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Associations of Work Hours and Actual Availability of Weekly Rest Days with Cardiovascular Risk Factors

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Abstract: Associations of Work Hours and Actual Availability of Weekly Rest Days with Cardiovascular Risk Factors: Osamu ITANI, *et al*. Division of Public Health, Department of Social Medicine, Nihon University School of Medicine—Objectives: The aim of study was to determine the associations of work hours and actual availability of weekly rest days with the onset of lifestyle-related diseases such as obesity, hypertension, hypertriglyceridemia, low levels of high-density lipoprotein (HDL) cholesterol and hyperglycemia. **Methods**: For this longitudinal study, we used data from checkups conducted in 1999 and 2006 for 30,194 men who worked for a local public institution in Japan. We calculated the cumulative incidence rates of onset of obesity, hypertension, hyperglycemia, hypertriglyceridemia and low HDL cholesterol over this 7-year period and performed a χ^2 test to determine the association between the above diseases and work conditions (work hours and actual availability of weekly rest days) at the time of the baseline survey. We then performed multiple logistic regression analysis of the diseases that showed significant associations. **Results**: The adjusted odds ratio for the onset of hypertriglyceridemia in subjects who worked ≥9 hours was high (1.11 [95% CI: 1.02−1.22], p=0.02) in comparison with those who worked <9 hours. The adjusted odds ratio for the onset of hypertriglyceridemia in subjects who could not often take weekly rest days was high (1.13 [95% CI: 1.01−1.27], p=0.03) in comparison with those who were able to take most of the available weekly rest days off work. **Conclusions**: These results show that work hours and actual availability of weekly rest days independently predict the onset of hypertriglyceridemia. Working only regular hours and taking advantage of weekly rest days can contribute to the prevention of hypertriglyceridemia.
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The so-called *karoshi* (death due to diseases such as cerebrovascular disease, ischemic heart disease and acute heart failure, which develop due to worsening of baseline diseases such as atherosclerosis as a result of working long hours) has been a social problem in Japan since the 1970s[1−3]. Therefore, guidelines aimed at helping the public to balance their work–life hours in order to improve their quality of life were developed at the policy level, and a decrease in the legally stipulated hours of work and a 5-day workweek system were implemented to reduce the number of work hours[4]. However, compared with total work hours 20 years ago, when a 5-day workweek system was not the standard practice in Japan, the current number of hours worked has not been reduced because of an increase in the number of hours worked on weekdays[4]. In addition, the proportion of employees working long hours is higher in Japan than in other countries[5]. Under such circumstances, the possible health hazards of long work hours have become a focus of interest, and many epidemiological studies of this issue have been conducted. These have indicated an association between long working hours and the onset of cardiovascular disease[6]. However, few studies have investigated the associations between hours worked and cardiovascular risk factors other than hypertension.

When examining the effects of work on health, the actual availability of rest days must also be considered. In Japan, provision of at least one rest day per week or 4 rest days within a 4-week period to employees is stipulated by law. According to the General Survey on Working Conditions 2010

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conducted by the Ministry of Health, Labour and Welfare of Japan, 87.0% of enterprises have adopted a 5-day workweek system[7]. Although the hours of weekly rest days account for a significant proportion of waking hours, few epidemiological studies have investigated the effects on health of weekly rest days that are actually available, as compared with studies that have assessed the association between work hours and health. As long working hours have an important impact on health in contemporary Japanese society, the actual availability of weekly rest days needs to be considered in any analysis of associations between work and health hazards in order to achieve a better work–life balance among workers. Therefore, the present study examined the effects of working hours and the actual availability of weekly rest days on initial onset of obesity, hypertension, hyperglycemia, hypertriglyceridemia and a low level of high-density lipoprotein (HDL) cholesterol, using cohort study data that had been obtained by following a large population exceeding 30,000 over a period of 7 years. One of the study objectives was to analyze the associations between hours worked and cardiovascular risk factors other than hypertension, such as obesity, diabetes mellitus and dyslipidemia. In addition, an attempt was made to examine the effects of working hours and weekly rest days that were actually available on cardiovascular risk factors by adjusting for these two items.

Methods

Study subjects and data collection

This study retrospectively analyzed data obtained at medical checkups of employees of a local government organization in Japan, which requires all employees to undergo such checkups annually. Data from checkups conducted as a baseline survey (1999) and those from a follow-up survey (2006) were used. The numbers of male employees examined were 42,136 in 1999 and 43,984 in 2006, and those of female employees were 3,186 in 1999 and 3,632 in 2006. We excluded female employees from the present analysis because they were considerably smaller in number than the male employees. The number of male employees rostered from 1999 to 2006 was 32,913, of whom 30,194 received checkups in both 1999 and 2006. The data for these 30,194 employees were used in the present study.

