A Prospective Observation of Onsets of Health Defects Associated with Working Hours

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Received June 6, 2002 and accepted February 6, 2003

Abstract: A prospective study examined whether working 50 hours or less per week was associated with an increase of mental and circulatory disorders, and if so, whether it was significant for managing workers' health. White-collar workers aged 20 to 60 working at an office of a Japanese company were surveyed from August 1997 to March 2001. The onsets of the diseases were confirmed using medical insurance claims, and the overall incidence rates were 6.6 and 15.7 per 10,000 person months for both the disorders, respectively. Though not significant, those who worked 45 hours or more showed higher relative risks for mental disorders compared with those who did not. No other analysis indicated distinct findings. The small number of onsets of the diseases, the attention to personal health for workers who worked shorter hours, and intensive health care system for circulatory diseases in the workplace may partly account for the findings above. However, through reviewing other reports, it was suggested that the perception of work time could disturb the association between these findings, especially for white-collar workers. Also, it might be useful to observe the onset of mental disorders in work of less than 50 hours with the workers' perception of work time.

Key words: Working hours, Mental disorders, Circulatory disorders, Medical insurance claims, Hazard ratios

Introduction

Various studies^{1–8)} have reported that long hours of work are one of the possible risk factors which may cause health defects in workers. In review papers^{1–3)} which examine this problem, the positive associations between these factors are strongly suggested. Despite these reports, some points are still debatable: one is whether there is a certain range of working hours that workers can endure without experiencing anxiety or health defects. Although work of 50 hours or more a week²⁾ is thought to be related to more frequent onsets of health defects, this is not definite, and the effects of working less than 50 hours are accordingly indistinct. Furthermore,

the health defects associated with working hours^{2, 3)} are not uniform, and it is worthwhile to examine which health defects are more intensely related to long working hours for maintaining workers' health in occupational settings.

In this study, the authors have attempted to investigate these problems through examinations of Japanese white-collar workers as a target population for a prospective study. That is, the effects of work of less than 50 hours were mainly explored. Also, health defects observed in relation to working hours are multifarious as described above, but only mental and circulatory disorders^{2, 3)} were surveyed because they are specified as major health defects associated with long working hours.

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Subjects and Methods

Subjects

The subjects consisted of white-collar workers who worked at the head office of a Japanese manufacturing company. All of them were regular and daytime workers and had been successively employed for at least one year prior to the study. The number of years of their employment was nearly proportionate to their ages because of the lifetime employment system⁹⁾ of Japanese companies. All of the subjects were engaged in clerical, business, engineering and managerial work. None of them were manual workers because such work was assigned only to temporary workers.

Methods

The period of survey was from August 1997 to March 2001. In conducting the prospective study, the following information was collected: The number of hours of work; the dates of the start and end of the follow-up; the dates of onsets of the diseases in question (mental and circulatory disorders); the presence of other possible confounding factors; and demographic variables. Because the workers surveyed in this study usually changed worksites on average every three years, the information necessary for this investigation, except for BMI (body mass index), was obtained every August by using questionnaires from those who changed to a different worksite. The dates of starting the follow-up were, therefore, set at the time of the first response to the questionnaire. Average working hours per week during the previous month and demographic items including the types of occupations and lifestyle items^{11, 12)} were common questions asked about every year. The lifestyle items questioned are as follows, and the response categories are in parentheses: smoking (currently, ex-smoker, never); drinking (daily, sometimes, rarely); physical exercise (two or more times a week, once a week, rarely); the average number of sleeping hours a day.

Body mass index¹⁰⁾ was considered as a possible factor related to circulatory disorders, and was obtained from the records of the medical checkups conducted annually.

