Industrial Health 2007, **45**, 237–246 **Original Article**

Overtime, Job Stressors, Sleep/Rest, and Fatigue of Japanese Workers in a Company

Takeshi SASAKI[1]*, Kenji IWASAKI[1], Ippei MORI[1], Naomi HISANAGA[2] and Eiji SHIBATA[3]

[1] National Institute of Occupational Safety and Health, 6-21-1 Nagao, Tama-ku, Kawasaki 214-8585, Japan
[2] Center for Campus Health and Environment, Aichi University of Education, Hirosawa 1, Igaya-cho, Kariya, Aichi 448-8542, Japan
[3] Department of Health and Psychosocial Medicine, Aichi Medical University School of Medicine, 21 Karimata, Yazako, Nagakute-cho, Aichi-gun, Aichi 480-1195, Japan

Received July 19, 2006 and accepted October 10, 2006

Abstract: To ascertain the usefulness of a 21-item checklist that assesses accumulated fatigue due to overwork, we examined (1) the associations between overtime work, job stressors, or the quantity of sleep/rest and subjective symptoms of fatigue, and (2) whether sleeping hours and monthly days off are associated with the accumulated fatigue parameter using the checklist. Questionnaire surveys were administered twice to Japanese workers at a plant of a manufacturing company. Among the 390 registered workers, 383 workers (284 males and 99 females) in the first survey and 350 workers (260 males and 90 females) in the second survey responded. The subjective symptoms score significantly increased according to the order of grade of overtime work, other job stressors, and sleep/rest subscales in both sexes by ANOVA. The subjective symptoms grade was significantly associated with the other job stressors grade and sleep/rest grade, but not with overtime work. The accumulated fatigue parameter was negatively correlated with daily sleeping hours (significant Spearman's correlation coefficient (r_s) =–0.318 and –0.340 in the 1st and 2nd surveys) and with monthly days off (r_s=–0.250 and –0.151) among all of the subjects. It may be possible to assess overwork by the accumulated fatigue parameter.

Key words: Overwork, Overtime work, Fatigue, Sleep, Rest, Job stressors

Introduction

Long working hours and overtime work are important issues in overwork, which is a factor in the development of cerebro- and cardio-vascular diseases[1–3] and which may lead to *karoshi* (death from overwork)[4, 5]. In Japan, the Ministry of Health, Labour and Welfare (MHLW) amended the standards for recognizing occupational cerebro- and cardio-vascular diseases based on medical research findings in 2001. In the amended standards, prolonged accumulated fatigue by overwork was considered to be a causal factor of deterioration in health. In 2002, the MHLW launched the "Comprehensive Program for the Prevention of Health Impairment Due to Overwork"[6]. In this program, employers make efforts to reduce the number of overtime work hours to 45 h or less per month. When the number of overtime work hours exceeds 45 h per month, employers receive guidance from occupational physicians on workplace health management. If the number of overtime work hours exceeds 100 h per month or 80 h per month for 2 to 6 consecutive months, the worker receives counseling through an interview with an occupational physician. Furthermore, in 2004, the MHLW presented the "Self-Diagnosis Checklist for Assessment of Worker's Accumulated Fatigue"[7], which workers themselves can take to estimate the level of accumulated fatigue based on work conditions and subjective symptoms.

It is necessary to manage work conditions so as to prevent

*To whom correspondence should be addressed.

adverse effects on the health of workers due to overwork[8]. The above-mentioned MHLW's Fatigue Checklist for workers includes seven items on work conditions and thirteen items on symptoms of the worker, and therefore, the results of the Fatigue Checklist may be useful for management of work conditions. To our knowledge, only one study on workload and health complaints that used MHLW's Checklist has been published[9]. Thus, further investigations are needed to ascertain its usefulness.

Various questionnaires that assess occupational fatigue have been developed[10–14]. One difference between previous fatigue questionnaires and the MHLW's Checklist is that previous questionnaires have contained only items regarding physical and mental symptoms, while MHLW's Checklist contains items regarding work conditions in addition to physical and mental symptoms. In the present study, we slightly modified MHLW's Checklist in order to estimate the level of accumulated fatigue in view of overtime work, other job stressors, sleep/rest, and subjective symptoms of fatigue.

The usefulness of the slightly modified MHLW's Checklist has not been ascertained. For this purpose, we investigated the associations of the amounts of overtime work, other job stressors, and sleep/rest with the number of subjective symptoms of fatigue, and whether the quantity of sleeping hours and monthly number of days off from work are associated with the amount of accumulated fatigue among Japanese workers using the Checklist. Because the work conditions of individuals such as working hours, irregular work, and business travel may vary at different times of the year, the survey was administered twice.