Measures and definitions

The checkups included the following: (1) body height/weight measurement, (2) blood test, (3) urinalysis, (4) a self-administered questionnaire, (5) electrocardiography and (6) chest roentgenography. Physical assessments included measurements of height, body weight, blood pressure (systolic/diastolic) and visual and hearing acuities. As a condition of blood collection, the subjects were instructed not to take any food or beverage, except for water and tea, within 10 hours before the checkup. The parameters included in the blood test were white blood cell count, red blood cell count, platelet count and the levels of hemoglobin, total protein, total cholesterol, HDL cholesterol, triglyceride, fasting plasma glucose, γ-glutamyl transpeptidase, alkaline phosphatase, lactate dehydrogenase, urea nitrogen, creatinine and uric acid. The parameters included in the urinalysis were protein, occult blood and sugar. The questionnaire sought information on previous diseases, physical and mental complaints, working hours, presence/absence of overnight work, actual availability of weekly rest days, eating habits, alcohol consumption, smoking, exercise and sleep duration. The main questions were used in both of the questionnaires conducted in 1999 and 2006. With regard to working hours, we asked the subjects to state the average number of hours worked per day over the previous 1−2 months, with the following answer options: <9 hours, ≥9 but <10 hours, ≥10 but <11 hours or ≥11 hours. The organization for which the subjects worked stipulated that 1 or 2 rest days per week were periodically provided in principle. We also asked whether the subjects had been able to take weekly rest days over the past 1−2 months, with the following answer options: "able to take most of the available weekly rest days off" and "unable to often take weekly rest days off". With regard to mental complaints, the subjects answered questions such as whether they experienced irritability, reduced concentration and lethargy. With regard to sleep hours, the subjects were requested to select their sleep hours per day as <5 hours, ≥5 hours but <7 hours or ≥7 hours. With regard to eating habits, the subjects answered questions such as whether they "skip meals", "eat poorly balanced meals" or "eat too much". With regard to drinking habits, the subjects answered a question on whether they consume alcoholic beverages. With regard to smoking habits, the subjects answered a question on whether they smoke, by selecting an option from among "yes", "no" and "quit smoking." With regard to exercise habits, the subjects answered a question on whether they exercise or not.

Obesity was defined as a body mass index (BMI) of 25 kg/m^2 or higher according to the standards of the Japan Society for the Study of Obesity[8]. Blood pressure was measured twice in the right upper arm with the subject seated on a chair, using the auscultatory method. Hypertension was defined as a mean value of 2 systolic blood pressure measurements of 140 mmHg or higher or a mean value of 2 diastolic blood pressure measurements of 90 mmHg or higher in accordance with the standards of the World Health Organization (WHO)[9] and the Japanese Society of Hypertension[10]. Hypertriglyceridemia was defined as a plasma triglyceride level of 150 mg/d*l* or higher, and low HDL cholesterol was defined as a plasma HDL cholesterol level of less than 40 mg/d*l*, both according to the standards of the Japan Atherosclerosis Society[11]. Dyslipidemia was defined as having hypertriglyceridemia and/or low HDL cholesterol. Diabetes mellitus was defined as a fasting plasma glucose level of 126 mg/d*l* or higher according to the standards of the Japan Diabetes Society[12]. In the present study, metabolic syndrome was defined according to the criteria stipulated by the Examination Committee of Criteria for Metabolic Syndrome[13], but the criterion for the visceral fat accumulation endpoint was modified. That is, we used the body mass index (BMI) criterion instead of the abdominal circumference criterion; individuals with a BMI of ≥25 kg/m^2 were considered to have visceral fat accumulation. Metabolic syndrome was defined using this endpoint.

