et al., 2002; Åstrand, Hanson, & Isacsson, 1989).

Other than those conducted on western populations, very few studies have addressed the health impacts of psychosocial job characteristics. The only available prospective report of a group with Japanese ancestry in Hawaii (Reed et al., 1989) showed a significant *inverse* association between job strain and the incidence of coronary heart disease. In this study, exposure to each job characteristic was imputed on the basis of job titles in the US, and possible cultural differences were not considered. The objective of the present study was to test the hypothesis that adverse psychosocial job characteristics are related to mortality in a Japanese community-based study.

Materials and methods

The Jichi Medical School Cohort Study

The objective of the Jichi Medical School Cohort Study was to investigate the risk factors of cardiovascular diseases in Japan. For this purpose, data of 12,490 Japanese (4911 men and 7579 women) from 12 communities located across Japan were collected between 1992 and 1995 using a standardized questionnaire and physical examination that took place in each community (Ishikawa, Gotoh, Nago, & Kayaba, 2002). An alumni group of Jichi Medical School played the leading role in establishing the cohort, taking full advantage of the collaboration of local governments of communities where they worked as medical doctors. The cohort makes use of data collected through a mass screening examination programme administered by these governments. In accordance with the provisions of the Health and Medical Service Law for the Aged, a mass screening examination programme concerned with cardiovascular risk factors has been conducted in Japan since 1983. The law requires municipal governments to manage the programme efficiently and offer it to all residents who are willing to participate. In each community, the local government office invited all potential participants to participate by sending letters or using public information. The invitation mentioned that persons visiting hospitals or clinics because of cardiovascular diseases did not have to take part in the examination. Employees offered physical examinations at their workplace or elsewhere were not necessarily required to participate. The target subjects varied according to each community. Residents aged 40–69 years were the subject of the mass screening examination programme in eight of the 12 communities, those aged 20–69 years were the subjects in one of the programmes, those aged 35 years and older (no upper limit) were the subjects in another, and all residents (no age limit) were the subjects in the remainder. Despite these limitations, participants outwith these defined groups were also allowed to participate. The overall response rate was 65.4%.

The study population was limited to 3659 male and 3995 female workers with a baseline age of $\leqslant 65$ years, with the aim being to observe the effect of job characteristics on mortality. We excluded those with a history of cancer, myocardial infarction, and stroke (50 men and 52 women). Workers without complete information on their psychosocial job characteristics were also excluded (431 men and 612 women). As a result, the final sample included 3178 men and 3331 women. The age and occupational distribution of the study population according to sex are displayed in Box 1; the occupational distribution of the Japanese working population aged 15 and over in 1995 is also listed as a reference. The study population included large numbers of workers engaged in pre-industrial occupations (farming, forestry or fishery). More than 99% of the participants were employed by companies with fewer than 300 employees. According to the Industrial Safety and Health Law and related regulations in Japan, Japanese companies are required to conduct an annual health check-up of employees. For those not offered physical examinations at their workplaces, such as workers with pre-industrial occupations or those who are self-employed, the mass screening examination programme is an opportunity to check their health status. As part of this cohort, we

Box 1
Age and occupational distributions of the study population at baseline (1992/95), and occupational distribution of the Japanese working population aged 15 and over in 1995.

	Men		Women	
	Jichi Medical School Cohort Study	Japanese working population	Jichi Medical School Cohort Study	Japanese working population
Mean age (SD; range)	51 (10; 18, 65)		51 (9; 19, 65)	
Occupation *n* (%)				
Managers	756 (23.8)	2,392,924 (6.2)	204 (6.1)	260,930 (1.0)
Professionals/ technicians	142 (4.5)	4,600,529 (11.9)	180 (5.4)	3,406,238 (13.3)
Clerks	109 (3.4)	4,552,818 (11.8)	299 (9.0)	7,566,977 (29.5)
Sales workers	124 (3.9)	6,131,153 (15.9)	302 (9.1)	3,597,458 (14.0)
Service workers	155 (4.9)	1,826,613 (4.7)	498 (15.0)	3,200,845 (12.5)
Farming, forestry, or fishery	1052 (33.1)	2,161,598 (5.6)	1101 (33.1)	1,645,547 (6.4)
Security	17 (0.5)	895,068 (2.3)	1 (0.0)	42,270 (0.2)
Transportation/ communications	75 (2.4)	2,260,352 (5.9)	4 (0.1)	125,262 (0.5)
Craft workers/ labourers	704 (22.2)	13,491,491 (35.0)	708 (21.3)	5,592,641 (21.8)
Unclassified	44 (1.4)	216,416 (0.6)	34 (1.0)	174,414 (0.7)
Total	3178 (100.0)	38,528,962 (100.0)	3331 (100.0)	25,612,582 (100.0)

inferred from repeated surveys that changes in occupation or job position are not frequent in the rural settings included here (Kayaba, Tsutsumi, Gotoh, Ishikawa, & Miura, 2005). Some part-time employees were possibly included in the study population, but this was not ascertained.

Endpoint

We collected mortality data using the Cause-of-Death Register at the public health centre in each community with permission of the Agency of General Affairs and the Ministry of Health, Labour, and Welfare. We were able to ascertain the endpoint of all participants who died between the date of their health examination and the end of 2002.

Psychosocial job characteristics

Job characteristics were derived at baseline using a Japanese version of the demand–control questionnaire from the WHO-MONICA Psychosocial Study Questionnaire (Uehata, 1993). The psychometric properties of the questionnaire have been reported elsewhere (Tsutsumi, Kayaba, Tsutsumi, & Igarashi, 2001). The job characteristics studied were job control and psychological demands and were defined on two scales. Job control was defined as the sum of two subscales given equal weight: (1) skill discretion, measured by four parameters (possibility for learning new things, skills required by the job, requirement for creativity, and the repetitious nature of the work) and (2) autonomy for decision making, measured by two parameters (right to make one's own decisions and freedom to choose the manner in which the work is performed). The second scale, psychological job demands, was defined by five parameters (speed in completing work, degree of difficulty of the work, excessive workload, insufficient time allowed to complete the work, and conflicting demands). All questions were scored on a Likert scale of 1–4. Cronbach's

Table 1
Relationships between job characteristics and the studied variables, male and female workers aged 65 and under and free from cancer and cardiovascular diseases, the Jichi Medical School Cohort Study, baseline 1992/95