Materials and Methods

Surveys and subjects

Questionnaire surveys were conducted twice on workers at a plant of a company that manufactures and sells electric infrastructure products and parts: the first survey was conducted from November to December 2003 and the second survey was conducted from June to July 2004. The same self-administered questionnaire was delivered to 390 workers of the plant at two different times in cooperation with the Employee Health department of the company. Of the 390 workers, 383 workers (284 males and 99 females) in the first survey and 350 workers (260 males and 90 females) in the second survey returned a completed questionnaire. Among the subjects who replied in each survey, approximately 95% of the males and all of the females were daytime workers; approximately 96% of males and 57% of females were regular full-time workers, and approximately 41% of females were part-time or temporary workers. This study was approved by the Ethics Committee of the National Institute of Industrial Health of Japan.

Questionnaire

The self-administered questionnaire consisted of the following sections.

Personal information: This section consisted of items regarding work conditions, daily number of sleeping hours in the previous month, and number of days off work during the previous month (including Sundays, national holidays, vacation days, etc.), and health status during the past six months. As to the number of days off work, the subjects selected from 0 d, 1–2 d, 3–4 d, 5–7 d, and ≥8 d.

"Checklist for Accumulated Fatigue due to Overwork" (Appendix): The checklist we administered was a slightly revised version of the "Self-Diagnosis Checklist for Assessment of Worker's Accumulated Fatigue"[7]. Our checklist (hereafter called the "Accumulated Fatigue Checklist") consisted of four subscales with a total of 21 items: number of hours of overtime work in the previous month (one item), other job stressors (5 items), sleep/rest (3 items), and subjective symptoms of fatigue (12 items). (Please see the Appendix for the individual items in the Accumulated Fatigue Checklist.) The subscale of the number of hours of overtime work in the previous month was categorized into <45 h, 45–80 h, or >80 h per month. In the other three subscales, the result for each item was scored as 0, 1, or 3 points. To obtain the number of points for each subscale, the number of points for each item in the subscale were added. Each of the four subscales was categorized into three grades: number of hours of overtime work per month, <45 h as grade A, 45–80 h as grade B, or >80 h as grade C; other job stressors, and sleep/rest, 0–2 points as grade A, 3–5 points as grade B, or ≥6 points as grade C; subjective symptoms of fatigue, 0–7 points as grade A, 8–15 points as grade B, or ≥16 points as grade C.

For each worker, the accumulated fatigue parameter was categorized as low, medium, high or very high according to the numbers of subscales with grade B or C: low, the number of subscales with grade B is ≤1 and the number of subscales with grade C is 0; medium, the number of subscales with grade B is ≥2 and the number with grade C is 0, or the number of subscales with grade B is 0 and the number with grade C is 1; high, the number of subscales with grade B is ≥1 and the number with grade C is 1; and very high, the number of subscales with grade C is ≥2.

Table 1. Age, occupation, number of sleeping hours and monthly number of days off work among workers in the two surveys

	1st survey			2nd survey		
	Male (N=284)	Female (N=99)	Total (N=383)	Male (N=260)	Female (N=90)	Total (N=350)
Age group (yr)						
<20	3 (1.1)	0 (0.0)	3 (0.8)	3 (1.2)	0 (0.0)	3 (0.9)
20–29	35 (12.3)	30 (30.3)	65 (17.0)	29 (11.2)	26 (28.9)	55 (15.7)
30–39	86 (30.3)	18 (18.2)	104 (27.2)	84 (32.3)	21 (23.3)	105 (30.0)
40–49	48 (16.9)	17 (17.2)	65 (17.0)	40 (15.4)	16 (17.8)	56 (16.0)
50–59	99 (34.9)	33 (33.3)	132 (34.5)	90 (34.6)	25 (27.8)	115 (32.9)
≥60	13 (4.6)	1 (1.0)	14 (3.7)	14 (5.4)	2 (2.2)	16 (4.6)
Occupation						
Engineers	66 (24.4)	10 (10.4)	76 (20.8)	60 (24.3)	5 (6.2)	65 (19.8)
Managers	51 (18.9)	0 (0.0)	51 (13.9)	40 (16.2)	0 (0.0)	40 (12.2)
Clerks	40 (14.8)	26 (27.1)	66 (18.0)	33 (13.4)	25 (30.9)	58 (17.7)
Salespersons	19 (7.0)	0 (0.0)	19 (5.2)	19 (7.7)	0 (0.0)	19 (5.8)
Technicians	69 (25.6)	50 (52.1)	119 (32.5)	67 (27.1)	38 (46.9)	105 (32.0)
Others	25 (9.3)	10 (10.4)	35 (9.6)	28 (11.3)	13 (16.0)	41 (12.5)
Sleeping hours per day† (h)	6.3 (1.0)	6.4 (0.9)	6.4 (1.0)	6.3 (1.0)	6.3 (0.9)	6.3 (0.9)
Days off work in the previous month (day)						
0	2 (0.7)	2 (2.0)	4 (1.1)	1 (0.4)	0 (0.0)	1 (0.3)
1–2	5 (1.8)	4 (4.1)	9 (2.4)	11 (4.2)	3 (3.4)	14 (4.0)
3–4	13 (4.6)	5 (5.1)	18 (4.7)	6 (2.3)	4 (4.5)	10 (2.9)
5–7	64 (22.7)	22 (22.4)	86 (22.6)	74 (28.5)	19 (21.3)	93 (26.6)
≥8	198 (70.2)	65 (66.3)	263 (69.2)	168 (64.6)	63 (70.8)	231 (66.2)

†: Sleeping hours are shown as means and standard deviations in parentheses. Other values are shown as numbers and percentages in parentheses.