Medical insurance claim records were utilized for determining the dates of onsets of the mental and circulatory disorders. Medical insurance coverage¹³⁾ is compulsory for workers in Japan, and companies employing a certain number of workers are authorized to manage their own medical insurance programs. These data provided us with the information about whether or not a worker visited a doctor, and whether there was a diagnosis during the visit. Mental and circulatory disorders correspond to the code numbers

Table 1. Outline of the workers who were engaged in the worksite surveyed during the period from August 1997 to March 2001 (persons)

Date	No. of workers	Eligible subjects for analysis [#]	Females (%)	Mean age (SD)
1997.8	612	589	25.3	38.9 (9.6)
1998.8	532	491	22.4	37.7 (9.3)
1999.8	565	453	21.2	41.6 (10.0)
2000.8	547	458	25.9	40.6 (9.4)

[#] Those who responded to the questionnaire and with no previous history of the diseases in question.

of F00-F99 and G90 of the ICD-10¹⁴⁾ and I00-I99, respectively. Although G90, a disorder of autonomic nervous system, is not a mental disorder, it is known that doctors used to substitute it for a diagnosis of certain mental disorders in Japan. Because medical insurance claims include diagnoses and the dates of the first visits with the diagnoses, the dates of onset were confirmed by these data. The dates of the loss of eligibility of membership due to retirement or change of companies were provided from the personnel database of the company insurance program. When workers neither suffered from the diseases in question nor dropped-out, the follow-up was ended at the end of March 2001.

Analysis

Subjects: The eligible subjects for analysis aged from 20 to 60 at the time of the beginning of the follow-up, and they responded to the questionnaires and had undergone an annual medical checkup at least once. Those who moved to other worksites of this company were included as long as they were members of the company's medical insurance program because the information related to onsets was still available. In calculating the incidence rates for mental and circulatory disorders, those who had these diseases at the time of the beginning of the follow-up were excluded in advance for analysis. After the procedure described above, the number of subjects investigated ranged from 453 to 589, with mean ages from 37.7 to 41.6 years. Female workers accounted for 21.2% to 25.9% of this total (Table 1).

Variables considered: The period of the follow-up was counted based on units of person months for each worker. If the start and end of follow-up occurred in the same month, it was conveniently assumed that a half of a month was followed-up.

The mean values of working hours, sleeping hours and BMIs were calculated from the data gathered every year, and these values reflected the practical features during the

observation periods and were thus used for analysis. The number of working hours was categorized in the following two ways: less than 45 hours a week, 45 to less than 50, and 50 or more; less than 45 hours, and 45 or more. Working hours were then taken into account in each analysis procedure as a discrete variable in order to examine whether 50 hours or less of work a week was hazardous.

The responses to the following variables were categorized as follows: smoking (currently, other); drinking (daily, other); physical exercise (two or more times a week, other); sleeping hours (less than 7 hours a day, 7 or more); type of occupation (engineering, other). If workers responded differently to these items, except for sleeping hours, the first values answered were used in each response category.

Statistical methods: First, in order to observe the relationship between working hours and onsets of health defects, the relative risks of the 45 to less than 50 and 50 or more working hour groups to the less than 45 working hour group were calculated for the mental and circulatory disorders, respectively. Assuming the Poisson distribution¹⁵⁾, the 95% CIs of the relative risks were calculated. The percentages and mean values of the variables considered characterized as subgroups broken down by working hours were tested by the chi-squared and the analysis of variance tests, respectively. The Kaplan-Meier method^{16, 17)} was applied to observe the onsets of the diseases according to the working hour groups (less than 45 hours, 45 or more), and the Kaplan-Meier estimators^{16, 17)} were plotted as curves. The difference between the curves was tested by the log-rank and generalized Wilcoxon tests¹⁶⁻¹⁸⁾.

Next, in order to evaluate the effects of working hours on the onsets of mental and circulatory disorders, the proportional hazards model analysis¹⁶⁻¹⁸⁾ was applied. Working hours were included as a categorical variable (less than 45, 45 or more), and their hazard ratios were calculated after adjustment for the following possible confounding variables: age, gender and type of occupation, all of which were commonly included for both mental and circulatory disorders. The number of hours of sleep was taken into account as a covariate for mental disorders, and BMI, smoking, drinking and physical exercise for circulatory disorders. The significance of these variables¹⁶⁾ was assessed using -2 log likelihood values, and the most suitable combination of covariates was finally chosen.