Statistical analyses

First, we calculated the proportions of the subjects divided according to working hours (<9 hours, 9–10 hours, 10–11 hours, 11 hours ≤) at the baseline survey (1999) according to age class. Subsequently, we calculated the actual availability of weekly rest days (most taken, most not taken) according to age class. We then calculated the proportions of the subjects in each working hours group based on the actual availability of weekly rest days. Among the 30,194 subjects who received checkups for both the baseline survey (1999) and the follow-up survey (2006), we selected only those who did not fall into the obesity category as of 1999. Among these individuals, the cumulative incidence rate of new-onset obesity in 2006 was calculated on the basis of their answers regarding work hours and actual availability of weekly rest days, and a χ^2 test was performed for each item. For hypertension, hypertriglyceridemia, low HDL cholesterol, dyslipidemia, hyperglycemia and metabolic syndrome, the cumulative incidence rates were calculated in a similar manner, and a χ^2 test was performed for work hours and actual availability of weekly rest days. For statistical analyses, work hours were categorized into two groups (<9 hours and ≥9 hours). For new onsets of obesity, hypertension, hypertriglyceridemia, low HDL cholesterol, dyslipidemia, hyperglycemia or metabolic syndrome, the items that indicated significant associations in a χ^2 test were selected, and then associations between the selected cardiovascular risk factors and work hours and actual availability of weekly rest days were examined by multiple logistic regression, with adjustment for confounding factors. For example, subjects who were categorized as obese in 2006 but not in 1999 were defined as those with new-onset obesity, and this new-onset obesity was taken as a response variable. Work hours and actual availability of weekly rest days were taken as independent variables. The following items were used as covariates: eating habits, alcohol consumption, presence/absence of overnight work, sleep duration, smoking, exercise habits, mental complaints and cardiovascular risk factors other than obesity. Similarly, multiple logistic regression analyses were performed on the cardiovascular risk factors that showed significant associations with work hours or actual availability of weekly rest days in the χ^2 test.

Ethical considerations

In this study, the following measures were taken to safeguard the privacy of the subjects: (1) Only one researcher had access to the subjects' personal data, and (2) the files containing the subjects' personal data were managed separately from those used for statistical analyses. This study was conducted in accordance with the tenets of the Personal Information Protection Act enforced in Japan and the Ethical Guidelines for Epidemiological Studies jointly announced by the Ministry of Health, Labour and Welfare and the Ministry of Education, Culture, Sports, Science and Technology of Japan.

Results

Analyzed subjects at the time of the baseline survey ranged from 20 to 53 years old (mean age [SD], 39.0 [9.1] years). The proportions of subjects divided according to the ranges of their work hours and age class are shown in Table 1. In total, the proportions of the subjects whose work hours were <9 hours, ≥9 but <10 hours, ≥10 but <11 hours and ≥11 hours were 47.0, 30.1, 11.5 and 7.8%, respectively; 3.6% of the subjects did not provide an answer. The reason for this distinctively high proportion of subjects aged less than 29 years who provided no answer regarding work was the inclusion of newly employed individuals, who had received checkups before starting actual work. The results of the χ^2 test demonstrated a significant association between age class and working hours (p<0.01): as age increased, working hours tended to become shorter. The actual availability of weekly rest days among subjects by age class is shown in Table 2. In total, 79.9% of the subjects were able to take most of the available weekly rest days off, and 16.0% were unable to do this often; 4.1% of the subjects did not provide an answer. The results of the χ^2 test demonstrated a significant association between the actual availability of weekly rest days and age class (p<0.01):

Table 1. Proportions of subjects by the ranges of working hours and age class

Age class	n	Working hours					Total	
		<9 h	9–10 h	10–11 h	≥11 h	No answer		
−29 yr	6,262	38.9%	25.9%	10.7%	8.0%	16.6%	100.0%	
30 yr–39 yr	7,890	43.3%	32.8%	13.7%	10.0%	0.2%	100.0%	
40 yr–49 yr	12,112	51.0%	30.5%	11.3%	7.0%	0.1%	100.0%	
50 yr–	3,930	54.7%	30.4%	9.1%	5.6%	0.1%	100.0%	
Total	30,194	47.0%	30.1%	11.5%	7.8%	3.6%	100.0%	χ^2=4167.1, p<0.01

Data at the time of the baseline survey (1999) were used. χ^2 test, 5 working hours ranges (<9 h, 9–10 h, 10–11 h, ≥11 h, no answer) × 4 age classes (−29 yr, 30–39 yr, 40–49 yr, 50 yr–).

Table 2. Subjects' actual use of weekly rest days by age class

Age class	n	Actual use of weekly rest days			Total	
		Most taken	Most not taken	No answer		
−29 yr	6,262	74.5%	8.6%	16.9%	100.0%	
30 yr–39 yr	7,890	82.1%	17.3%	0.6%	100.0%	
40 yr–49 yr	12,112	81.2%	17.9%	0.8%	100.0%	
50 yr–	3,930	80.0%	18.9%	1.1%	100.0%	
Total	30,194	79.9%	16.0%	4.1%	100.0%	χ^2=3419.1, p<0.01

Data at the time of the baseline survey (1999) were used. χ^2 test, 3 use of weekly rest days categories (most taken, most not taken, no answer) × 4 age classes (29 yr, 30–39 yr, 40–49 yr, 50 yr–).