	Men					Women				
	Low strain	Active job	Passive job	Strain job	p^a	Low strain	Active job	Passive job	Strain job	p^a
No. of subjects	495	954	917	812		669	941	906	815	
Age (years) (%)										
18–39	13.3	15.2	13.5	13.8	<0.001	10.2	10.8	12.8	10.1	<0.001
40–49	30.3	36.1	22.1	28.7		28.0	34.4	30.5	33.1	
50–59	30.7	30.5	28.6	33.7		35.7	39.0	32.8	40.1	
60–65	25.7	18.2	35.8	23.8		26.2	15.7	24.0	16.7	
Socioeconomic status (%)										
Occupation										
Managers	27.7	35.2	13.1	20.1	<0.001	6.4	11.9	3.5	2.1	<0.001
Professionals/technicians/clerks	5.9	8.7	8.2	7.9		15.8	16.2	15.9	9.4	
Sales/service workers	11.3	6.4	8.9	9.9		24.7	23.4	26.8	21.1	
Farming/forestry/fishery	42.8	28.2	39.7	30.9		47.7	38.5	27.7	24.9	
Security/transportation/ communications/craft workers/ labourers/unclassified	12.3	21.5	30.1	31.3		5.4	10.1	26.0	42.5	
Education (age at completion)										
≤15	37.0	33.5	44.1	42.5	<0.001	41.9	39.3	45.3	45.0	0.046
16–18	46.7	51.0	44.8	46.0		44.8	44.5	44.0	47.2	
≥19	16.3	15.5	11.1	11.4		13.3	16.3	10.7	7.8	
Behavioural characteristics (%)										
Smoking										
Lifetime non-smoker	21.7	20.8	22.2	22.2	0.175	91.2	91.4	90.8	92.0	0.947
Ex-smoker	22.5	25.2	23.9	24.8		2.4	1.8	2.7	2.5	

Table 1 (*continued*)

	Men					Women				
	Low strain	Active job	Passive job	Strain job	p^a	Low strain	Active job	Passive job	Strain job	p^a
Current smoker (< = 20/day)	36.8	33.9	38.9	34.7		6.2	6.5	6.1	5.2	
Current smoker (>20/day)	19.0	20.1	15.0	18.4		0.2	0.2	0.3	0.2	
Alcohol intake (g/day)										
Non-drinker	20.0	20.4	25.5	18.4	0.003	71.1	65.3	74.0	68.3	0.002
<28.9	32.3	30.1	28.4	27.3		23.0	28.6	21.2	27.2	
⩾28.9	47.7	49.5	46.1	54.3		5.9	6.1	4.8	4.5	
Physical activity index[b]										
⩽28	18.7	17.0	18.9	20.2	<0.001	24.3	22.4	28.3	27.6	<0.001
29–36	38.8	34.7	44.2	32.4		49.2	46.7	54.3	50.9	
⩾37	42.5	48.3	36.9	47.4		26.4	30.9	17.4	21.5	
Biological characteristics										
Body mass index (kg/m^2) (%)										
<22	35.5	32.9	39.8	39.7	0.007	33.5	38.0	40.3	41.9	0.049
22–24.9	40.2	40.9	40.3	36.9		40.2	38.6	37.6	35.8	
⩾25	24.3	26.2	19.9	23.4		26.3	23.4	22.2	22.2	
Mean total cholesterol (mg/dl)	188.7	186.8	182.2	186.3	0.002	192.5	192.3	192.3	191.2	0.877
Hypertension[c] (%)	19.6	23.8	26.2	26.3	0.024	20.4	18.0	18.0	17.1	0.423
Diabetes mellitus[d] (%)	5.3	5.6	6.7	5.3	0.577	1.3	1.7	2.6	2.6	0.186

[a]Tests for heterogeneity.

[b]Physical activity index refers to metabolic equivalent task (MET) hours.

[c]Individuals were classified as hypertensive if (1) their systolic blood pressure was equal to or greater than 160 mmHg, (2) their diastolic blood pressure was equal to or greater than 90 mmHg, or (3) they were clinically diagnosed as hypertensive.

[d]Presence of diabetes was defined as (1) a fasting blood glucose level of at least 126 mg/dl, (2) a casual blood glucose level of at least 200 mg/dl, or (3) in treatment.

coefficient alphas for the job control index and psychological demand index were 0.65 and 0.69, respectively. The job conditions assessed as part of this cohort during the follow-up demonstrated a moderate degree of stability, with 5-year-interval intraclass correlation coefficients of 0.63 ($n = 377$) for job control and 0.55 ($n = 378$) for job demands (Kayaba et al., 2005).

The scores for each index were categorized using the median, and the two categorical variables were used to determine the four-level rank-ordered job-strain variables corresponding to Karasek's 2×2 model of job demand–control, with low job demand and high job control representing a low-strain job (reference category), high job demand and high job control representing an active job, low job demand and low job control representing a passive job, and high job demand and low job control representing a strain job.

Statistical analysis

The relationships between psychosocial job characteristics and the studied variables at baseline were examined using the χ^2 test for discrete variables and analysis of variance for continuous variables. Person-years of follow-up were counted for each participant from the date of her/his health examination to the date of death, date of emigration outside the study community, or the end of 2002, whichever occurred first. Data on emigration of the study population were obtained every year from the participants' municipal governments. A total of 159 subjects (2.4% of the analytic cohort) moved out of their communities during the follow-up and were analyzed as censored cases. The mean length of the follow-up was 9.4 years. The total observed person-years was 60,831. Cox's proportional hazard regression analysis was used to examine the association between psychosocial job characteristics and mortality after adjusting for age (18–39, 40–49, 50–59, and 60–65 years, respectively), educational attainment ($\leqslant 15$ years: age at completion of compulsory education, 16–18 years: age at finishing senior high school, $\geqslant 19$ years: age at entering college or further education), occupation (five strata: managers, professionals/technicians/clerks, sales/service workers, farming/forestry/fishery, security/transportation/communications/craft workers/labourers/unclassified), smoking status (lifetime non-smoker, ex-smoker, current light smoker ($\leqslant 20$/day), current heavy smoker (>20/day)), alcohol consumption (non-drinker, $<1\,go$ daily (*go*, a traditional Japanese alcohol unit; $1\,go = 28.9$ g of alcohol), $\geqslant 1\,go$ daily), physical activity index (Kannel & Sorlie, 1979) (<29, 29–36, $\geqslant 37$), body mass index (<22, 22–24.9, $\geqslant 25\,kg/m^2$), hypertension, diabetes, total cholesterol and study community. Covariate variables were measured at baseline. Ordinal or nominal variables were represented by dummy variables, and serum total cholesterol was analyzed as a continuous variable. In sub-analyses, we utilized categories based on individual quartiles of the demand and control scores as the main exposure to see which component contributes more to the effect. Statistical tests were two-tailed. All analyses were conducted with SPSS for Windows, release 13.

The study design and procedures were reviewed and approved by each municipal government and the Ethics Committee for Epidemiological Research at Jichi Medical School. Written informed consent was obtained from all prospective participants.

Results

Table 1 shows the relationships between psychosocial job characteristics and the studied variables at baseline. Men reporting active jobs were younger, and those with passive jobs older. The socioeconomic status was lower in men with passive or strain jobs than in those with active or low-strain jobs; the former group was more likely to be engaged in blue-collar work and have less education. Prevalence of pre-industrial occupations (farming/forestry/fishery) was high among men with low strain jobs, while managers were prevalent among men with active jobs. Men exposed to job strain were more likely to be heavy drinkers. Men with active jobs had a higher level of physical activity. Body mass index and total cholesterol levels were lowest in men with passive jobs, while the prevalence of hypertension was highest in men exposed to job strain.

Women with low-strain jobs were older and more obese. The relationship between psychosocial job characteristics and socioeconomic status was similar to that of men. Active jobs were associated with alcohol consumption and a high level of physical activity.