Statistical analysis

Comparisons of the level of subjective symptoms of fatigue among the grades of overtime work, other job stressors, and sleep/rest were performed using one-way analysis of variance (ANOVA) in the case of subjective symptoms score, and Fisher's exact test or the chi square test in the case of the subjective symptoms grade. Spearman's rank correlation coefficient was used to evaluate the relationships between daily sleeping hours or the number of days off work during the previous month and amount of accumulated fatigue. Statistical significance was set at $p<0.05$. All analyses were performed using the SPSS 14.0J statistical package (SPSS Japan Inc., Tokyo, Japan).

Results

Subjects

Table 1 shows the age group, occupation, daily number of sleeping hours, and number of days off work during the previous month among workers who participated in each survey. The mean age (standard deviation) was 43.2 (11.3) yr among males, 40.6 (12.2) yr among females, and 42.5 (11.6) yr among all subjects in the first survey. As for the occupation, approximately 50% of the males were engineers or technicians and approximately 50% of the females were technicians in each survey.

The Accumulated Fatigue Checklist

The results of the Accumulated Fatigue Checklist are summarized in Table 2. The intra-class correlation coefficients between the overtime work subscale grades of the 1st and 2nd surveys, that between the other job stressors subscale grades, that between the sleep/rest subscale grades, that between the subjective symptoms subscale grades, and that between the accumulated fatigue parameters ranged from 0.425 to 0.711 among males, from 0.367 to 0.645 among females, and from 0.454 to 0.690 among all workers (Table 3). No female subject worked more than 80 h of overtime in the previous month in the second survey. The percentage of male subjects who worked more than 80 h of overtime in the previous month in the second survey was about 50% of that in the first survey.

Table 2. Results of the Accumulated Fatigue Checklist among workers in the two surveys

Subscale	1st survey			2nd survey		
	Male	Female	Total	Male	Female	Total
Overtime work per month						
Grade A (<45 h)	156 (58.0)	75 (82.4)	231 (64.2)	160 (64.3)	74 (90.2)	234 (70.7)
Grade B (45–79 h)	96 (35.7)	13 (14.3)	109 (30.3)	80 (32.1)	8 (9.8)	88 (26.6)
Grade C (>80 h)	17 (6.3)	3 (3.3)	20 (5.6)	9 (3.6)	0 (0.0)	9 (2.7)
Other job stressors						
Grade A (0–2 points)	178 (63.8)	62 (63.3)	240 (63.7)	170 (67.2)	70 (80.5)	240 (70.6)
Grade B (3–5 points)	77 (27.6)	24 (24.5)	101 (26.8)	63 (24.9)	12 (13.8)	75 (22.1)
Grade C (≥6 points)	24 (8.6)	12 (12.2)	36 (9.5)	20 (7.9)	5 (5.7)	25 (7.4)
Daily sleep and rest on day off						
Grade A (0–2 points)	183 (65.4)	58 (58.6)	241 (63.6)	167 (65.7)	56 (63.6)	223 (65.2)
Grade B (3–5 points)	73 (26.1)	34 (34.3)	107 (28.2)	67 (26.4)	26 (29.5)	93 (27.2)
Grade C (≥6 points)	24 (8.6)	7 (7.1)	31 (8.2)	20 (7.9)	6 (6.8)	26 (7.6)
Subjective symptoms						
Grade A (0–7 points)	135 (48.0)	44 (44.9)	179 (47.2)	128 (50.6)	36 (40.9)	164 (48.1)
Grade B (8–15 points)	99 (35.2)	38 (38.8)	137 (36.1)	79 (31.2)	40 (45.5)	119 (34.9)
Grade C (≥16 points)	47 (16.7)	16 (16.3)	63 (16.6)	46 (18.2)	12 (13.6)	58 (17.0)
Accumulated fatigue†						
Low	132 (46.5)	52 (52.5)	184 (48.4)	127 (48.8)	55 (61.1)	182 (53.2)
Medium	80 (28.2)	22 (22.2)	102 (26.8)	67 (25.8)	16 (17.8)	83 (24.3)
High	44 (15.5)	17 (17.2)	61 (16.1)	38 (14.6)	13 (14.4)	51 (14.9)
Very high	25 (8.8)	8 (8.1)	33 (8.7)	22 (8.5)	4 (4.4)	26 (7.6)

Values are shown as numbers and percentages in parentheses.