Table 3. Working hours based on actual availability of weekly rest days

	n	Working hours			Total	p
		<9 h	9–10 h	≥10 h		
Actual use of weekly rest days						<0.01
Most taken	24,120	55.1%	29.7%	15.2%	100.0%	
Most not taken	4,818	16.7%	39.1%	44.2%	100.0%	
Total	28,938	48.7%	31.3%	20.0%	100.0%	

Data at the time of the baseline survey (1999) were used. χ^2 test, 2 use of weekly rest days categories (most taken, most not taken) × 3 working hours ranges (<9 h, 9–10 h, ≥10 h). Missing data were excluded from the statistical analyses.

as age increased, the proportion of subjects who were unable to take weekly rest days off tended to be higher. The proportions of subjects divided according to working hours based on actual availability of weekly rest days are shown in Table 3. Using the χ^2 test, we observed a significant association between actual availability of weekly rest days and working hours (p<0.01). Furthermore, calculations after stratifying the subjects into age groups in units of 10 years showed a significant association between the actual availability of weekly rest days and working hours in all age groups (data not shown).

The associations of the cumulative incidence rates of obesity, hypertension, hyperglycemia, hypertriglyceridemia, low HDL cholesterol, dyslipidemia and metabolic syndrome with work hours and actual availability of weekly rest days are shown in Table 4. A significant association was observed between the cumulative incidence rate of obesity and work hours (p=0.01), the rate being significantly high for those who worked ≥9 hours. A significant association was also observed between the cumulative incidence rate of hypertension and actual availability of weekly rest days (p=0.01), a significantly high rate being found for those who could not often take weekly rest days off. With regard to hypertriglyceridemia, there were significant associations with working hours (p<0.01) as well as the actual availability of weekly rest days

Table 4. Cumulative incidence rates of obesity, hypertension, hyperglycemia, hypertriglyceridemia, low HDL cholesterol, dyslipidemia and metabolic syndrome by working hours and actual availability of weekly rest days

	Obesity[a]			Hypertension[b]			Hyperglycemia[c]			Hypertriglyceridemia[d]		
	n	Cumulative incidence rate, %	p-value[h]	n	Cumulative incidence rate, %	p-value[h]	n	Cumulative incidence rate, %	p-value[h]	n	Cumulative incidence rate, %	p-value[h]
Working hours			0.01			0.50			0.27			<0.01
<9 h	7,936	20.5 (19.6–21.4)		11,893	15.5 (14.8–16.2)		10,988	5.8 (5.4–6.2)		7,471	18.1 (17.2–19.0)	
≥9 h	8,115	22.1 (21.2–23.0)		12,735	15.1 (14.5–15.7)		11,201	6.2 (5.8–6.6)		7,510	20.6 (19.7–21.5)	
Total	16,051	21.3 (20.7–21.9)		24,628	15.3 (14.9–15.7)		22,189	6.0 (5.7–6.3)		14,981	19.4 (18.8–20.0)	
Actual use of weekly rest days			0.83			0.01			0.19			<0.01
Most taken	13,612	21.2 (20.5–21.9)		20,469	15.0 (14.5–15.5)		18,210	5.9 (5.6–6.2)		12,394	18.8 (18.1–19.5)	
Most not taken	2,347	21.4 (19.7–23.1)		4,017	16.7 (15.5–17.9)		3,844	6.4 (5.6–7.2)		2,498	22.4 (20.8–24.0)	
Total	15,959	21.2 (20.6–21.8)		24,486	15.3 (14.8–15.8)		22,054	6.0 (5.7–6.3)		14,892	19.4 (18.8–20.0)	