During the follow-up, 157 men and 64 women died (Table 2). Men with active jobs had the lowest mortality rates among the job demand–control categories. The adjusted relative risk of mortality

Table 2
Adjusted relative risk of all-cause mortality by levels of psychosocial job characteristics, male and female workers aged 65 and under and free from cancer and cardiovascular diseases, the Jichi Medical School Cohort Study, 1992/1995–2002

Job characteristics category	No. of cases	Person-years of follow-up	Age-adjusted		Multivariate	
			RR[a]	95% CI[a]	RR[b]	95% CI
Men						
Low strain[c]	32	4572	1.00		1.00	
Active job	28	8936	0.50	0.30, 0.83	0.53	0.31, 0.89
Passive job	55	8476	0.83	0.54, 1.28	0.87	0.55, 1.40
Strain job	42	7630	0.79	0.50, 1.26	0.79	0.47, 1.31
Women						
Low strain[c]	18	6234	1.00		1.00	
Active job	15	8818	0.68	0.34, 1.35	0.76	0.35, 1.65
Passive job	16	8523	0.67	0.34, 1.32	0.78	0.37, 1.65
Strain job	15	7640	0.76	0.38, 1.51	0.72	0.32, 1.64

[a]RR, relative risk; CI, confidence interval.
[b]Adjusted for age (18–39, 40–49, 50–59, or 60–65), educational attainment (age at completion; ≤15, 16–18, ≥19), occupation (managers, professionals/technicians/clerks, sales/service workers, farming/forestry/fishery, or security/transportation/communications/craft workers/labourers/unclassified), smoking (lifetime non-smoker, ex-smoker, current light smoker (≤20/day), or current heavy smoker (>20/day)), alcohol intake (non-drinker, <28.9 g/day, or ≥28.9 g/day), physical activity index (≤28, 29–36, or ≥37), body mass index (kg/m^2; <22, 22–24.9, or ≥25), total cholesterol (mg/dl), hypertension (yes/no), diabetes (yes/no), and the community.
[c]Reference category.

was reduced by almost one-half among individuals with active jobs and this reduction was statistically significant. In women, no statistically significant differences were found for mortality among the job characteristic categories.

A separate investigation of the effects of job control and demands showed that men with lower job control tended to have a higher risk of mortality, but the associations were not significant. The relative risk for the second-highest job demands was significantly below 1.0, and the test for trends showed a tendency towards a protective effect. Among women, point estimates of the effects of job control and demands on mortality were in unexpected directions, but were statistically insignificant (Table 3).

Analyses of cause-specific mortality might explain some mechanisms of the association between psychosocial job characteristics and mortality. The associations with mortality from cancer (ICD 10th revision codes C00 to D48), cardiovascular diseases (ICD 10th revision codes I00–I52 and I60–I69) and external causes (ICD 10th revision codes V01–Y98) were examined separately. Because the number of deaths was particularly small among women, we pooled the data for men and women. The interaction between psychosocial job characteristics and sex was not statistically significant, so further analyses were based on the total sample and sex was adjusted for in each Cox's proportional hazard regression model (Table 4).

A total of 102 workers (66 men and 36 women) died of cancer. The site-trend of cancer deaths in our study population was similar to the national data (Statistics and Information Department, 2002; Appendix A). The multivariate relative risk of cancer mortality was lowest among workers with active jobs. We re-ran the analysis for smoking-related cancers (lip, oral cavity and pharynx ($n = 2$), oesophagus (1), stomach (14), liver (8), pancreas (7), bronchus and lung (23), kidney (1), myeloid leukaemia (2)), producing similar results to the analysis of total cancers, though the findings were statistically insignificant. Compared with the low-strain category, the multivariate relative risk of an active job was 0.46 (95% CI: 0.19, 1.07; $p = 0.070$).

A total of 35 workers (25 men and 10 women) died of cardiovascular diseases. The patterns for cardiovascular disease mortality were somewhat different from those of all-cause mortality. Workers exposed to job strain had the highest risk of cardiovascular mortality, and those with low strain had the lowest. But there were no statistically significant differences.

A total of 45 workers (37 men and 8 women) died of external causes. The relative risk for external causes of mortality was lowest among workers with job strain, but associations were not statistically significant.

Table 3
Multivariate relative risk of all-cause mortality by levels of job control and job demands, male and female workers aged 65 and under and free from cancer and cardiovascular diseases, the Jichi Medical School Cohort Study, 1992/1995–2002

Levels of job control and job demands	No. of cases	Person-years of follow-up	Multivariate[a]	
			RR[b]	95% CI[b]
Men				
Level of control				
Highest[c]	18	4599	1.00	
Higher middle	42	8909	0.99	0.56, 1.75
Lower middle	53	8437	1.25	0.70, 2.20
Lowest	44	7670	1.11	0.61, 2.01
p for trend[d]				0.527
Level of demand				
Lowest[c]	65	8731	1.00	
Lower middle	22	4318	0.87	0.52, 1.45
Higher middle	36	8579	0.60	0.39, 0.94
Highest	34	7987	0.76	0.48, 1.19
p for trend[d]				0.078
Women				
Level of control				
Highest[c]	14	6390	1.00	
Higher middle	19	8663	0.97	0.44, 2.13
Lower middle	20	9654	0.87	0.39, 1.91
Lowest	11	6509	0.82	0.33, 2.04
p for trend[d]				0.618
Level of demand				
Lowest[c]	16	5914	1.00	
Lower middle	18	8843	0.83	0.40, 1.72
Higher middle	16	8810	0.76	0.36, 1.61
Highest	14	7649	0.79	0.35, 1.74
p for trend[d]				0.523

[a]Adjusted for age (18–39, 40–49, 50–59, or 60–65), educational attainment (age at completion; ⩽15, 16–18, ⩾19), occupation (managers, professionals/technicians/clerks, sales/service workers, farming/forestry/fishery, or security/transportation/communications/craft workers/labourers/unclassified), smoking (lifetime non-smoker, ex-smoker, current light smoker (⩽20/day), or current heavy smoker (>20/day)), alcohol intake (non-drinker, <28.9 g/day, or ⩾28.9 g/day), physical activity index (⩽28, 29–36, or ⩾37), body mass index (kg/m^2; <22, 22–24.9, or ⩾25), total cholesterol (mg/dl), hypertension (yes/no), diabetes (yes/no), and the community.
[b]RR, relative risk; CI, confidence interval.
[c]Reference category.
[d]Tests for trends were performed by modelling the group scores of psychosocial work variables (1, 2, 3) as one variable.

Discussion

Among a community-based Japanese working population, the job strain hypothesis was not supported with regard to all-cause mortality. However, men with active jobs had the lowest mortality risk from all causes; both high job control and high job demands had a small, statistically insignificant protective effect against mortality. Cause-specific analyses revealed that this finding was most likely explained by the association between active jobs and low cancer mortality. To the best of our knowledge, this is the first prospective report, other than those in western societies, to address psychosocial job characteristics and mortality. The job demand–control model was developed in western populations, and although growing research suggests its applicability to Japanese populations (Kawakami et al., 2000; Kawakami, Haratani, & Araki, 1998; Tsutsumi, Kayaba, Ishikawa et al., 2003; Tsutsumi et al., 2001; Tsutsumi, Kayaba, Yoshimura et al., 2003; Yoshimasu & The Fukuoka Heart Study Group, 2001), prospective studies have been warranted as evidence has been limited to cross-sectional or case–control studies.