†: The accumulated fatigue parameter was categorized as low, medium, high or very high according to the numbers of subscales with grade B or C: low, the number of subscales with grade B is ≤1 and the number of subscales with grade C is 0; medium, the number of subscales with grade B is ≥2 and the number with grade C is 0, or the number of subscales with grade B is 0 and the number with grade C is 1; high, the number of subscales with grade B is ≥1 and the number with grade C is 1; and very high, the number of subscales with grade C is ≥2.

Table 3. Intra-class correlation coefficients of the four subscales and the accumulated fatigue parameter between the first and second surveys

	Male	Female	Total
Overtime work per month†	0.425***	0.367***	0.454***
Other job stressors††	0.469***	0.424***	0.457***
Daily sleep and rest on day off††	0.583***	0.645***	0.597***
Subjective symptoms†††	0.711***	0.617***	0.690***
Accumulated fatigue††††	0.646***	0.586***	0.633***

Values are intra-class correlation coefficients. ***: $p<0.001$.

†: Grade A, <45 h; Grade B, 45–80 h; and Grade C, >80 h.

††: Grade A, 0–2 points; Grade B, 3–5 points; and Grade C, ≥6 points.

†††: Grade A, 0–7 points; Grade B, 8–15 points; and Grade C, ≥16 points.

††††: as per Table 2.

Associations of overtime work, job stressors, and sleep/rest with subjective symptoms

As shown in Fig. 1, the subjective symptoms score among workers with grade C in the overtime work, other job stressors, or the sleep/rest subscales was higher than that among workers with grade A or B in all comparisons. Moreover, these relationships were statistically significant using ANOVA, except for the overtime work grade for females in the second survey. Similar results were obtained by using analysis of covariance adjusted for age group (data not shown).

Comparison of the subjective symptoms grades of workers with each grade in the other subscales among males, females, and all workers are shown in Table 4. In contrast to the comparisons of the subjective symptoms scores, there were no significant differences in the subjective symptoms grades among males with each grade of hours of overtime work in

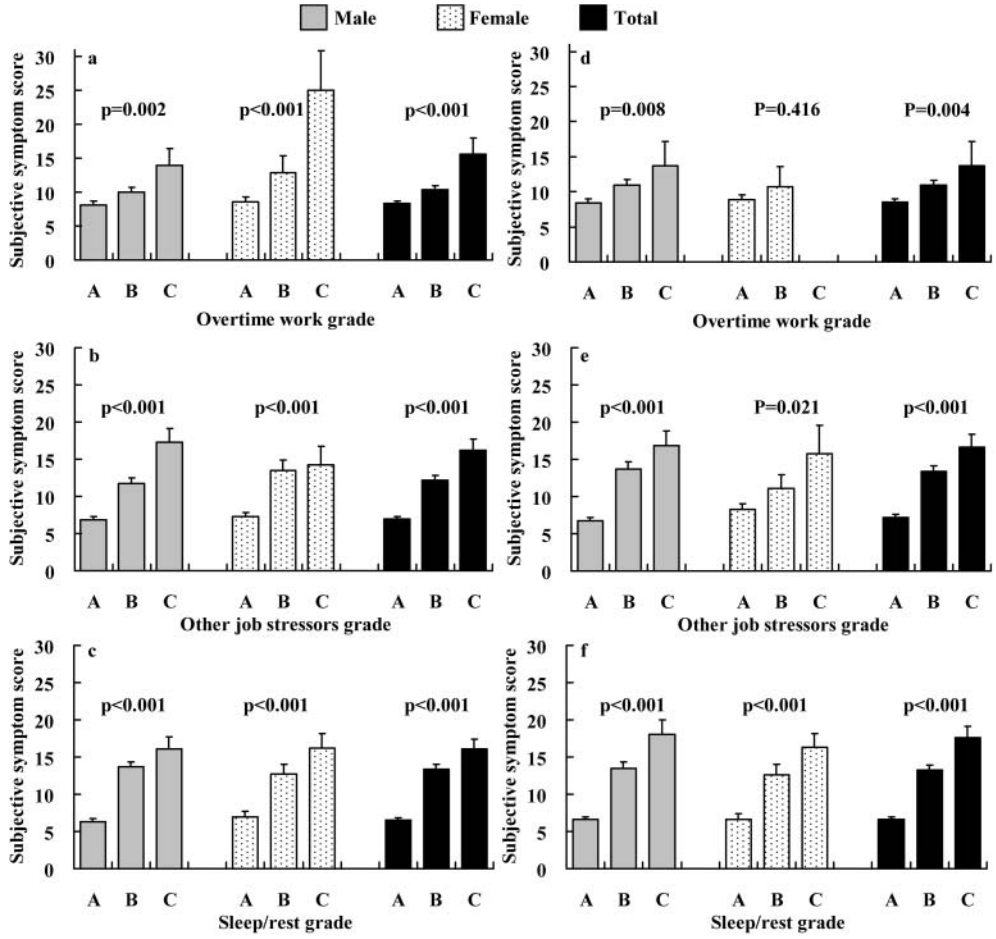

Fig. 1. Comparison of the subjective symptom score of subjects with grade A, B or C in the overtime work, job stressors, and sleep/rest subscales.

