

Three-Shift System Increases Job-Related Stress in Japanese Workers

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Abstract: Three-Shift System Increases Job-Related Stress in Japanese Workers: Hideto HARADA, et al. Department of Occupational and Environmental Medicine, Graduate School of Medicine, Chiba University—We assessed the relationship between shift work and job stress. The target subjects were 4,962 male workers (3,078 day workers and 1,884 shift workers) aged 18 to 60 yr who work in a Japanese steel company. We used the “Brief Job Stress Questionnaire”, which was developed by a research group organized by the Japanese Ministry of Labour. We evaluated the effect of shift work on job stress using logistic regression analysis including age, lifestyle factors, work conditions, marital status, and living arrangements in the model. Job schedule type was significantly associated with job control, with an odds ratio of 2.22 for shift workers compared to day workers. The logistic regression analysis revealed that the odd ratios for having one or more stressor items in an unfavorable condition were significantly higher for shift workers compared to day workers. Increase in the amount of overtime and decrease in the number of holidays led to a significant deterioration in job stress. Our study reveals that the 3-shift system of employment increases work-related stress, and that job control is low among shift workers. To reduce job stress in this occupational population, a reduction in the amount of overtime and an increase in the number of holidays seem to be useful interventions.

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Recently, industrialization in Japan and other countries

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has given rise to increases in the number of companies adopting a 24-h continuous operation system and the number of workers engaged in shift work¹. According to the Japanese Ministry of Labour², 17.5% of Japanese companies had adopted shift work, including night work, in 1999. The proportion of companies having adopted shift work is higher among larger companies. The percentage of electricity, gas, energy, and water companies, which are responsible for the needs of daily life around the clock, that have adopted shift work is 71.2%. This is followed in decreasing order by the mining industry (28.9%), manufacturing industry (27.5%), transport and communication industries (27.3%), real estate sector (18.9%), and service industry (18.0%). Furthermore, the number of female laborers in shift work is expected to increase as a result of recent changes to Japanese labor laws. Until several years ago shift work had been regarded as affecting only a small minority of workers, but it has become an increasingly common work type due to recent changes in social and economic circumstances. This makes the effects of shift work on worker health an ever more urgent and important focus for research.

It has been reported that shift work, including night work, contributes to cerebrovascular and cardiovascular disease^{3–9}. An association between these disorders and job stress, an increasingly recognized problem in recent years, has also been pointed out^{10–15}.

We conjecture that job stress is an important contributor to the health problems caused by shift work. An association between shift work and job stress has been reported in some studies, but no consensus on this issue has yet been reached. Some studies suggest that job stress of shift workers is higher than that of day workers^{16–22}, while another study found that the job stress of shift workers did not exceed that of day workers²³. Most of these studies did not adjust for confounding factors such as the workers' lifestyle factors and employment conditions, including the amount of overtime and number

of holidays. As a consequence, the relationship between shift work and job stress is still obscure, prompting us to undertake the present research.

Many questionnaires have been devised to evaluate job stress, including the Job Content Questionnaire (JCQ)^{24, 25)} and the National Institute for Occupational Safety and Health (NIOSH) generic job stress instrument²⁶⁾, and the validity of their questionnaire categories and evaluation methods has already been established. In this study we used the "Brief Job Stress Questionnaire"²⁷⁾ that was developed based on these questionnaires, and takes confounding factors such as the type of work, number of holidays, amount of overtime, and lifestyle factors of the workers into account. We then carried out a multivariate analysis to better clarify the relationship between shift work and job stress.

Materials and Methods

Subjects

The subjects comprised 5,338 male workers between the ages of 18 and 60 yr who worked in a Japanese steel company and who had received routine health check-ups between July 2002 and June 2003. All of these subjects were male because of the virtual absence of female shift workers in this company. We distributed questionnaires to the subjects to be filled out by themselves when they had their health check up in their birthday month, and then collected them when the health check was completed. The questionnaire return rate was 100%. We omitted 376 subjects who had not filled out all sections of the questionnaire. The final number of people who were analyzed with regard to job stress was 4,962, of whom 3,078 were day workers, and 1,884 shift workers. The study protocol was approved by the ethical review boards of the Graduate School of Medicine, Chiba University.