All of the calculations and statistical procedures were conducted using SPSS software (SPSS Inc., Chicago) on a personal computer.

Results

Characteristics of the subjects

The exact diagnoses and the number of onsets observed during the period of follow-up are indicated for mental and circulatory disorders in Table 2. For mental disorders, the number of neurotic, stress-related and somatoform disorders was 8 (42.1%), and was the most frequent diagnoses observed. For circulatory disorders, the number of workers who had suffered from hypertension was 18 (42.9%), and that of ischemic heart disease was 15 (35.7%).

The percentages and mean values of the variables surveyed show the characteristics of the subgroups broken down by working hours (Table 3). Along with working hours, mean ages decreased ($p < 0.05$). The percentages of male workers and those who were engaged in engineering work increased along with working hours, and the difference of the former was statistically significant ($p < 0.001$). Also, BMI, smoking and drinking habits showed an increasing tendency with additional working hours, and the differences of the mean values and percentages among the working hour groups were significant ($p < 0.001$, $p < 0.05$, $p < 0.001$, respectively). Sleeping hours decreased along with an increase of working hours ($p < 0.05$). Physical exercise showed no consistent association with working hours.

Relative risk and incidence rate

Relative risks for mental disorders showed an increasing tendency with additional working hours, though those were not significant (Table 4): 1.32 (95% CI: 0.44–3.93) for the 45 to less than 50 working hour group, and 1.36 (95% CI: 0.46–4.06) for the 50 or more working hour group. Those of circulatory disorders were also insignificant and were 1.54 (95% CI: 0.76–3.16) and 1.26 (95% CI: 0.59–2.69) for the same working hour groups, respectively.

The overall incidence rate of mental disorders was 6.6 per 10,000 person-months, and that of circulatory disorders was 15.7.

Onset of health defects

The Kaplan-Meier estimators decreased stepwise along with time in both working hour groups (Fig. 1). For mental disorders, the curve for the 45 or more working hour group was lower than that for the less than 45 working hour group. This meant those who worked longer hours suffered from a greater number of onsets, though these curves were not significantly different. For circulatory disorders, the curves largely descended at three time points during the period of follow-up, and the curves were not significantly different from each other.

Table 2. Diagnoses of new onsets observed during the period of follow-up

Diagnosis	ICD-10	No. of patients (%)
Mental disorders:		
Mental and behavioral disorders due to psychoactive substance use	F10-F19	3 (15.8)
Mood disorders	F30-F39	4 (21.1)
Neurotic, stress-related and somatoform disorders	F40-F48	8 (42.1)
Other mental or behavioral disorders	F00-F99 except above	1 (5.3)
Disorders of autonomic nervous system	G90	3 (15.8)
Total		19 (100.0)
Circulatory disorders:		
Hypertension	I10-I15	18 (42.9)
Ischaemic heart diseases	I20-I25	15 (35.7)
Intracerebral hemorrhage	I61, I69.1	1 (2.4)
Cerebral infarction	I63, I69.3	3 (7.1)
Cerebral atherosclerosis	I67.2	1 (2.4)
Atherosclerosis	I70	4 (9.5)
Total		42 (100.0)

ICD-10: International classification of diseases, 10th revision.

Table 3. Comparison of characteristics in subgroups broken down by working hours

Variables surveyed	Working hour groups (No. of workers)			
	–44.9 (377)	45.0–49.9 (244)	50.0– (246)	
Age (years), mean (SD)	40.0 (10.6)	39.4 (9.4)	37.9 (8.4)	*
Gender (% male)	61.5	89.8	98.8	***
Type of occupation (% engineers)	11.4	15.2	16.7	–
BMI, mean (SD)	22.6 (3.3)	23.6 (3.2)	23.8 (2.7)	***
Smoking habit (% smokers)	28.0	33.5	39.7	*
Drinking habits (% daily drinkers)	39.0	56.9	55.0	***
Sleeping hours [#] (%)	29.6	26.0	19.3	*
Physical exercise [§] (%)	21.9	24.1	17.6	–

[#]Those who sleep 7 or more hours per day. [§]Those who have a habit of physical exercise two times or more per week. The difference of percentages was tested by the chi-squared test, and that of means by the analysis of variance test. *: $p < 0.05$, ***: $p < 0.001$, –: insignificant.