The graphs on the left side (a, b, and c) show the results of the 1st survey, and the graphs on the right side (d, e, and f) show the results of the 2nd survey. Columns and vertical bars indicate mean and standard error, respectively. *p* values were calculated using ANOVA.

both surveys and among females with each grade of other job stressors in the second survey. The other relationships between the subjective symptoms grades and the grades of each subscale were significant.

Relationship between daily sleeping hours or monthly number of days off work and accumulated fatigue

Table 5 shows the Spearman's rank correlation coefficients between the level of accumulated fatigue and daily sleeping hours or monthly number of days off work. Daily sleeping hours was negatively and significantly correlated with the level of accumulated fatigue among males in both surveys and among females in the second survey. The number of days off work during the previous month was also negatively correlated with the level of accumulated fatigue; however, the correlation coefficient for the monthly number of days off work was slightly lower than that for daily sleeping hours (Table 5).

Discussion

In this study of Japanese workers at a manufacturing company, although slight gender differences were found, a high level of other job stressors and low quantity of sleep/rest, but not a high quantity of overtime work hours, were considerably related to a high level of subjective symptoms of fatigue among workers of both sexes. Furthermore, the accumulated fatigue parameter, which was estimated from the grades for the overtime work, other job stressors, sleep/rest, and subjective symptoms subscales, was negatively correlated with daily sleeping hours and with the monthly number of days off work, whereas a few relationships did

Table 4. Cross-tabulation of the levels of overtime, job stressors and sleep/rest with the number of subjective symptoms of fatigue in the two surveys

Subscale	Subjective symptoms†								
	Male			Female			Total		
	Grade A	Grade B	Grade C	Grade A	Grade B	Grade C	Grade A	Grade B	Grade C
1st survey									
Overtime work per month		p=0.165			p<0.001			p=0.004	
Grade A (<45 h)	81 (51.9)	54 (34.6)	21 (13.5)	35 (46.7)	33 (44.0)	7 (9.3)	116 (50.2)	87 (37.7)	28 (12.1)
Grade B (45–80 h)	41 (42.7)	37 (38.5)	18 (18.8)	6 (46.2)	1 (7.7)	6 (46.2)	47 (43.1)	38 (34.9)	24 (22.0)
Grade C (>80 h)	6 (35.3)	5 (29.4)	6 (35.3)	0 (0.0)	0 (0.0)	3(100.0)	6 (30.0)	5 (25.0)	9 (45.0)
Other job stressors		p<0.001			p<0.001			p<0.001	
Grade A (0–2 points)	110 (61.8)	54 (30.3)	14 (7.9)	35 (56.5)	25 (40.3)	2 (3.2)	145 (60.4)	79 (32.9)	16 (6.7)
Grade B (3–5 points)	20 (26.0)	36 (46.8)	21 (27.3)	7 (29.2)	8 (33.3)	9 (37.5)	27 (26.7)	44 (43.6)	30 (29.7)
Grade C (≥6 points)	3 (12.5)	9 (37.5)	12 (50.0)	2 (16.7)	5 (41.7)	5 (41.7)	5 (13.9)	14 (38.9)	17 (47.2)
Daily sleep and rest on day off		p<0.001			p<0.001			p<0.001	
Grade A (0–2 points)	124 (67.8)	47 (25.7)	12 (6.6)	36 (63.2)	17 (29.8)	4 (7.0)	160 (66.7)	64 (26.7)	16 (6.7)
Grade B (3–5 points)	8 (11.0)	40 (54.8)	25 (34.2)	8 (23.5)	18 (52.9)	8 (23.5)	16 (15.0)	58 (54.2)	33 (30.8)
Grade C (≥6 points)	2 (8.3)	12 (50.0)	10 (41.7)	0 (0.0)	3 (42.9)	4 (57.1)	2 (6.5)	15 (48.4)	14 (45.2)
2nd survey									
Overtime work per month		p=0.140			p=0.532			p=0.160	
Grade A (<45 h)	87 (54.4)	47 (29.4)	26 (16.3)	31 (41.9)	34 (45.9)	9 (12.2)	118 (50.4)	81 (34.6)	35 (15.0)
Grade B (45–80 h)	34 (42.5)	30 (37.5)	16 (20.0)	3 (37.5)	3 (37.5)	2 (25.0)	37 (42.0)	33 (37.5)	18 (20.5)
Grade C (>80 h)	3 (33.3)	2 (22.2)	4 (44.4)	0 (0.0)	0 (0.0)	0 (0.0)	3 (33.3)	2 (22.2)	4 (44.4)
Other job stressors		p<0.001			p=0.106			p<0.001	
Grade A (0–2 points)	108 (63.5)	50 (29.4)	12 (7.1)	32 (45.7)	30 (42.9)	8 (11.4)	140 (58.3)	80 (33.3)	20 (8.3)
Grade B (3–5 points)	16 (25.4)	25 (39.7)	22 (34.9)	3 (25.0)	7 (58.3)	2 (16.7)	19 (25.3)	32 (42.7)	24 (32.0)
Grade C (≥6 points)	4 (20.0)	4 (20.0)	12 (60.0)	0 (0.0)	3 (60.0)	2 (40.0)	4 (16.0)	7 (28.0)	14 (56.0)
Daily sleep and rest on day off		p<0.001			p<0.001			p<0.001	
Grade A (0–2 points)	112 (67.5)	44 (26.5)	10 (6.0)	32 (57.1)	22 (39.3)	2 (3.6)	144 (64.9)	66 (29.7)	12 (5.4)
Grade B (3–5 points)	14 (20.9)	29 (43.3)	24 (35.8)	4 (15.4)	14 (53.8)	8 (30.8)	18 (19.4)	43 (46.2)	32 (34.4)
Grade C (≥6 points)	2 (10.0)	6 (30.0)	12 (60.0)	0 (0.0)	4 (66.7)	2 (33.3)	2 (7.7)	10 (38.5)	14 (53.8)