The Questionnaire

The questionnaire we used to study stress adopted the survey topics for job stress in the "Brief Job Stress Questionnaire"²⁷⁾ published in a research report relating to stress in the workplace and its impact on workers' health, which was a part of the "Research Concerning the Prevention of Work-Associated Disorders" conducted by the Ministry of Labour in 1999.

We used its simple scoring method, and for the tick-box type questions on the level of job demand (0–7) were: 1) You have to do an enormous amount of work, 2) You cannot complete all your work in the allotted time, 3) You have to work very hard, 4) You have to focus your attention quite a lot, 5) You do a difficult job that requires a high level of knowledge and skill, 6) You have to constantly think about the work during your work hours, 7) You do a lot of physical work. We added up and calculated the number of items to which the subject had replied "Yes" or "Yes, to some extent".

The tick-box type questions about the level of job control the subjects had over their job (0–3) were: 8) You can work at your own pace, 9) You can decide the order in which you do your work and the way you do it, 10) You can reflect your own opinions on the workplace's work strategy. We added up and calculated the number of items to which the subject had replied "Not really", or "No".

With the tick-box type questions about interpersonal relationships (0–3), the first two were: 12) There are differences of opinion within my department, 13) My department does not get on well with other departments. We added up and calculated the number of items to which the subject had replied "Yes" or "Yes to some extent". The last question in this section was: 14) The atmosphere in my workplace is friendly. We added up and calculated the number of replies of "Not really" or "No".

With the tick-box type questions about the subjects' compatibility with their work (0–3), for the first two were 16) The content of my work suits me, and 17) I have job satisfaction in my work. We added up and calculated the replies of "Not really" or "No". The last question in this section was: 11) I do not often use my own skills and knowledge in my job. We added up and calculated the replies of "Yes" or "Yes, to some extent". The higher the total number of such replies, the greater the job-related stress was considered to be.

Job demand was defined to be in an unfavorable condition when six or more questions on job demand were ticked by the subject. Job control, interpersonal relationships, and compatibility with work were defined to be in an unfavorable condition when two or more items were ticked for each item. Then we calculated the total number of stressor items in an unfavorable condition (0–4).

Job schedule type

Job schedule was planned based on 4 teams, 3 shifts and clockwise rotation (5 day shifts, 2 rest days, 5 evening shifts, 1 rest day, 5 night shifts and 2 rest days). Day, evening and night shifts start at 07:00, 15:00 and 23:00, respectively. The shift workers are divided up into 4 teams, and every day one team is off, making it possible for work operations to be run smoothly around the clock.

Other factors

We also surveyed with the questionnaire the workers' lifestyle factors and work conditions. Questions about their lifestyle covered their drinking habits, smoking habits, habitual exercise, dietary habits, marital status, and their living arrangements, while questions about their work conditions covered the type of work, number of holidays, and amount of overtime put in. Usually the amount of overtime is limited to within 30 h per month. The company has to confer with the labor union if it

wishes to exceed the limit. Drinking habits were classified into two categories: drinking every day and not drinking every day. Smoking habits were classified into two categories: smoker and non-smoker. Habitual exercise was classified into two categories: regular exercise (2 or more days a week) or no regular exercise. With regard to dietary habits, we asked if workers regularly consumed fried food, sweet food, or salty food. We also asked if they were married or not, and if they lived with their families, in a dormitory, or alone. The subjects' type of work was divided into the following five categories: office work, onsite work, managerial work, research and technical work, or other. The number of days off was stratified into four categories based on the number of holidays per month: 9 days or more, 7–8 days, 5–6 days, 3–4 days. For the amount of overtime done, we determined the number of hours performed in the month prior to the questionnaire being completed.

Statistical Analysis

In univariate analysis, age, lifestyle factors, and work conditions were calculated and tested by the chi-square test and t-test according to job schedule type (day work and three-shift work). The distribution of stressor items in an unfavorable condition in the “Brief Job Stress Questionnaire” were calculated and evaluated by the chi-square test according to job schedule type.

In multivariate analysis, to evaluate the effect of shift work on job stress taking other potential factors into account, a logistic regression analysis was performed. The dependent variable was whether each stressor item was in an unfavorable condition or not, or the number of items in an unfavorable condition (one or more, two or more, three or more). The independent variables were age, lifestyle factors, working conditions (job schedule type, type of work, number of holidays and amount of overtime), marital status, and living arrangements. Age and amount of overtime were used as continuous variables. With regard to the job schedule type, we calculated the odds ratio for shift work compared to day work. For the type of work, we used a dummy variable and calculated the odds ratio compared to office work. We also used a dummy variable for the number of holidays, and calculated the odds ratio compared to 9 days or more of holidays. The analyses were performed with SPSS 10.0J software (SPSS Japan Inc.). *p* values <0.05 were considered to be statistically significant.