Men with active jobs had the lowest all-cause mortality, and this finding appeared largely attributable to a reduction in cancer mortality. A

Table 4
Adjusted relative risk of cause-specific mortality by levels of psychosocial job characteristics, male and female workers aged 65 and under and free from cancer and cardiovascular diseases, the Jichi Medical School Cohort Study, 1992/1995–2002

Job characteristics category	No. of cases	Age, sex-adjusted		Multivariate	
		RR[a]	95% CI[a]	RR[b]	95% CI
Cancer mortality					
Low strain[c]	27	1.00		1.00	
Active job	22	0.53	0.30, 0.93	0.55	0.30, 1.00
Passive job	29	0.61	0.38, 1.04	0.64	0.36, 1.12
Strain job	26	0.67	0.39, 1.16	0.72	0.40, 1.30
Cardiovascular diseases mortality					
Low strain[c]	4	1.00		1.00	
Active job	7	1.18	0.34, 4.05	1.15	0.33, 4.01
Passive job	12	1.63	0.52, 5.06	1.74	0.54, 5.64
Strain job	12	2.47	0.81, 7.51	1.98	0.59, 6.70
External causes of mortality					
Low strain[c]	10	1.00		1.00	
Active job	11	0.62	0.26, 1.46	0.71	0.28, 1.79
Passive job	17	0.95	0.43, 2.08	0.95	0.39, 2.31
Strain job	7	0.45	0.17, 1.17	0.44	0.15, 1.30

[a]RR, relative risk; CI, confidence interval.
[b]Adjusted for sex, age (18–39, 40–49, 50–59, or 60–65), educational attainment (age at completion; ⩽15, 16–18, ⩾19), occupation (managers, professionals/technicians/clerks, sales/service workers, farming/forestry/fishery, or security/transportation/communications/craft workers/labourers/unclassified), smoking (lifetime non-smoker, ex-smoker, current light smoker (⩽20/day), or current heavy smoker (>20/day)), alcohol intake (non-drinker, <28.9 g/day, or ⩾28.9 g/day), physical activity index (⩽28, 29–36, or ⩾37), body mass index (kg/m^2; <22, 22–24.9, or ⩾25), total cholesterol (mg/dl), hypertension (yes/no), diabetes (yes/no), and the community.
[c]Reference category.

definite conclusion as to the association between active jobs and cancer awaits further investigations, because despite the heavy health burden of cancer evidence regarding the connection between job characteristics and cancer is scarce and inconsistent (Achat, Kawachi, Byrne, Hankinson, & Colditz, 2000; Courtney, Longnecker, & Peters, 1996; Jansson et al., 2004; Schernhammer et al., 2004; Spiegelman & Wegman, 1985). Moreover, as of yet there is no direct biological evidence regarding an association. However, since suppression of immune function is suspected among middle-aged men exposed to adverse job characteristics, in particular low job control (Kawakami et al., 1997; Nakata et al., 2002), more insight might be gained by investigating the effects of psychosocial job characteristics on cancer.

Point estimates of the effect of job strain on cardiovascular disease mortality were consistent with the strain hypothesis, but observed associations were small in magnitude and did not reach a level of statistical significance. The age-adjusted mortality rates for ischaemic heart diseases among Japanese represent the internationally lowest levels (National Heart Lung and Blood Institute, 1993). If job strain exerts its effects primarily through ischaemic heart diseases, the impact of job strain on cardiovascular mortality in Japan should be weaker than in western countries where mortality due to ischaemic heart diseases is much higher. The inconclusive findings to date therefore warrant further examination of the effect of job strain on cardiovascular outcome.

The results showed no statistically significant associations in women, consistent with previous studies (Achat et al., 2000; Belkić, Landsbergis, Schnall, & Baker, 2004; Hall, Johnson, & Tsou, 1993; Lee et al., 2002). In addition to the limited number of outcome cases and incomplete adjustment for gender-related confounding variables such as home-work interference, we should also bear in mind that the labour force participation rate of Japanese women is lower than that in western societies. Except for large enterprises, female attitudes toward work might therefore be less proactive. Inclusion of part-time workers, the majority of whom are assumed to be women, might also have affected the results.

Autonomy for decision making was measured using two parameters: the right to make one's own decisions and freedom to choose the manner in which the work is performed. Since our database included a large proportion of managers and employers (presumably including a large number of self-employed), we tested the importance of the above measures in these two groups. The level of decision authority was significantly higher among managers and employers than respective counterpart groups. Moreover, in these sub-groups, those with the highest decision authority had the lowest mortality risk but the association was not statistically significant (data not shown).

Limitations

The study population was composed of relatively healthy Japanese adults, mortality rates for whom are considerably below those of the general population (Ishikawa et al., 2002). The mass screening examination programme is not mandatory and employees who undergo health-checks at their workplaces do not have to participate. Thus, participants might have a more health-oriented predisposition than non-participants. In addition, the invitation to participate did not insist that those receiving care for cardiovascular diseases should sign up. Moreover, participants were relatively old, and thus, a considerable number might have sustained a long career with the same job (the healthy worker effect). Furthermore, the follow-up was short. All these conditions probably accounted for the small number of outcome events. In addition, the relatively low response rate might imply that workers with demanding work situations did not participate in the programme. Consequently, the results probably give a conservative estimate of the risk of job strain on mortality. Workers with major diseases at baseline were excluded from the analyses, but some individuals might have changed their jobs according to their *pre*-clinical health condition (Karasek, Schwartz, & Theorell, 1982). If participants shifted to less-demanding jobs because of health problems, there would be selection bias leading to underestimation of the association between job strain and mortality on one hand and an overestimation of the association between active jobs and 'low' mortality on the other. Lastly, since under-representation of those with access to occupational health limits generalizability of the findings, replication is needed in the future among representative samples of employed workers.

There is great potential for confounding of the association between job characteristics and cancer mortality; those in active jobs were younger, of higher socioeconomic status and physically active. We took into account relevant covariate variables in the analyses, but there is still room for residual confounding. For example, negative emotions such as hostility and depression (Williams et al., 1997) as well as employment status (full- vs. part-time) and income level were not measured. Immunologic factors are another plausible pathway.

All-cause mortality is too vague an outcome to explore the exact mechanisms through which psychosocial job characteristics affect the health of workers. Many diseases contribute to mortality with a different incidence according to the population examined. The same is true for cancers as a single group, since cancer is a heterogeneous mix of specific cancers with different causes. Research on one specific type of cancer is therefore important in accurately examining the role of stress in the development of cancer (Burke & Goodkin, 1997). In addition, non-fatal cases were not considered in this study, and thus, the incidence of defined diseases among Japanese workers should be addressed in the future.

Cronbach's alpha coefficient of job control was slightly low, and our exposure assessment was limited to one point in time; both likely caused associations toward the null. However, statistically significant long-term stability was confirmed in our measurements (Kayaba et al., 2005). Moreover, previous studies have shown the importance of cumulative job control (Bosma et al., 1997) and an active job as a protector (Amick et al., 2002; Johnson, Stewart, Hall, Fredlund, & Theorell, 1996).