	Low HDL cholesterol[e]			Dyslipidemia[f]			Metabolic syndrome[g]		
	n	Cumulative incidence rate, %	p-value[h]	n	Cumulative incidence rate, %	p-value[h]	n	Cumulative incidence rate, %	p-value[h]
Working hours			0.24			<0.01			0.16
<9 h	10,045	3.2 (2.9–3.5)		7,028	18.3 (17.4–19.2)		11,246	11.5 (10.9–12.1)	
≥9 h	10,146	3.5 (3.1–3.9)		7,014	20.5 (19.6–21.4)		11,688	12.1 (11.5–12.7)	
Total	20,191	3.3 (3.1–3.5)		14,042	19.4 (18.7–20.1)		22,934	11.8 (11.4–12.2)	
Actual use of weekly rest days			0.20			<0.01			<0.01
Most taken	16,591	3.3 (3.0–3.6)		11,639	18.8 (18.1–19.5)		19,134	11.3 (10.9–11.7)	
Most not taken	3,479	3.7 (3.1–4.3)		2,325	22.5 (20.8–24.2)		3,666	13.9 (12.8–15.0)	
Total	20,070	3.3 (3.1–3.5)		13,964	19.4 (18.7–20.1)		22,800	11.8 (11.4–12.2)	

Values in parentheses are 95% confidence intervals. HDL, high-density lipoprotein. Among the subjects who did not have the respective pathological conditions at the time of the baseline survey (1999), the proportions of subjects who had newly developed the respective diseases at the follow-up survey (2006) were defined as cumulative incidence rates. [a]Obesity: BMI ≥25 kg/m^2 [b]Hypertension: ≥140/90 mmHg [c]Hyperglycemia: ≥126 mg/d*l* [d]Hypertriglyceridemia: ≥ 150 mg/d*l* [e]Low HDL cholesterol: <40mg/d*l* [f]Dyslipidemia: hypertriglyceridemia and/or low HDL cholesterol. [g]Metabolic syndrome: BMI ≥25 kg/m^2 and 2 or more of the following conditions being met: 1) blood pressure ≥130/85 mmHg, 2) triglyceride ≥150 mg/d*l* or HDL cholesterol <40 mg/d*l* and 3) glucose ≥110 mg/d*l*. [h]All *p*-values were calculated using χ^2 tests. Missing data were excluded from the statistical analyses.

($p<0.01$): the cumulative incidence rates of hypertriglyceridemia were significantly higher for employees who worked ≥9 hours and those who were not often able to take weekly rest days off. With regard to hyperglycemia and low HDL cholesterol, no significant associations were observed with work hours or actual availability of weekly rest days. With regard to dyslipidemia, there were significant associations with working hours ($p<0.01$) as well as the actual availability of weekly rest days ($p<0.01$): the cumulative incidence rates of dyslipidemia were significantly higher for employees who worked ≥9 hours and those who were not often able to take weekly rest days off. A significant association was also observed between the cumulative incidence rate of metabolic syndrome and actual availability of weekly rest days ($p<0.01$), a significantly higher rate being found for those who could not often take weekly rest days off.

For obesity, hypertension, hypertriglyceridemia, dyslipidemia and metabolic syndrome, which had shown significant associations in the χ^2 tests, multiple logistic regression analysis was performed. The results indicated no significant associations between the onset of obesity and hours worked or the actual availability of weekly rest days. In addition, there were no significant associations between the onset of hypertension and work hours or actual availability of weekly rest days.

The results of multiple logistic regression analysis using the onset of hypertriglyceridemia as a response variable, are shown in Table 5. For analyses of hypertriglyceridemia, the subjects were divided into 3 groups (all ages, under 40 years old and 40 years or older). Each age group was analyzed using models in which confounding factors were not adjusted for (Model 1) and adjusted for (Model 2). In the all ages group, compared with the <9 hours work hours category, the adjusted odds ratio for the ≥9 hours work hours category was significantly higher in Model 1 (1.13 [95% confidence interval: 1.04–1.23], $p<0.01$). In addition, with regard to actual use of weekly rest days, compared with the most taken category, the adjusted odds ratio for the most not taken category was significantly higher (1.19 [95% CI: 1.07–1.27], $p<0.01$). In Model 2, in which confounding factors were adjusted for, the adjusted odds ratio for the ≥9 hours work

Table 5. Associations of working hours and actual availability of weekly rest days with hypertriglyceridemia

	All ages				Under 40 years			
	Model 1[a]		Model 2[b]		Model 1[a]		Model 2[b]	
	AOR	*p*-value	AOR	*p*-value	AOR	*p*-value	AOR	*p*-value
Working hours								
<9 h	1.00		1.00		1.00		1.00	
≥9 h	1.13 (1.04–1.23)	<0.01	1.11 (1.02–1.22)	0.02	1.09 (0.95–1.26)	0.21	1.08 (0.93–1.25)	0.31
Actual use of weekly rest days								
Most taken	1.00		1.00		1.00		1.00	
Most not taken	1.19 (1.07–1.33)	<0.01	1.13 (1.01–1.27)	0.03	1.25 (1.04–1.51)	0.02	1.19 (0.98–1.46)	0.08