Values are shown as numbers and percentages in parentheses. p values are calculated by using Fisher's exact test or the chi square test.
†: Grade A, 0–7 points; Grade B, 8–15 points; and Grade C, ≥16 points.

not reach a significant level.

In this survey, although the number of hours of overtime work was significantly related to the subjective symptoms score, there was no significant relationship between the number of hours of overtime work and subjective symptoms grade. This may be explained by the fact that a small number of subjects who worked overtime elevated the mean value of the subjective symptoms score, but all of the subjects who worked overtime did not get tired or feel stress. Several studies reported that overtime work was related to mental fatigue[15–17] or stress[18], while overtime work did not directly influence psychological indices[19–22]. Although the causes of these discrepancies are not clear, they might be explained by the characteristics of particular subjects, voluntary overtime work, and so on[1, 5, 19, 23].

The items in the other job stressors subscale in the present checklist contained work conditions such as shift work, irregular work, and business travel (see Appendix). These items came from the questionnaire used in the program launched by the MHLW[6]. Not only overtime work but also shift work has been shown to influence the physical and mental health of workers[2]. No female shift workers participated in the surveys of the present study, and approximately 41% of the female subjects were part-time or temporary workers. These workers would have little opportunity to experience irregular work schedules and business travel. The reason why the other job stressors grade was not significantly related to the subjective symptoms grade in the second survey of females was that these work conditions were not applicable for many of the female

Table 5. Correlations between the accumulated fatigue parameter† and quantity of daily sleeping hours or days off from work during the previous month in the two surveys

	Accumulated fatigue (1st survey)			Accumulated fatigue (2nd survey)		
	Male	Female	Total	Male	Female	Total
Daily sleeping hours	–0.369***	–0.169	–0.318***	–0.340***	–0.341**	–0.340***
Monthly number of days off††	–0.234***	–0.304**	–0.250***	–0.162**	–0.108	–0.151**

Values are Spearman's rank correlation coefficients. *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$.

†: as per Table 2.

††: Five categories: 0 d, 1–2 d, 3–4 d, 5–7 d, and ≥8 d.

workers. Also, among the males, the fact that only approximately 4% of the male subjects were shift workers might have slightly depressed the other job stressors subscale.

As for the sleep and rest issues, it has been reported that disturbed sleep[19] and sleep duration[22], rather than the number of hours of overtime work, are significant predictors of physiological indices. Despite a study that showed no significant association of disturbed sleep and rest with overtime work[24], the quantity of sleep and rest would, in general, be negatively related to the number of hours of overtime work or overwork[3, 23]. Japanese overtime workers tend not to take holidays or days off[5] and their lack of taking holidays or days off may be one of the factors leading to *karojisatsu* (work-related suicide)[25]. Liu *et al.*[26] demonstrated that insufficient sleep and taking only a few days off in men were related to increased risk of acute myocardial infarction. From the above-mentioned studies, short sleeping hours and lack of taking days off may be useful indices of overwork. In our study, there were significant negative correlations between the quantity of sleeping hours or monthly number of days off from work and the level of accumulated fatigue due to overwork. These results suggest that the checklist used in the present study may be useful for assessment of overwork.