Despite the above, our study had a number of strengths. For example, the study population is the largest Japanese cohort of this kind to date. Moreover, information about exposure to job strain was obtained from self-reports with a validated instrument rather than by assigning scores based on job description; hence, each score accurately represents individual work environments (Belkić et al., 2004). Self-reporting bias is unlikely to be important because of the hard endpoint (mortality) and prospective study design, and bias attributable to sample attrition is thought to be implausible as the follow-up rate was high.

Our study adds to the literature on demand–control psychosocial job characteristics and workers' health in a non-western society. In this Japanese working population, job strain did not predict all-cause mortality. However, further evaluation of the hypothesis that active jobs have beneficial effects on, for example, active learning behaviour and/or personal growth, both of which could potentially improve health (Theorell & Karasek, 1996), is warranted. Moreover, investigation of the effect of psychosocial job characteristics on cancer might provide valuable insights into the health of workers.

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Appendix A. Cancer mortality by site, male and female workers aged 65 and under and free from cancer and cardiovascular diseases, the Jichi Medical School Cohort Study, 1992/1995–2002

Sites	*n*
Lip, oral cavity and pharynx	2
Digestive organs	
Stomach	14
Colon	7
Other sites	18
Respiratory and intrathoracic organs	
Bronchus and lung	23
Other sites	1
Breast	1
Female genital organs	7
Male genital organs	1
Urinary tract	1
Eye, brain and other parts of central nervous system	3
Thyroid and other endocrine glands	1
Malignant neoplasms of ill-defined, secondary and unspecified sites	16
Lymphoid/haematopoietic	6
Neoplasms of uncertain or unknown behaviour	1
Total	102

Appendix B

The Jichi Medical School Cohort Study Group: Akizumi Tsutsumi (University of Occupational and Environmental Health), Atsushi Hashimoto (Aichi Prefectural Aichi Hospital), Eiji Kajii (Jichi Medical School), Hideki Miyamoto (former Jichi Medical School), Hidetaka Akiyoshi (Fukuoka University School of Medicine), Hiroshi Yanagawa (Saitama Prefectural University), Hitoshi Matsuo (Gifu Prefectural Hospital), Jun Hiraoka (Tako Central Hospital), Kaname Tsutsumi (Kyushu International University), Kazunori Kayaba (Saitama Prefectual University), Kazuomi Kario, Kazuyuki Shimada (Jichi Medical School), Kenichiro Sakai (Akaike Town Hospital), Kishio Turuda (Takasu National Health Insurance Clinic), Machi Sawada (Agawa Osaki National Health Insurance Clinic), Makoto Furuse (Jichi Medical School), Manabu Yoshimura (Kuze Clinic), Masahiko Hosoe (Gero Hot-Spring Hospital), Masahiro Igarashi (Igarashi Clinic), Masafumi Mizooka (Kamagari National Health Insurance Clinic), Naoki Nago (Yokosuka General Hospital Uwamachi), Nobuya Kodama (Sakugi Clinic), Noriko Hayashida (Tako Central Hospital), Rika Yamaoka (Awaji-Hokudan Public Clinic), Seishi Yamada (Wara National Health Insurance Hospital), Shinichi Muramatsu, Shinya Hayasaka, Shizukiyo Ishikawa (Jichi Medical School), Shuzo Takuma (Akaike Town Hospital), Tadao Gotoh (Wara National Health Insurance Hospital), Takafumi Natsume (Oyama Municipal Hospital), Takashi Yamada (Kuze Clinic), Takeshi Miyamoto (former Okawa Komatsu National Health Insurance Clinic), Tomohiro Deguchi (Akaike Town Hospital), Tomohiro Saegusa (Sakuma National Health Insurance Hospital), Yoshihiro Shibano (Saiseikai Iwaizumi Hospital) Yoshihisa Ito (Asahikawa Medical College), and Yosikazu Nakamura (Jichi Medical School).

References

Achat, H., Kawachi, I., Byrne, C., Hankinson, S., & Colditz, G. (2000). A prospective study of job strain and risk of breast cancer. *International Journal of Epidemiology, 29*, 622–628.

Alfredsson, L., Spetz, C.-L., & Theorell, T. (1985). Type of occupation and near-future hospitalization for myocardial infarction and some other diagnoses. *International Journal of Epidemiology, 14*(3), 378–388.

Alterman, T., Shekelle, R. B., Vernon, S. W., & Burau, K. D. (1994). Decision latitude, psychologic demand, job strain, and

coronary heart disease in the Western Electric Study. *American Journal of Epidemiology, 139*(6), 620–627.

Amick, B. C., 3rd., McDonough, P., Chang, H., Rogers, W., Pieper, C., & Duncan, G. (2002). Relationship between all-cause mortality and cumulative working life course psychosocial and physical exposures in the United States labor market from 1968 to 1992. *Psychosomatic Medicine, 64*(3), 370–381.

Åstrand, N.-E., Hanson, B. S., & Isacsson, S.-O. (1989). Job demands, job decision latitude, job support, and social network factors as predictors of mortality in a Swedish pulp and paper company. *British Journal of Industrial Medicine, 46*, 334–340.

Belkić, K., Landsbergis, P. A., Schnall, P. L., & Baker, D. (2004). Is job strain a major source of cardiovascular disease risk? *Scandinavian Journal of Work & Environmental Health, 30*(4), 85–128.

Bosma, H., Marmot, M. G., Hemingway, H., Nicholson, A. C., Brunner, E., & Stansfeld, S. A. (1997). Low job control and risk of coronary heart disease in Whitehall II (prospective cohort) study. *British Medical Journal, 314*, 558–565.

Bosma, H., Peter, R., Siegrist, J., & Marmot, M. (1998). Two alternative job stress models and the risk of coronary heart disease. *American Journal of Public Health, 88*(1), 68–74.

Burke, M. A., & Goodkin, K. (1997). Stress and the development of breast cancer: A persistent and popular link despite contrary evidence. *Cancer, 79*(5), 1055–1059.

Courtney, J. G., Longnecker, M. P., & Peters, R. K. (1996). Psychosocial aspects of work and the risk of colon cancer. *Epidemiology, 7*(2), 175–181.

de Bacquer, D., Pelfrene, E., Clays, E., Mak, R., Moreau, M., de Smet, P., et al. (2005). Perceived job stress and incidence of coronary events: 3-year follow-up of the Belgian job stress project cohort. *American Journal of Epidemiology, 161*(5), 434–441.

Eaker, E., Sullivan, L., Kelly Hayes, M., D'Agostino, R. S., & Benjamin, E. (2004). Does job strain increase the risk for coronary heart disease or death in men and women? The Framingham offspring study. *American Journal of Epidemiology, 159*(10), 950–958.

Falk, A., Hanson, B. S., Isacsson, S.-O., & Östergren, P.-O. (1992). Job strain and mortality in elderly men: Social network, support, and influence as buffers. *American Journal of Public Health, 82*(8), 1136–1139.

Haan, M. N. (1988). Job strain and ischaemic heart disease: An epidemiologic study of metal workers. *Annals of Clinical Research, 20*, 143–145.

Hall, E. M., Johnson, J. V., & Tsou, T. S. (1993). Women, occupation, and risk of cardiovascular morbidity and mortality. *Occupational Medicine—State of the Art Reviews, 8*(4), 709–719.