	40 years or older			
	Model 1[a]		Model 2[b]	
	AOR	*p*-value	AOR	*p*-value
Working hours				
<9 h	1.00		1.00	
≥9 h	1.13 (1.01–1.26)	0.03	1.13 (1.01–1.27)	0.03
Actual use of weekly rest days				
Most taken	1.00		1.00	
Most not taken	1.18 (1.03–1.35)	0.02	1.11 (0.96–1.28)	0.17

AOR, adjusted odds ratio; values in parentheses are 95% confidence intervals. Multiple logistic regression analysis was used. Subjects (14,348) who had not developed hypertriglyceridemia at the time of the baseline survey (1999) were analyzed. Onset of hypertriglyceridemia at the follow-up survey (2006) was determined as a response variable. Working hours and actual availability of weekly rest days were used as independent variables. [a]Model 1: Model in which other confounding factors were not adjusted for. [b]Model 2: Model in which other confounding factors were adjusted for. Age, dietary habits, alcohol consumption, smoking, exercise habits, depression, sleep duration, overnight work, obesity, hypertension, low HDL cholesterol and hyperglycemia were used as covariates. Hypertriglyceridemia: ≥150 mg/d*l*. Missing data were excluded from the statistical analyses.

hours category was significantly higher as compared with the <9 hours category (1.11 [95% CI: 1.02–1.22], *p*=0.02). The adjusted odds ratio for the subjects who were unable to often take weekly rest days off was significantly higher (1.13 [95% CI: 1.01–1.27], *p*=0.03) compared with that for the subjects who were able to take most of the available weekly rest days off work. For the under 40 years old category, no significant association was observed with regard to working hours in Model 1. With regard to actual use of weekly rest days, compared with the most taken category, the adjusted odds ratio for the most not taken category was significantly higher (1.25 [95% CI: 1.04–1.51], *p*=0.02). In Model 2, in which confounding factors were adjusted for, no significant association was observed for working hours or actual use of weekly rest days. For the 40 years or older group, compared with the <9 hours work hours category, the adjusted odds ratio for the ≥9 hours work hours category was significantly higher in Model 1 (1.13 [95% CI: 1.01–1.26], *p*=0.03). In addition, with regard to actual use of weekly rest days, compared with the most taken category, the adjusted odds ratio for the most not taken category was significantly higher (1.18 [95% CI: 1.03–1.35], *p*=0.02). In Model 2, in which confounding factors were adjusted for, the adjusted odds ratio for the ≥9 hours work hours category was significantly higher compared with the <9 hours category (1.13 [95% CI: 1.01–1.27], *p*=0.03). No association was observed for working hours.

With regard to dyslipidemia, no association was observed for working hours, but the adjusted odds ratio for the subjects who were unable to often take weekly rest days off was significantly higher (1.15 [95% CI: 1.02–1.30], *p*=0.02) compared with those who were able to take most of the available weekly rest days off work. With regard to metabolic syndrome, no association was observed for working hours, but the adjusted odds ratio for the subjects who were unable to often take weekly rest days off was significantly higher (1.15 [95% CI: 1.02–1.29], *p*=0.02) compared with those who were able to take most of the available weekly rest days off work.

Discussion

Two findings of this longitudinal study are noteworthy. First, the analysis of associations between hours worked and cardiovascular risk factors proved that the risk of onset of hypertriglyceridemia increased when employees worked ≥9 hours daily. Second, the risk of onset of hypertriglyceridemia increased in individuals who were unable to often take weekly rest days off work. Lifestyle-related diseases are closely associated with lifestyle habits, such as diet, physical activities and smoking. In the present study, we performed analyses after adjusting for such lifestyle habits as confounding factors. As a significant association was observed between working hours and actual use of weekly rest days, as shown in Table 3, we input both of these parameters into the models as covariates to adjust for their mutual interactions and performed multiple logistic regression analysis. The results indicated that working hours and actual use of weekly rest days were independently associated with the onset of lifestyle-related diseases. To our knowledge, this study is the first to have demonstrated an association between the actual availability of weekly rest days and the onset risk of hypertriglyceridemia.