Results

The results examining the connection between the job schedule type, lifestyle factors, and work conditions are shown in Table 1. The shift workers made up 38.0% of the total subjects. The average age of the day workers was 45.4 yr, and that of the shift workers 44.0 yr. With regard to the subjects' lifestyle factors, the percentages

of shift workers who smoked and ate fried foods were significantly higher than the day workers. The percentage of day workers who engaged in habitual exercise was significantly higher than that in shift workers. Furthermore, a significant difference was also recognized among the type of work, number of holidays, marital status, and living environment. The average amount of overtime done was 14.3 h by day workers, and 6.7 h by shift workers, representing a significantly lower figure for the latter.

The results for the correlations between each category in the “Brief Job Stress Questionnaire” and the job schedule type are shown in Table 2. For low job control, there was a significant difference between day workers (23.7%) and shift workers (46.6%). For low interpersonal relationships, there was a significant difference between day workers (17.2%) and shift workers (14.8%). For low compatibility with work, there was a significant difference between day workers (26.1%) and shift workers (31.6%). No significant difference was seen in job demand. The percentage of day workers with one or more stressor items in an unfavorable condition was 59.4%, in contrast to 71.2% of shift workers. For two or more stressor items in unfavorable conditions, the percentage of day workers was 25.4% and that of shift workers 34.8%. For three or more stressor items in unfavorable conditions the percentage of day workers was 7.3% and that of shift workers 9.8%. In all cases the percentages of items checked were significantly higher in shift workers.

The results of the logistic regression analysis between unfavorable conditions in each stressor item and the job schedule type are shown in Table 3. Job schedule type was not significantly associated with job demand. Among the types of work, the odds ratios for onsite work, research and technical work were significantly higher than that for office work. For the number of holidays, the odds ratio was significantly higher for the groups with fewer holidays than that for the group with 9 days or more. For the amount of overtime, the odds ratio became significantly higher as the number of hours of overtime increased. Job schedule type was significantly associated with job control, with a significant odds ratio of 2.22 for shift workers relative to day workers. Among the types of work, the odds ratio for onsite work was significantly higher than that for office work, whereas it was significantly lower than that for managerial work. With the number of holidays, the odds ratios were significantly higher for the groups with fewer holidays than that for the group with 9 days or more. For the amount of overtime, the odds ratio became significantly higher as the number of hours of overtime increased. Of the lifestyle factors, the odds ratio was significantly lower for smokers than that for non-smokers. Job schedule type was not significantly associated with interpersonal