Ishikawa, S., Gotoh, T., Nago, N., Kayaba, K. & Jichi Medical School (JMS) Cohort Study Group. (2002). The Jichi Medical School (JMS) cohort study: Design, baseline data and standardized mortality ratios. *Journal of Epidemiology, 12*(6), 408–417.

Jansson, C., Johansson, A. L., Jeding, K., Dickman, P. W., Nyren, O., & Lagergren, J. (2004). Psychosocial working conditions and the risk of oesophageal and gastric cardiac cancers. *European Journal of Epidemiology, 19*(7), 631–641.

Johnson, J. V., Stewart, W., Hall, E. M., Fredlund, P., & Theorell, T. (1996). Long-term psychosocial work environment and cardiovascular mortality among Swedish men. *American Journal of Public Health, 86*(3), 324–331.

Kannel, W. B., & Sorlie, P. (1979). Some health benefits of physical activity: The Framingham study. *Archives of Internal Medicine, 139*(2), 857–861.

Karasek, R., Baker, D., Marxer, F., Ahlbom, A., & Theorell, T. (1981). Job decision latitude, job demands, and cardiovascular disease: A prospective study of Swedish men. *American Journal of Public Health, 71*(7), 694–705.

Karasek, R., & Theorell, T. (1990). *Healthy work: Stress, productivity, and the reconstruction of working life*. New York: Basic Books.

Karasek, R. A., Schwartz, J. E., & Theorell, T. (1982). *Stress at work and cardiovascular disease*. New York: Columbia University.

Kawakami, N., Akachi, K., Shimizu, H., Haratani, T., Kobayashi, F., Ishizaki, M., et al. (2000). Job strain, social support in the workplace, and haemoglobin A1c in Japanese men. *Occupational and Environmental Medicine, 57*, 805–809.

Kawakami, N., Haratani, T., & Araki, S. (1998). Job strain and arterial blood pressure, serum cholesterol, and smoking as risk factors for coronary heart disease in Japan. *International Archives of Occupational and Environmental Health, 71*, 429–432.

Kawakami, N., Tanigawa, T., Araki, S., Nakata, A., Sakurai, S., Yokoyama, K., et al. (1997). Effects of job strain on helper-inducer (CD4+CD29+) and suppressor-inducer (CD4+CD45RA+) T cells in Japanese blue-collar workers. *Psychotherapy and Psychosomatics, 66*, 192–198.

Kayaba, K., Tsutsumi, A., Gotoh, T., Ishikawa, S., & Miura, Y. (2005). Five-year stability of job characteristics scale scores among a Japanese working population. *Journal of Epidemiology, 15*(6), 228–234.

Kivimäki, M., Leino-Arjas, P., Luukkonen, R., Riihimaki, H., Vahtera, J., & Kirjonen, J. (2002). Work stress and risk of cardiovascular mortality: Prospective cohort study of industrial employees. *British Medical Journal, 325*(7369), 857–860.

Kuper, H., & Marmot, M. (2003). Job strain, job demands, decision latitude, and risk of coronary heart disease within the Whitehall II study. *Journal of Epidemiology and Community Health, 57*(2), 147–153.

Lee, S., Colditz, G., Berkman, L., & Kawachi, I. (2002). A prospective study of job strain and coronary heart disease in US women. *International Journal of Epidemiology, 31*, 1147–1153.

Nakata, A., Tanigawa, T., Fujioka, Y., Kitamura, F., Iso, H., & Shimamoto, T. (2002). Association of low job control with a decrease in memory (CD4+CD45RO+) T lymphocytes in Japanese middle-aged male workers in an electric power plant. *Industrial Health, 40*(2), 142–148.

National Heart Lung and Blood Institute. (1993). *International activities report, fiscal year 1993*. Bethesda, USA: National Heart, Lung and Blood Institute.

Reed, D. M., LaCroix, A. Z., Karasek, R. A., Miller, D., & MacLean, C. A. (1989). Occupational strain and the incidence of coronary heart disease. *American Journal of Epidemiology, 129*(3), 495–502.

Schernhammer, E. S., Hankinson, S. E., Rosner, B., Kroenke, C. H., Willett, W. C., Colditz, G. A., et al. (2004). Job stress and breast cancer risk: The Nurses' Health Study. *American Journal of Epidemiology, 160*(11), 1079–1086.

Spiegelman, D., & Wegman, D. H. (1985). Occupation-related risks for colorectal cancer. *Journal of the National Cancer Institute, 75*(5), 813–821.

Statistics and Information Department, Minister's Secretariat, Ministry of Health Labour and Welfare. (2002). *Vital statistics of Japan*. Tokyo: Health and Welfare Statistics Association.

Steenland, K., Johnson, J., & Nowlin, S. (1997). A follow-up study of job strain and heart disease among males in the NHANES1 population. *American Journal of Industrial Medicine, 31*, 256–260.

Suadicani, P., Hein, H. O., & Gyntelberg, F. (1993). Are social inequalities as associated with the risk of ischaemic heart disease a result of psychosocial working conditions? *Atherosclerosis, 101*, 165–175.

Theorell, T., & Karasek, R. A. (1996). Current issues relating to psychosocial job strain and cardiovascular disease research. *Journal of Occupational Health Psychology, 1*(1), 9–26.

Tsutsumi, A., Kayaba, K., Ishikawa, S., Gotoh, T., Nago, N., Yamada, S., et al. (2003). Job characteristics and serum lipid profile in Japanese rural workers: The Jichi Medical School Cohort Study. *Journal of Epidemiology, 13*(2), 63–71.

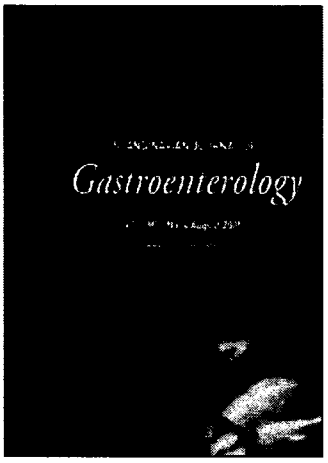
Tsutsumi, A., Kayaba, K., Tsutsumi, K., & Igarashi, M. (2001). Association between job strain and prevalence of hypertension: A cross sectional analysis in a Japanese working population with a wide range of occupations: The Jichi Medical School Cohort Study. *Occupational and Environmental Medicine, 58*(6), 367–373.

Tsutsumi, A., Kayaba, K., Yoshimura, M., Sawada, M., Ishikawa, S., Sakai, S., et al. (2003). Association between job characteristics and health behaviors in Japanese rural workers. *International Journal of Behavioral Medicine, 10*(2), 125–142.

Uehata, T. (1993). Stress, life style and health. *Bulletin of the Institute of Public Health, 42*(3), 385–401.

Williams, R., Barefoot, J., Blumenthal, J., Helms, M., Luecken, L., Pieper, C., et al. (1997). Psychosocial correlates of job strain in a sample of working women. *Archives of General Psychiatry, 54*(6), 543–548.

Yoshimasu, K. & The Fukuoka Heart Study Group. (2001). Relation of type A behavior pattern and job-related psychosocial factors to nonfatal myocardial infarction: A case–control study of Japanese male workers and women. *Psychosomatic Medicine, 63*(5), 797–804.