Working hours

The results of this study suggest that long hours of work increase the onset risk of hypertriglyceridemia. Nakamura *et al*. examined the association between long hours of work and dyslipidemia in 230 male white-collar workers by investigating changes in waist size, BMI value and serum lipid level (total cholesterol and triglyceride) over a period of 3 years[14]. Their results indicated that an increase in monthly overtime hours could be a risk factor for increased BMI values and waist size but demonstrated no significant association between monthly overtime hours and serum lipid level. Moreover, Nakanishi *et al*. conducted a cross-sectional study of associations between lifestyle habits and serum lipid level in 1,580 Japanese middle-aged workers and observed a negative correlation between working hours and blood triglyceride level[15]. They postulated that this negative association might be explained by the increase in energy consumption per day due to long hours of work. The results of these previous studies do not concur with our present findings, and the discrepancies may be explained by the large differences in study design, sample size and follow-up period. Energy consumption due to long hours of work may largely vary depending on the type of business and work. In addition, mental stress due to long hours of work may influence energy consumption. To date, few studies have focused on the association between hours worked and serum lipid level; further epidemiological studies will be required to accumulate findings on this issue. The biological mechanism underlying the onset of hypertriglyceridemia induced by long hours of work could not be clarified in the present study. A possible explanation is that long hours of work increase the tendency to consume late-evening snacks and longer hours spent sitting translate to lower physical activity[16]. Another possible explanation is that extended time of exposure to a stressful work environment stimulates the pituitary-cortisol system, leading to increased accumulation of visceral fat[17]. Further studies will be required to test this hypothesis. In addition, in our study the results of analyses on associations between hypertriglyceridemia and working hours for the under 40 years old and 40 years or older groups showed different outcomes. In particular, although no significant association was observed between hypertriglyceridemia and working hours in the group under 40 years old, a significant association was observed in the group 40 years or older. This finding suggests that the effects of working hours on the onset of hypertriglyceridemia differ according to age group. This result will help shed light on the biological mechanism underlying the onset of hypertriglyceridemia induced by long hours of work and provide a suggestion for developing policies on occupational health in the future.

Many epidemiological studies have investigated the effects of working hours on the health of employees[6], particularly the associations between working hours and cardiovascular diseases. Russek *et al*. reported that occupational stress, including long hours of work, was evident in 91% of patients aged <40 years with coronary heart disease, this percentage being 4.6 times higher than that in the normal control group[18]. In addition, Buell *et al*. analyzed 3 years worth of data for occupational deaths in California and found that the risk of mortality due to coronary artery disease among workers aged less than 45 years increased when they worked 48 hours or longer per week[19]. Moreover, in a case-control study, Liu *et al*. found that the odds ratio for the onset of acute myocardial infarction was significantly higher (1.8; 95% CI: 1.0–3.0) in a group who worked an annual weekly average of 60 hours or longer, compared with a group who worked an annual weekly average of less than 40 hours[20].

Many studies have investigated the associations between the onset of hypertension, diabetes mellitus, or dyslipidemia (cardiovascular risk factors) and working hours. Among these cardiovascular risk factors, hypertension has been the most frequently studied. However, the results of these studies have varied considerably. Some studies reported that an increase in working hours promoted the onset of hypertension[16, 21–23]; others reported that an increase in working hours suppressed the onset of hypertension[24, 25]; and still some other studies reported no association between the onset of hypertension and an increase in working hours[26, 27]. In our present study, we found no association between the onset of hypertension and the number of hours worked. Nakanishi *et al*. assumed that differences in the type of work might be one factor accounting for such discrepancies in the results[26]. In fact, the subjects of our study were not selected from the general population but were limited to a specific type of work (local government employees). This may have impacted our results. With regard to associations between the onset of diabetes mellitus and work hours, Davila *et al*., in a study of 369 type 2 diabetes patients in the United States, reported that the odds ratio for poor diabetes control (HbA_{1C} 7% or higher) was 5.09 for those who worked 40 hours or longer per week, compared with those who worked less than 20 hours per week[28]. Davila *et al*. pointed out that insufficient time available for treatment of diabetes mellitus due to long hours of work might be one of the reasons for poor diabetes control among employees working long hours. In our study, we found no association between long hours of work and diabetes mellitus, and this difference in findings may have been because of the difference in the methods used for diagnosis of diabetes: Davila *et al*. used HbA_{1C}, whereas we used only the fasting plasma glucose level, as measurement of HbA_{1C} was not performed for all of our study subjects. In addition, the difference in study design may have been a contributory factor. To date, few studies have investigated the association between working hours and diabetes mellitus, and this issue warrants further investigation.