This study had some limitations. The first was that our findings do not indicate the causal relationships among several factors and outcomes, since the two surveys yielded cross-sectional data. In addition to cross-sectional data analysis, longitudinal data analysis would contribute to investigation of the changes in the amount of sleep/rest, subjective symptoms and the accumulated fatigue parameter that result from changes in overtime and work conditions. The second limitation was that it is difficult to generalize these results for the following reasons: (1) the present surveys were conducted on workers in a company in Japan; (2) several kinds of occupations were included; and (3) approximately 40% of the female workers were part-time or temporary workers. Further questionnaire surveys will need to be conducted in other workplaces. The third limitation was that the reliability and validity of the checklist used in the surveys were not sufficiently verified. Test-retest reliability by using intra-class correlation coefficients of the four subscales and the accumulated fatigue parameter between the first and second surveys in males and females ranged from 0.425 to 0.711 and from 0.367 to 0.645, respectively. Japanese workers tend to underreport overtime hours[4], and such underreporting might have caused the low intra-class correlation coefficients of the overtime work subscale. Furthermore, it will be necessary to confirm the internal consistency reliability and construct validity of the checklist.

In summary, a high level of subjective symptoms of fatigue was considerably related to a high level of other job stressors and low quantity of sleep/rest rather than to a high number of overtime work hours. The accumulated fatigue parameter, which was estimated from the four subscales (overtime work, job stressors, sleep/rest, and subjective symptoms), was negatively correlated with daily sleeping hours and monthly number of days off from work. Since a low number of sleeping hours and a low monthly number of days off work are generally related to overwork, these results suggest that the accumulated fatigue parameter, which was multidimensionally estimated by the above subscales, is an appropriate tool for the assessment of overwork.

References

1) Spurgeon A, Harrington JM, Cooper CL (1997) Health and safety problems associated with long working hours: a review of the current position. Occup Environ Med **54**, 367–75.
2) Steenland K, Fine L, Belkic K, Landsbergis P, Schnall P, Baker D, Theorell T, Siegrist J, Peter R, Karasek R, Marmot M, Brisson C, Tuchsen F (2000) Research findings linking workplace factors to cardiovascular disease outcomes. Occup Med **15**, 7–68.
3) van der Hulst M (2003) Long workhours and health. Scand J Work Environ Health **29**, 171–88.
4) Uehata T (1991) Long working hours and occupational stress-

related cardiovascular attacks among middle-aged workers in Japan. J Hum Ergol (Tokyo) **20**, 147–53.
5) Shimomitsu T, Levi L (1992) Recent working life changes in Japan. Eur J Public Health **2**, 76–86.
6) Labor Standards Bureau, The Ministry of Health, Labour and Welfare. Announcement of Comprehensive Program for the Prevention of Health Impairment Due to Overwork, 2002. http://www.jicosh.gr.jp/english/guideline/OverworkMeasures.html. Accessed July 6, 2006.
7) The Ministry of Health, Labour and Welfare. Self-Diagnosis Check List for Assessment of Worker's Accumulated Fatigue. http://www.jicosh.gr.jp/english/topics/AccumulatedFatigueCheckList/AccumulatedFatigueCheckList.html. Accessed July 6, 2006.
8) Park J (2006) Impact of acute coronary syndrome (ACS) on work-relatedness evaluation in cerebrovascular and cardiovascular diseases among workers. J Occup Health **48**, 141–4.
9) Kawada T, Ooya M (2005) Workload and health complaints in overtime workers: a survey. Arch Med Res **36**, 594–7.
10) Yoshitake H (1971) Methodological study on the inquiry into subjective symptoms of fatigue. J Sci Labour **47**, 797–802.
11) Ahsberg E, Garnberale F, Kjellberg A (1997) Perceived quality of fatigue during different occupational tasks: Development of a questionnaire. Int J Ind Ergon **20**, 121–35.
12) Sluiter JK, van der Beek AJ, Frings-Dresen MH (1999) The influence of work characteristics on the need for recovery and experienced health: a study on coach drivers. Ergonomics **42**, 573–83.
13) Michielsen HJ, De Vries J, Van Heck GL (2003) Psychometric qualities of a brief self-rated fatigue measure: The Fatigue Assessment Scale. J Psychosom Res **54**, 345–52.
14) Winwood PC, Winefield AH, Dawson D, Lushington K (2005) Development and validation of a scale to measure work-related fatigue and recovery: the Occupational Fatigue Exhaustion/Recovery Scale (OFER). J Occup Environ Med **47**, 594–606.
15) Proctor SP, White RF, Robins TG, Echeverria D, Rocskay AZ (1996) Effect of overtime work on cognitive function in automotive workers. Scand J Work Environ Health **22**, 124–32.
16) Park J, Kim Y, Chung HK, Hisanaga N (2001) Long working hours and subjective fatigue symptoms. Ind Health **39**, 250–4.
17) Åkerstedt T, Fredlund P, Gillberg M, Jansson B (2002) Work load and work hours in relation to disturbed sleep and fatigue in a large representative sample. J Psychosom Res **53**, 585–8.
18) Maruyama S, Morimoto K (1996) Effects of long workhours on life-style, stress and quality of life among intermediate Japanese managers. Scand J Work Environ Health **22**, 353–9.
19) Åkerstedt T, Knutsson A, Westerholm P, Theorell T, Alfredsson L, Kecklund G (2004) Mental fatigue, work and sleep. J Psychosom Res **57**, 427–33.
20) Hobson J, Beach JR (2000) An investigation of the relationship between psychological health and workload among managers. Occup Med (Lond) **50**, 518–22.
21) Tarumi K, Hagihara A, Morimoto K (2004) Moderating effects of psychological job strain on the relationship between working hours and health: an examination of white-collar workers employed by a Japanese manufacturing company. J Occup Health **46**, 345–51.
22) Nishikitani M, Nakao M, Karita K, Nomura K, Yano E (2005) Influence of overtime work, sleep duration, and perceived job characteristics on the physical and mental status of software engineers. Ind Health **43**, 623–9.
23) White J, Beswick J (2003) Working long hours, Health & Safety Laboratory (HSL), Sheffield.
24) Åkerstedt T, Knutsson A, Westerholm P, Theorell T, Alfredsson L, Kecklund G (2002) Sleep disturbances, work stress and work hours: a cross-sectional study. J Psychosom Res **57**, 741–8.
25) Amagasa T, Nakayama T, Takahashi Y (2005) Karojisatsu in Japan: characteristics of 22 cases of work-related suicide. J Occup Health **47**, 157–64.
26) Liu Y, Tanaka H; The Fukuoka Heart Study Group (2002) Overtime work, insufficient sleep, and risk of non-fatal acute myocardial infarction in Japanese men. Occup Environ Med **59**, 447–51.