Table 1. Job schedule type, lifestyle factors, and work conditions

		Job schedule type				<i>p</i>	Total	
		Day		Shift			M	SD
		M	SD	M	SD			
	Age	45.4	10.3	44.0	11.2	<0.001	44.9	10.7
	Overtime	14.3	16.6	6.7	7.5	<0.001	11.4	14.3
		N	%	N	%	<i>p</i>	N	%
Age	-19	12	(0.4%)	20	(1.1%)	<0.001	32	(0.6%)
	20-29	289	(9.4%)	303	(16.1%)		592	(11.9%)
	30-39	574	(18.6%)	239	(12.7%)		813	(16.4%)
	40-49	839	(27.3%)	489	(26.0%)		1,328	(26.8%)
	50-59	1,239	(40.3%)	803	(42.6%)		2,042	(41.2%)
	60-	125	(4.1%)	30	(1.6%)		155	(3.1%)
Drinking habit	Not every day	2,569	(83.5%)	1,545	(82.0%)	0.187	4,114	(82.9%)
	Every day	509	(16.5%)	339	(18.0%)		848	(17.1%)
Smoking habit	Non-smoker	1,486	(48.3%)	715	(38.0%)	<0.001	2,201	(44.4%)
	Smoker	1,592	(51.7%)	1,169	(62.0%)		2,761	(55.6%)
Habitual exercise	Regular	1,010	(32.8%)	564	(29.9%)	0.035	1,574	(31.7%)
	Not regular	2,068	(67.2%)	1,320	(70.1%)		3,388	(68.3%)
Consumed fried food	Not regular	1,791	(58.2%)	1,021	(54.2%)	0.006	2,812	(56.7%)
	Regular	1,287	(41.8%)	863	(45.8%)		2,150	(43.3%)
Consumed sweet food	Not regular	2,302	(74.8%)	1,404	(74.5%)	0.840	3,706	(74.7%)
	Regular	776	(25.2%)	480	(25.5%)		1,256	(25.3%)
Consumed salty food	Not regular	1,998	(64.9%)	1,202	(63.8%)	0.427	3,200	(64.5%)
	Regular	1,080	(35.1%)	682	(36.2%)		1,762	(35.5%)
Type of work	Office	602	(19.6%)	25	(1.3%)	<0.001	627	(12.6%)
	Onsite	1,222	(39.7%)	1,692	(89.8%)		2,914	(58.7%)
	Managerial	405	(13.2%)	8	(0.4%)		413	(8.3%)
	Research and technical	676	(22.0%)	109	(5.8%)		785	(15.8%)
	Other	173	(5.6%)	50	(2.7%)		223	(4.5%)
	Holidays	3-4 days	84	(2.7%)	29		(1.5%)	<0.001
	5-6 days	217	(7.1%)	172	(9.1%)	389	(7.8%)	
	7-8 days	1,491	(48.4%)	1,204	(63.9%)	2,695	(54.3%)	
	9 days or more	1,286	(41.8%)	479	(25.4%)	1,765	(35.6%)	
Marital status	Married	2,441	(79.3%)	1,393	(73.9%)	<0.001	3,834	(77.3%)
	Not married	637	(20.7%)	491	(26.1%)		1,128	(22.7%)
Living arrangements	With family	2,661	(86.5%)	1,618	(85.9%)	0.002	4,279	(86.2%)
	In a dormitory	259	(8.4%)	130	(6.9%)		389	(7.8%)
	Alone	158	(5.1%)	136	(7.2%)		294	(5.9%)
Total		3,078		1,884			4,962	

M: mean, SD: standard deviation

relationships. Among the types of work, the odds ratio for onsite work was significantly lower than that for office work. With the number of holidays, the odds ratio was significantly higher for the groups with 7-8 holidays than that for the group with 9 days or more. Job schedule type was not significantly associated with compatibility. Among the types of work, the odds ratio for managerial

work was significantly lower than that for office work. For the amount of overtime, the odds ratio became significantly lower as the number of hours of overtime increased. Regarding age, the odds ratio became significantly lower as the number of decades increased in all the categories: level of job demand, job control, interpersonal relationships, and compatibility.

Table 2. Job schedule type and job stress

		Job schedule type				<i>p</i>	Total	
		Day		Shift			N	%
		N	%	N	%			
Job demand	Low	2,253	(73.2%)	1,422	(75.5%)	0.077	3,675	(74.1%)
	High	825	(26.8%)	462	(24.5%)		1,287	(25.9%)
Job control	High	2,350	(76.3%)	1,006	(53.4%)	<0.001	3,356	(67.6%)
	Low	728	(23.7%)	878	(46.6%)		1,606	(32.4%)
Interpersonal relationship	High	2,550	(82.8%)	1,605	(85.2%)	0.032	4,155	(83.7%)
	Low	528	(17.2%)	279	(14.8%)		807	(16.3%)
Compatibility	High	2,275	(73.9%)	1,288	(68.4%)	<0.001	3,563	(71.8%)
	Low	803	(26.1%)	596	(31.6%)		1,399	(28.2%)
The number of stressor items in unfavorable condition	0	1,250	(40.6%)	543	(28.8%)	<0.001	1,793	(36.1%)
	≥1	1,828	(59.4%)	1,341	(71.2%)		3,169	(63.9%)
The number of stressor items in unfavorable condition	0–1	2,296	(74.6%)	1,228	(65.2%)	<0.001	3,524	(71.0%)
	≥2	782	(25.4%)	656	(34.8%)		1,438	(29.0%)
The number of stressor items in unfavorable condition	0–2	2,852	(92.7%)	1,700	(90.2%)	0.003	4,552	(91.7%)
	≥3	226	(7.3%)	184	(9.8%)		410	(8.3%)
Total		3,078		1,884			4,962	