Table 4. Relative risks for mental and circulatory disorders broken down by working hours and overall incidence rates (per 10,000 person months)

Working hours (hr/wk)	Mental disorders				Circulatory disorders			
	Follow-up periods (person months)	No. of onsets	Relative risks (95% CI)		Follow-up periods (person months)	No. of onsets	Relative risks (95% CI)	
–44.0	377	12,573	7	1.00	355	11,728	15	1.00
45.0–49.9	244	8,187	6	1.32 (0.44–3.93)	234	7,593	15	1.54 (0.76–3.16)
50.0–	246	7,902	6	1.36 (0.46–4.06)	235	7,448	12	1.26 (0.59–2.69)
				<u>Incidence rate</u>				<u>Incidence rate</u>
Total	867	28,662	19	6.6	824	26,769	42	15.7

Fig. 1. The Kaplan-Meier estimators^{17, 18)} for event-free workers.

Table 5. Estimated hazard ratios (HR) and 95% confidence intervals (95% CI) for mental and circulatory disorders: Results from the proportional hazards model analysis

Covariates considered	Mental disorders		Circulatory disorders	
	HR	95% CI	HR	95% CI
Working hours (45 or more)	1.56	(0.49–4.98)	1.10	(0.53–2.26)
Age (gain of one year)	0.97	(0.92–1.03)	1.05	(1.01–1.09)
Gender (male)	0.69	(0.16–2.87)	4.86	(0.60–39.29)
Type of occupation (engineering)	2.15	(0.66–6.96)	1.09	(0.45–2.64)
BMI (gain of one unit)	— [#]		1.10	(0.98–1.22)
Physical exercise (less than 2/wk)	—		1.36	(0.59–3.12)
Significance levels for the model	chi-square=3.94, df=4 n=864, ns		chi-square=16.40, df=6 n=797, p<0.05	

The hazard ratios are indicated by the values in the parentheses. [#]BMI and physical exercise were not included in the final equation for circulatory disorders.

Hazard ratios

The hazard ratio of working hours was 1.56 (95% CI: 0.49–4.98) for mental disorders (Table 5). None of the covariates was significant, nor was the model equation itself. For circulatory disorders, the hazard ratio of age was 1.05 (95% CI: 1.01–1.09) and statistically significant ($p<0.05$), while that of working hours was 1.10 (95% CI: 0.53–2.26) and not significant. The model equation was significant as well ($p<0.05$).

Discussion

Relative risks are given based on incidence rates, and incidence rates should be assessed first. There is not a sufficient number of reports on incidence rates for mental disorders. By using interview methods, Sandanger *et al.*¹⁹⁾ examined incidence rates for psychiatric disorders (depression, anxiety and somatoform disorders) in Norwegian residents aged 18 years or more, and reported rates of 8.0

per 1,000 person-years. Hensing *et al.*²⁰⁾ examined the National Sickness Benefit Register data, and reported that 1.9% of cumulative incidences of absences caused by sickness were due to psychiatric diagnosis. Though it is not appropriate to simply compare the incidence rates with the results in other studies because of the difference of outcome variables, the incidence rate obtained in our study (6.6 per 10,000 person months, see Table 4) was not much different from theirs. For definite hypertension, Nakanishi *et al.*²¹⁾ prospectively examined Japanese male white-collar workers and reported incidence rates of 6.1 to 25.4 per 1,000 person years according to working hour groups. Hypertension was the most frequent diagnoses for circulatory disorders in our study (see Table 2), which was 15.7 per 10,000 person months (see Table 4) which appeared to be close to their results.

Relative risks increased along with an increase in working hours, especially for mental disorders (Table 4), and gender may have had a certain amount of influence. As indicated in Table 3, the number of male workers increased along with additional working hours. Young male engineers tended to work longer hours in the worksite surveyed, and as a result, this caused a decrease of mean ages and increasing tendencies of engineering work, BMIs, smoking and drinking habits in the longer working hour groups.