Appendix

A Checklist for Accumulated Fatigue due to Overwork

Please fill ✓ in the □ or a numerical value in the ( ) according to your working circumstances and health during **the past one month**.

I. Overtime work per month

(Overtime work means work exceeding 40 hours a week. It does not include lunch or dinner and commuting time)

□ 45 hours or less	□ more than 45 hours and 80 hours or less	□ more than 80 hours

II. Other job stressors

1. Psychological stressors	□ small (0)	□ medium (1)	□ large (3)
2. Physical workload	□ small (0)	□ medium (1)	□ large (3)
3. Load associated with shift and night work	□ nothing or small (0)	□ medium (1)	□ large (3)
4. Load associated with irregular work	□ nothing or small (0)	□ medium (1)	□ large (3)
5. Load associated with business travel	□ nothing or small (0)	□ medium (1)	□ large (3)

＜Subscale score＞ Add all the points in the ( ) of your answers. ( ) points

III. Daily sleep and rest on day off

1. Daily sleeping hours	□ sufficient (0)	□ slightly insufficient (1)	□ insufficient (3)
2. Rest on day off	□ sufficient (0)	□ slightly insufficient (1)	□ insufficient (3)
3. Do not sleep well	□ rarely (0)	□ sometimes (1)	□ often (3)

＜Subscale score＞ Add all the points in the ( ) of your answers. ( ) points

IV. Subjective symptoms

1. Feel irritated	□ rarely (0)	□ sometimes (1)	□ often (3)
2. Feel anxious	□ rarely (0)	□ sometimes (1)	□ often (3)
3. Feel restless	□ rarely (0)	□ sometimes (1)	□ often (3)
4. Feel depressed	□ rarely (0)	□ sometimes (1)	□ often (3)
5. Have trouble concentrating	□ rarely (0)	□ sometimes (1)	□ often (3)
6. Make mistakes frequently	□ rarely (0)	□ sometimes (1)	□ often (3)
7. Become very sleepy during work	□ rarely (0)	□ sometimes (1)	□ often (3)
8. Feel no desire to do anything	□ rarely (0)	□ sometimes (1)	□ often (3)
9. Feel exhausted (except for after exercise)	□ rarely (0)	□ sometimes (1)	□ often (3)
10. Feel tired when I get up in the morning	□ rarely (0)	□ sometimes (1)	□ often (3)
11. Get tired more quickly than before	□ rarely (0)	□ sometimes (1)	□ often (3)
12. Physically feel in a bad shape	□ rarely (0)	□ sometimes (1)	□ often (3)

＜Subscale score＞ Add all the points in the ( ) of your answers. ( ) points

V. Degree of accumulated fatigue

Please make the list of subscale grades using the results of I to IV in the previous page.

List of subscale grades

Subscale	Score	Grade		
		A	B	C
I. Overtime work per month	−	□ 45 hours or less	□ 46−80 hours	□ more than 80 hours
II. Other job stressors	( )	□ 0−2 points	□ 3−5 points	□ 6 points or more
III. Daily sleep and rest on day off	( )	□ 0−2 points	□ 3−5 points	□ 6 points or more
IV. Subjective symptoms	( )	□ 0−7 points	□ 8−15 points	□ 16 points or more

Please assess the degree of accumulated fatigue using the results of subscale grades.

Degree of accumulated fatigue

Subscale grades		Accumulated fatigue
Number of C	Number of B	
□ 0	□ 1 or less	□ Low
	□ 2 or more	□ Medium
□ 1	□ 0	
	□ 1 or more	□ High
□ 2 or more	□ 0−2	□ Very high