Table 3. Results of logistic regression analysis between an unfavorable condition in each stressor item and the job schedule type

	Job demand (n= 4962) Odds ratio (95% C.I.)	Job control (n= 4962) Odds ratio (95% C.I.)	Interpersonal relationship (n= 4962) Odds ratio (95% C.I.)	Compatibility (n= 4962) Odds ratio (95% C.I.)
Shift/day	0.95 (0.81–1.12)	2.22 (1.92–2.58)**	0.94 (0.78–1.14)	1.15 (0.99–1.33)
Age	0.99 (0.98–1.00)*	0.98 (0.97–0.99)**	0.99 (0.98–1.00)*	0.99 (0.98–0.99)**
Drinking habit +/-	0.93 (0.77–1.11)	0.88 (0.73–1.05)	1.02 (0.82–1.26)	1.08 (0.91–1.29)
Smoking habit +/-	1.01 (0.88–1.15)	0.83 (0.73–0.95)*	0.97 (0.83–1.13)	0.96 (0.84–1.09)
Habitual exercise -/+	0.91 (0.79–1.04)	1.00 (0.87–1.15)	1.09 (0.92–1.29)	1.07 (0.93–1.23)
Consumed fried food +/-	0.97 (0.84–1.10)	0.98 (0.86–1.12)	0.97 (0.83–1.14)	0.98 (0.86–1.12)
Consumed sweet food +/-	1.06 (0.91–1.23)	1.14 (0.98–1.31)	1.08 (0.91–1.29)	1.15 (0.99–1.33)
Consumed salty food +/-	1.05 (0.91–1.21)	0.88 (0.77–1.01)	1.05 (0.89–1.23)	1.03 (0.90–1.17)
Type of work (/office)				
Onsite	1.44 (1.14–1.80)*	1.61 (1.29–2.02)**	0.70 (0.55–0.90)*	0.92 (0.75–1.14)
Managerial	1.15 (0.85–1.56)	0.62 (0.44–0.88)*	0.83 (0.60–1.15)	0.61 (0.45–0.83)*
Research and technical	1.38 (1.08–1.78)*	0.93 (0.71–1.20)	0.85 (0.65–1.12)	0.79 (0.62–1.01)
Other	0.77 (0.51–1.17)	1.45 (1.02–2.07)*	0.66 (0.43–1.03)	1.05 (0.74–1.47)
Holidays (/9 days or more)				
3–4 days	1.67 (1.09–2.55)*	1.12 (0.72–1.73)	1.49 (0.93–2.40)	0.79 (0.50–1.24)
5–6 days	1.37 (1.07–1.77)*	1.32 (1.03–1.68)*	1.18 (0.88–1.60)	1.04 (0.81–1.33)
7–8 days	1.23 (1.06–1.42)*	1.19 (1.04–1.37)*	1.22 (1.03–1.45)*	0.99 (0.87–1.14)
Overtime	1.03 (1.02–1.03)**	1.01 (1.00–1.01)*	1.00 (1.00–1.01)	0.99 (0.99–1.00)*
Not married /married	0.69 (0.55–0.86)*	1.12 (0.92–1.38)	1.07 (0.83–1.37)	1.16 (0.95–1.43)
Living (/with family)				
In a dormitory	0.88 (0.66–1.18)	1.27 (0.98–1.66)	0.96 (0.70–1.31)	0.94 (0.72–1.23)
Alone	1.47 (1.07–2.00)*	1.14 (0.85–1.53)	0.87 (0.60–1.27)	1.29 (0.96–1.72)

***p*<0.001, **p*<0.05, 95% C.I.: 95% confidence interval, odds ratio: the ratio of the former to the latter was estimated for categorical variables

Table 4. Results of logistic regression analysis between the increased number of stressor items in an unfavorable condition and the job schedule type