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Abnormal relationship between dissociation and hypnotic susceptibility in irritable bowel syndrome

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SHORT REPORT

Abnormal relationship between dissociation and hypnotic susceptibility in irritable bowel syndrome

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Introduction

Irritable bowel syndrome (IBS) is a functional gastrointestinal disorder characterized by abdominal pain or discomfort which is associated with changes in stool frequency and/or form [1]. Standard medical treatment is of benefit to only about 50% of patients with IBS. In contrast, hypnotherapy has been shown to be very effective in the treatment of IBS in up to 80% of patients [2]. However, few reports are available on the relationship between IBS and hypnotic susceptibility. The previous studies demonstrated that a dissociative tendency toward time, location, and sense of self increased hypnotic susceptibility [3]. The present study was therefore designed to test the hypothesis that a dissociative tendency can account for the link between IBS and hypnotic susceptibility.

Material and methods

One hundred and eighty-seven male volunteers were recruited from universities in Sendai and screened with the dissociative experiences scale (DES) [3]. Men were enrolled to preclude the possible influence of the menstrual cycle on gastrointestinal symptoms. The DES consists of 28 questions to assess dissociative experiences [3]. Experiences were rated on a scale of 0% (never have the experience) to 100% (always have the experience). The averaged DES was 9.7 ± 8.5. Individuals with the mean DES score above the 80 percentile were considered as "high dissociative subjects" ($n = 39$, mean 22.1 ± 8.4), while those with a score of below the 30 percentile were considered "low dissociative subjects" ($n = 44$, mean 1.7 ± 0.8). These high/low cut-offs have been used in previous research [4]. IBS status was diagnosed using the Rome II criteria [1] and 39 subjects out of 187 individuals had IBS. As a result, the following subjects were identified; 18 healthy-high dissociative, 19 healthy-low dissociative, 12 IBS-high dissociative and 8 IBS-low dissociative. Group mean ages were 20.1 ± 2.3, 20.4 ± 1.8, 20.1 ± 2.0 and 20.5 ± 1.6, respectively. The subjects completed the Japanese version of the Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS-A) [5] in a temperature-controlled, quiet room. The Tohoku University Ethics Committee approved the experimental procedure. All volunteers gave written informed consent before participation. Data were expressed as means $\pm$ SE and were analyzed with the SPSS software (version 10.0). The Mann-Whitney U-test, two-way analysis of variance (ANOVA), and *post hoc* test were used and a p-value of less than 0.05 (ANOVA) and a p-value of less than 0.01 (*post hoc*) were considered as significant.

Results

There was no significant difference in DES score between healthy controls (10.7 ± 7.4) and IBS subjects (11.0 ± 7.6) ($z = -1.66$, $p > 0.05$). Two-way ANOVA of the HGSHS-A revealed significant interaction between groups (controls versus IBS subjects) and dissociative status (high DES versus low DES), ($F(1.53) = 4.84$, $p < 0.05$, Figure 1). The *post hoc* test indicated that high dissociative controls have significantly higher HGSHS-A than low dissociative controls ($p < 0.01$). However, high dissociative IBS subjects have similar HGSHS-A to low dissociative IBS subjects ($p > 0.05$) and scored

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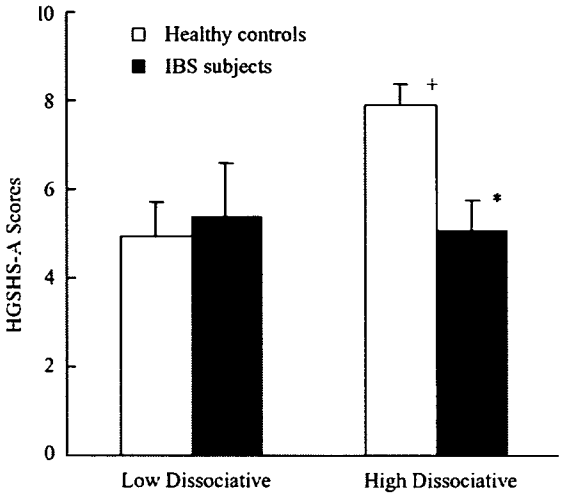

Figure 1. Differences in Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS-A) among four groups. Data are expressed as means±SE. □ =healthy controls; ■ =IBS (irritable bowel syndrome) subjects; Low Dissociative =subjects with low DES; High Dissociative =subjects with high DES. Two-way analysis of variance (ANOVA), interaction ($p < 0.05$)+ $p < 0.01$: versus healthy – low dissociative subjects, *$p < 0.01$: versus healthy – high dissociative subjects, *post hoc* test.

significantly lower HGSHS-A than high dissociative controls ($p < 0.01$).

Comment

The results of the present study refuted our initial hypothesis that a dissociative tendency could account for the link between IBS and hypnotic susceptibility. On the contrary, IBS subjects failed to demonstrate a normal association between dissociative tendency and hypnotic susceptibility that has been reported in studies of non-IBS subjects. This study is limited by only having included male subjects but provides basic information for neuroimaging research. A recent study with functional magnetic resonance imaging revealed that placebo analgesia was related to decreased brain activity in pain-sensitive brain regions and was associated with increased activity during anticipation of pain in the prefrontal cortex, providing evidence that suggestion alters the experience of pain [6]. IBS patients are known to have more activation of dorsolateral prefrontal cortex blood flow to colorectal distension [1]. Therefore, individuals with IBS may have disturbed pain-modulating brain processing in the cortical levels, and this characteristic may account for the lack of association between a dissociative tendency and hypnotic susceptibility.

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References

[1] Drossman DA, Corazziari E, Talley NJ, Thompson WG, Whitehead WE. Rome II: the functional gastrointestinal disorders, 2nd ed. McLean: Degnon Associates; 2000. pp 1–432.

[2] Whorwell PJ, Prior A, Faragher EB. Controlled trial of hypnotherapy in the treatment of severe refractory irritable bowel syndrome. Lancet 1984;2:1232–4.

[3] Bernsein EM, Putnam FW. Development, reliability, and validity of a dissociation scale. J Nervous Mental Dis 1986; 174:727–35.

[4] Engel CC, Walker EA, Katon WJ. Factors related to dissociation among patients with gastrointestinal complaints. J Psychosom Res 1996;40:643–53.

[5] Shor RE, Orne EC. Harvard Group Scale of Hypnotic Susceptibility, Form A. Palo Alto, CA: Consulting Psychologists Press; 1962.

[6] Wager TD, Rilling JK, Smith EE, Sokolik A, Casey KL, Dvidson RJ, et al. Placebo-induced changes in fMRI in the anticipation and experience of pain. Science 2004;303: 1162–7.

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Immune, endocrine and cardiovascular responses to controllable and uncontrollable acute stress

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Abstract

This study, using a triadic-yoked design, clarified the effects of controllability of acute stress on responses of immune, cardiovascular (heart rate and blood pressure), and cortisol activities. Forty-three women in their follicular phase completed a mental arithmetic task as a stressor in which controllability was manipulated by correct or yoked-bogus feedback. The task decreased proportions of CD3+ T cells, CD4+ T cells, and CD19+ B cells, whereas it increased the numbers of white blood cells, lymphocytes, natural killer (NK) cells, and NK cell activity (NKCA). Our main hypothesis that greater immune and cardiovascular responses to the task would be obtained under the uncontrollable condition than under the controllable condition was not supported. However, the uncontrollable stress condition, but not the controllable situation, led to higher correlations between heart rate or blood pressure, and various immune parameters. On the other hand, parameters of heart rate variability reflecting sympathetic and parasympathetic activities showed significant correlations only with NKCA. These results suggest that immune responses were most directly associated with cardiovascular activities under the uncontrollable condition.