The use of medical insurance claim data may possibly have had some influence on the small and insignificant relative risks. That is, those who are suffering from health defects do not always visit a doctor, and whether a person visits a doctor or not may be affected by his or her personality. Our previous study²²⁾ in which white-collar workers were subjects showed that those who held preferable lifestyles which included ordinary working hours tended to visit medical facilities more frequently than those who did not. Also, Kondou *et al.*²³⁾ found the same tendency in their study, and reported that mean medical costs were higher for workers who did not have a smoking habit compared to those who did. If such a tendency is applicable to the results here, those who worked fewer hours would have been more likely to visit physicians due to their careful attention to health. This behavior may naturally explain the small differences of the relative risks between those who worked longer hours and those who worked shorter hours for both the disorders.

Despite the views above, the difference of the relative risks seemed to be obvious at 45 hours, and not at 50 hours (Table 4). The analyses of the effects of working 45 or more hours on workers' health surely showed no distinct findings (Fig. 1, Table 5), and the small number of those who suffered from the diseases in question may be one of causes. However,

the health care system in the workplace may partly explain this finding. As mentioned above, those who work shorter hours tend to keep preferable lifestyles and are more careful about their health. For mental disorders, since there was no effective confidential psychiatric counseling at the worksite, workers naturally would seek more outpatient visits to off-site doctors than they would otherwise. The increasing tendency for mental disorders with work of 45 hours or more might suggest that it is important to carefully consider the effects on workers' health of working less than 50 hours.

On the other hand, the annual health checkups targeted circulatory health problems because these particular health problems were legally mandated²⁴⁾. Sharp and synchronous declines of the Kaplan-Meier estimators in both the longer and shorter working hour groups observed at three distinct times in Fig. 1 coincided with the timings of work-site health screenings. Workers with abnormal findings were instructed to seek doctors' consultations as part of insurance-covered medical treatment, which is included in health insurance claims. As shown in Table 3, major risk factors for circulatory disorders such as BMI and drinking habits¹⁰⁾ were high in those who worked longer hours. This early intervention may have caused the relative risks observed in the working hour groups to be small.

In this study, white-collar workers were the subjects for analysis. Spurgeon *et al.*²⁾ introduced in their review paper a report in which academic personnel showed decreased stress levels during overtime, and this finding was accounted for because these workers were able to work without interference. Hobson and Beach²⁵⁾ examined 51 managers working at two UK companies and found no direct associations between working hours and self-reported stress measures. They did, however, find significant positive associations between working hours and perceived workload and between perceived workload and self-reported stress measures. They discussed these results in terms of the relationship between working hours to impaired psychological health mediated by the workers' perception toward their workload. The above results were inconsistent with each other, but the workers' perception of long working hours or their workload was commonly assumed in their discussion. Furthermore, for circulatory disorders, Sokejima *et al.*²⁶⁾ conducted a case-control study focusing on the effects of long working hours on the onsets of acute myocardial infarction (AMI) in Japanese occupational settings, and found that work of 11 hours or more a day was significantly associated with more onsets of AMI. However, results^{21, 27)} from a prospective study using male white-collar workers working at a Japanese construction company showed significant negative

associations between working hours and onsets of hypertension. In the latter, the authors²⁷⁾ pointed out that long working hours were associated with increased percentages of architects or research workers, and referred to the effects of moderating factors including perception or type of occupation. That is, in such types of occupations, workers tended to have more control over their work and worked longer hours. Long hours of work did not seem to contribute to stress in this case.

For white-collar work, it has been suggested that workers freely arrange their work time. This is applicable for managerial workers in the UK²⁵⁾ and for Japanese white-collar workers as well^{27, 28)}. If this is the case, for white-collar workers, long working hours would be psychologically less influential because of the discretionary nature of the work time, and the positive but insignificant results in our study might be partly attributed to the nature of white-collar work. In order to make the effects of working hours on workers' health more distinct, it may be proper to examine workers' perceptions towards their work time as one of the possible moderating factors, especially when white-collar workers are the subjects for analysis.

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