	The number of stressor items in an unfavorable condition		
	One or more (n= 4962) Odds ratio (95% C.I.)	Two or more (n= 4962) Odds ratio (95% C.I.)	Three or more (n= 4962) Odds ratio (95% C.I.)
Shift/day	1.53 (1.33–1.78)**	1.41 (1.21–1.63)**	1.36 (1.06–1.74)*
Age	0.98 (0.97–0.99)**	0.98 (0.97–0.98)**	0.99 (0.97–1.00)*
Drinking habit +/-	0.96 (0.82–1.13)	0.94 (0.79–1.12)	1.00 (0.74–1.34)
Smoking habit +/-	0.93 (0.83–1.06)	0.88 (0.77–1.00)	0.93 (0.75–1.15)
Habitual exercise -/+	0.96 (0.84–1.09)	1.02 (0.89–1.17)	1.12 (0.89–1.40)
Consumed fried food +/-	1.03 (0.91–1.16)	0.94 (0.82–1.07)	0.86 (0.70–1.07)
Consumed sweet food +/-	1.15 (1.00–1.32)	1.15 (0.99–1.32)	1.12 (0.88–1.41)
Consumed spicy and salty food +/-	1.01 (0.89–1.15)	0.99 (0.87–1.14)	0.96 (0.77–1.20)
Type of work (/office)			
Onsite	1.24 (1.02–1.50)*	1.23 (0.99–1.54)	0.92 (0.65–1.30)
Managerial	0.79 (0.61–1.02)	0.75 (0.54–1.02)	0.51 (0.29–0.89)*
Research and technical	0.93 (0.75–1.16)	0.96 (0.75–1.23)	0.86 (0.58–1.26)
Other	1.07 (0.78–1.48)	0.96 (0.66–1.39)	0.80 (0.44–1.47)
Holidays (/9 days or more)			
3–4 days	1.06 (0.71–1.60)	1.10 (0.71–1.69)	2.08 (1.17–3.69)*
5–6 days	1.28 (1.01–1.63)*	1.33 (1.04–1.69)*	1.46 (1.00–2.13)*
7–8 days	1.20 (1.06–1.37)*	1.19 (1.04–1.37)*	1.19 (0.94–1.50)
Overtime	1.01 (1.01–1.02)**	1.01 (1.01–1.02)**	1.01 (1.00–1.02)*
Not married /married	0.86 (0.70–1.05)	1.03 (0.84–1.26)	1.29 (0.95–1.77)
Living (/with family)			
In a dormitory	1.20 (0.92–1.57)	0.90 (0.69–1.18)	0.90 (0.60–1.34)
Alone	1.44 (1.07–1.94)*	1.32 (0.98–1.76)	1.00 (0.63–1.58)

** $p < 0.001$, * $p < 0.05$, 95% C.I.: 95% confidence interval, odds ratio: the ratio of the former to the latter was estimated for categorical variables

The results of the logistic regression analysis between the increased number of stressor items in unfavorable conditions and the job schedule type are shown in Table 4. For having one or more stressor items in an unfavorable condition, the odds ratio of shift workers was 1.53, and significantly higher than that for day workers. Among the types of work, the odds ratio for onsite work was significantly higher than that for office work. Regarding the number of holidays, the odds ratio was significantly higher for the groups with 7–8 and 5–6 days holiday than that for the group with 9 days or more. For the amount of overtime, the odds ratio became significantly higher as the number of hours of overtime increased. For having 2 or more stressor items in an unfavorable condition, the odds ratio of shift work was 1.41, significantly higher than that for day workers. For the number of holidays, the odds ratio was significantly higher in the groups with 7–8 and 5–6 days holiday than that for the group with 9 days or more. For the amount of overtime, the odds ratio became significantly higher as the number of hours of overtime increased. For having 3 or more stressor items in an unfavorable condition, the odds ratio was 1.36,

significantly higher than that for day workers. Among the types of work, the odds ratio for managerial work was significantly lower than that for office work. For the number of holidays, the odds ratio was significantly higher in the groups with 5–6 and 3–4 days holiday than that for the group with 9 days or more. For the amount of overtime, the odds ratio became significantly higher as the number of hours of overtime increased. Age was significantly and negatively related to having “one or more”, “two or more” or “three or more” stressor items in unfavorable condition. Targeting only the shift workers, the odds ratio for high job demand was significantly higher in the groups with 7–8 holidays/month (odds ratio: 1.32, $p = 0.041$) than that for the group with 9 holidays/month or more.