Keywords: Stress; Controllability; Mental arithmetic; Psychoneuroimmunology

1. Introduction

There is much evidence that experimental acute stress tasks such as mental arithmetic influence the function of peripheral immunity. Previous studies have reported that innate immunity and mucosal immunity (e.g., the number of natural killer (NK) cells, NK cell activity (NKCA), and salivary secretory immunoglobulin A (S-IgA)[1]) are enhanced, whereas specific or acquired immunity (e.g., numbers of helper T cells and B cells) either does not change or decreases during mental arithmetic (Delahanty et al., 1996; Pike et al., 1997; Burleson et al., 1998; Willemsen et al., 1998, 2002; Ring et al., 1999, 2000; Bosch et al., 2001, 2002; Isowa et al., 2004; Kimura et al., in press; for review, see Segerstrom and Miller, 2004).

In addition, numerous studies have provided evidence that the nature and magnitude of the immune, endocrine, and cardiovascular responses induced by acute stress may depend on specific situational determinants such as controllability over stressors (Laudenslager et al., 1983; Maier et al., 1986; Weisse et al., 1990; Sieber et al., 1992; Peters et al., 1998, 1999, 2003). The effects of controllability have been widely studied in animal models using a triadic-yoked design (Seligman, 1975). Some previous studies using animal such as rat found that controllability of stress task was effective to physiological responses to it (Laudenslager et al., 1983; Nakata et al., 1996).

Several researchers have tried to extend these findings to human subjects (Weisse et al., 1990; Sieber et al., 1992; Gomez et al., 1994; Peters et al., 1998, 1999, 2003), though the results of these studies have been inconsistent. Weisse et al. (1990) reported decreased lymphocyte proliferation in

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[1] The concentration or secretion rate of S-IgA is an index of specific immunity function in local mucosal sites. However, the roles and characteristics of S-IgA are quite unique compared to those of general specific immunity represented by the production of the other subsets of immunoglobulin. Thus, we specifically refer to mucosal immunity for the value of S-IgA.

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response to concanavalin A (ConA) and PHA in subjects who had control over a stress task. Sieber et al. (1992) found decreased NKCA after uncontrollable stress but not after controllable stress. Gomez et al. (1994) found no effect of uncontrollability on various immune parameters. One possible explanation for the contradictory results may be that these experiments employed slightly different stress tasks of different durations. Furthermore, because most of the previous studies did not measure parameters of all three of the aspects of homeostasis (autonomic nervous, endocrine, and immune systems), it is difficult to examine in detail the interaction of these systems during controllable and uncontrollable acute stress. To our knowledge, only one study by Peters et al. (1999) examined the effects of controllability on the cardiovascular, endocrine, and immune systems of humans. They found that in vitro production of cytokine interleukin-6 (IL-6) was decreased after an uncontrollable stressor, and concluded that this phenomenon was induced by activation of the hypothalamus-pituitary-adrenocortex (HPA) axis. Although their finding is very valuable and important for examining the effect of controllability in acute stress, regrettably, the mediation of activity of the autonomic nervous system in the effects of controllability has not previously been reported.

Many previous experiments have demonstrated that the autonomic nervous system can react more rapidly than the HPA axis (Isowa et al., 2004; Burleson et al., 1998; Pike et al., 1997; Fokkema et al., 1988; Bohous et al., 1987). Moreover, Swenson and Vogel (1983) found that plasma NE and E levels in rats exposed to inescapable shock were higher than those in rats exposed to escapable shock, whereas the corticosterone level was the same in the two groups. Peters et al. (1998) reported that under an uncontrollable stressful condition, the level of plasma NE in humans increased more than it did under a controllable stressful condition, and that blood pressure under the uncontrollable condition was higher than that under the controllable condition. Such evidence suggests that controllability of an acute stressor will have a greater impact on autonomic parameters than on parameters of the HPA axis. In turn, it can be predicted that the autonomic activity induced by the controllability will have a rapid effect on peripheral immune functions. However, no study has directly examined such processes in an experimentally manipulated uncontrollable stressful situation.

Therefore, using a triadic-yoked design, we examined the effects of controllability on the responses of the human autonomic, endocrine, and immune systems to acute stress. For this purpose, we estimated the autonomic (sympathetic versus parasympathetic) activity through heart rate variability (HRV) and examined the effects of cardiovascular activity itself (heart rate (HR) and blood pressure (BP)) on immune parameters. On the basis of the previous studies described above, we predicted that the acute stress task would elicit prompt activation of the autonomic nervous system, and that this system, in turn, would mediate the enhancement of innate immunity (NKCA and proportions of NK cells in blood) and the suppression of specific immunity (proportions of T cells and helper T cells in blood). Specifically, we anticipated that the magnitude of the responses of the autonomic and immune parameters under the uncontrollable condition would be larger than that under the controllable condition.

2. Methods

2.1. Subjects

Forty-three female undergraduates in the Mie Prefectural College of Nursing (age range, 19–34 years; mean = 21.51, S.D. = 2.66) participated in the present study. Each participant was randomly assigned to one of three groups: a controllable stressors (C), an uncontrollable stressors (UC), or a no stressors (control) group. The C and UC groups were assigned 18 subjects, and the control group 7 subjects.

The mean BMI of the subjects was 21.03 kg/m^2 (S.D. = 2.22). None of the subjects were suffering from any chronic or oral illness, and none were taking medication known to influence immunity. In addition, no subjects were using oral contraceptives. Considering the effects of the menstrual cycle on the immune system, all subjects were required to measure their basal body temperature (BBT) daily for more than 3 months before the experimental sessions. They participated in the experiments during the late luteal and early follicular phases. In these periods, secretion of female sex hormones (progesterone and estrogen) is at low levels; thus, the influence of these hormones on the autonomic nervous and immune systems was minimized. For confirmation of the periods of the menstrual cycle, participants reported about both their current menstrual cycles and their BBT, and serum levels of estradiol (E_2) and progesterone were measured in all subjects on the days of the experiment. The mean value of estradiol was 50.87 pg/ml (S.D. = 55.31), and the mean value of progesterone was 0.96 ng/ml (S.D. = 1.78). In most cases, the hormone levels matched the levels expected based on the participant's self report. All subjects provided written informed consent. The Ethics Committee of the Mie Prefectural College of Nursing approved the present study.

2.2. Immunological measures

Blood samples for immunological determinations were collected in heparinized tubes. The numbers of total white blood cells (WBC), lymphocytes, monocytes, and granulocytes per sample were determined by standard means. Percentages of lymphocyte subsets were determined by flow cytometry (FACS Calibur; Becton-Dickinson, San Jose, CA). A whole-blood lysis method was used to stain the cell with the following pairs of Fluorescein isothiocyanate (FITC)/Phycoerythrin (PE) conjugated, isotype-matched