Discussion

Many of the previously published reports focusing on shift work and job stress recognized a connection between the two, although Knutsson *et al.*²³⁾ found no clear association between shift work and job stress, including the degree of job demand. Of reports that have noted a

connection, that of Kawakami *et al.*¹⁶⁾ used an NIOSH work-related stress questionnaire among 612 male employers at a manufacturing plant. After classifying the subjects according to day worker, 2-team 2-shift, 3-team 3-shift, and 4-team 3-shift employment and reviewing the results, they found that, among the 4-team 3-shift workers, job demand was higher and job control was lower compared with the other work patterns. However, this research did not consider confounding factors such as work conditions (the type of work and amount of overtime) or lifestyle parameters.

Parkes¹⁷⁾ carried out cross-sectional research targeting 736 two-shift workers and 1,131 day workers at an oil refinery, and conducted a survey of job stress that included such items as degree of job demand, job control and supervisor support. This research included a multivariate analysis that covered the workplace environment, type of work, and level of education, with the results showing that compared to day workers, the 2-shift workers had a higher job demand and less job control over their work. However, in that survey, different lifestyle factors, number of holidays, and amount of overtime associated with job stress were not considered. Many of the reports¹⁶⁻²²⁾ up to now that have hinted at a connection between job stress and shift work, however, surveys were not conducted that included confounding factors such as the workers' lifestyle factors and work conditions contrasting with themes that directly evaluate job stress.

The validity of the "Brief Job Stress Questionnaire" that we used on this occasion has been amply demonstrated before, and is established as a method for assessing job stress. It was drawn up after reviewing the question categories in the JCQ Scale^{24, 25)}, and the NIOSH generic job stress instrument²⁶⁾, and for simple evaluation and judgment methods, a survey was carried out of 12,188 employees (10,025 male, 2,163 female) at 21 businesses all over Japan²⁷⁾. The number of replies for job stress items and the number of replies for psychological and physical stress reactions were reviewed, and then the criteria defining the condition for each item was defined. As part of the comprehensive evaluation of the 4 stressors, that is to say job demand, level of job control, interpersonal relationships, and compatibility with the work, it was reported that the odds ratio in men who had 2 stressor items in an unfavorable condition relative to those with none was 2.35 for the psychological stress reaction and 1.56 for the physical stress reaction. The odds ratio of those with 3 stressor items in unfavorable condition was 4.61 for the psychological stress reaction, and 2.58 for the physical stress reaction. An examination was also made of its usefulness and simplicity, and its use at industrial sites was highly rated. Consequently, in Japan, the "Brief Job Stress Questionnaire", as compared to other survey questionnaires, has been established as the one that can most conveniently and precisely assess

stress caused by working conditions. As far as we could determine, no other reports have assessed the condition of stress among 3-shift system workers using this questionnaire.

Furthermore, we surveyed on this occasion around 4,962 workers in the steel industry, of whom a relatively high number, 1,884, were 3-shift workers. Moreover, with regard to the questions, prior surveys about the connection between stress and shift work have not included an examination of conditions such as the workers' lifestyle factors, job types, amount of overtime, and number of holidays, while our research this time analyzes the relationship between job stress and the 3-shift workers while taking into account various items including lifestyle factors and work conditions, thereby enhancing the accuracy of the results.

In the results regarding the relationship between job stress and 3-shift work, it can be seen that the level of job control exercised by these workers over their work is low. Most of the 3-shift workers are factory laborers, and their working days and job content are constant, with increases in new/different work being a rare occurrence. Accordingly, we may consider that they do not work on their own initiative, but rather passively within the flow of the factory processes.

The number of stressor items in an unfavorable condition was significantly higher for the shift workers as compared to the day workers, strongly suggesting that the former are subjected to greater physical and mental stress. Furthermore, the results of this survey demonstrate that increases in the amount of overtime and decreases in the number of holidays lead to a significant rise in job stress, indicating that limits on overtime and an increase in the number of holidays would be useful in improving the psychological health of shift workers.

Within research on shift workers, the Healthy Worker Effect is usually taken into consideration; in other words, shift workers who are highly stressed are moved to day work. However at the company surveyed here, most transfers from shift work to regular day work were done for work-related reasons, and transfers due to health problems, such as psychological disorders and cardiac infarctions, amounted to no more than a few a year. Consequently, the Healthy Worker Effect was regarded as not having influenced these results.

In conclusion, this cross-sectional survey demonstrated that the 3-shift system of employment increases work-related stress, and job control is low among shift workers. To reduce job stress in this occupational population, a reduction in the amount of overtime and an increase in the number of holidays would seem to be useful interventions.

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