Actual availability of weekly rest days

One important finding of this study was the positive association between the unavailability of weekly rest days and the risk of onset of hypertriglyceridemia. In our present multiple logistic regression analysis, eating habits, exercise habits, smoking, alcohol consumption, sleep duration, presence/absence of overnight work and hours worked were used as model covariates. Our results indicated that unavailability of weekly rest days increased the risk of onset of hypertriglyceridemia, independently from the other covariates, including hours worked. Although the effects of lifestyle factors such as work hours and exercise on cardiovascular disease and its risk factors have been studied previously, the association between availability of weekly rest days, which is antithetical to working, and cardiovascular disease has received little attention. The present study indicated that unavailability of weekly rest days increased the onset risk of hypertriglyceridemia, which we consider an important epidemiological finding. Our results suggest that a weekly rest day is not simply a day of "non-working time" and that it has a direct effect on the health of workers. Unfortunately, our study was unable to clarify the biological basis for how taking weekly rest days influences the onset of hypertriglyceridemia. Apart from weekly rest days, which are provided periodically between working days for 1−2 days, longer rest days are also provided as a vacation. Gump *et al*. conducted a study on the effects of actual availability of vacation opportunities on health, in which they followed 12,338 middle-aged individuals in the United States who were at high risk of cardiovascular disease over a period of 9 years[29]. They reported that the relative risk of mortality due to any cause for individuals who took annual vacations was 0.83, compared with those who did not. As for the relative risks according to cause of death, the relative risk of cardiovascular disease was 0.71 (0.68 for coronary heart disease, including myocardial infarction) and that of noncardiovascular diseases was 0.98. Gump *et al*. postulated from these results that taking a vacation could reduce continuous or latent stresses that cause coronary heart disease; moreover, taking a vacation could provide opportunities for interaction with family members and friends and for physical activities and thus promote physiological well-being. Weekly rest days that are provided periodically between working days may have effects similar to those of vacations. However, the biological mechanism responsible for this effect is still unclear, and further epidemiological and biological studies of this issue are warranted.

Limitations

The present study had certain limitations. First, it was retrospective in design and used previously collected data, and thus, not all the necessary information was covered in the questionnaires. For example, as detailed information on the type of work done by each subject was not obtained, we were unable to analyze the effects of the type of work on the study results. We were also unable to analyze the effects of activities during weekly rest days because information on how each subject spent weekly rest days was not included in the questionnaires. Moreover, because only data on working hours and actual availability of weekly rest days during 1−2 months before the checkups were obtained, the effects of long hours of work or difficulty in obtaining weekly rest days in the medium to long term may not have been evaluated properly. If working hours are taken as an example, in a case where a subject worked ≥9 hours per day in 1999 but <9 hours per day for the following years, the effects of such a change in working hours would not be reflected in the results of this study with the current study methods. In addition, although this was a prospective study, with the current analytical method, only the data of the beginning and end years were used, and the data for the other 5 years were not calculated. Furthermore, information on medication was not included in the questionnaires; thus, subjects who already had hypertension or other metabolic disorders and had been receiving medication may not have been properly categorized to the respective diseases, since the measured values in such subjects were lower than the defined standard levels because of the medication. Particularly, although the results of our analysis of hypertension were negative, the fact that the effects of medication could not be eliminated may have affected the results.

Second, as self-administered questionnaires were used, some data obtained would have been subjective. For example, information on working hours and actual availability of weekly rest days was based on self-reported data, and there may have been some discrepancies between the reported data and the actual status of individuals. In the same way, data on sleep duration and smoking were also self-reported, and there may have been some discrepancies for these items as well. A prospective study that includes the above-mentioned parameters will need to be conducted to verify the present results.

Conclusion

We conducted a study of approximately 30,000 Japanese male workers to investigate the associations of working hours and actual availability of weekly rest days with cardiovascular risk factors. The results revealed that hours worked and actual availability of weekly rest days independently increased the risk of onset of hypertriglyceridemia. Working only regular hours and taking advantage of weekly rest days are important factors for preventing the onset of hypertriglyceridemia and should be considered when developing lifestyle-related policies for workers. Particularly, further epidemiological studies are needed to investigate the beneficial effects of weekly rest days on the health of workers, focusing on how such rest days should be spent in order to obtain optimum health benefits.

References

1) Uehata T. Long working hours and occupational stress-related cardiovascular attacks among middle-aged workers in Japan. J Hum Ergol 1991; 20: 147–53.
2) Nishiyama K, Johnson JV. Karoshi—death from overwork: occupational health consequences of Japanese production management. Int J Health Serv 1997; 27: 625–41.
3) Iwasaki K, Takahashi M, Nakata A. Health problems due to long working hours in Japan: working hours, workers' compensation (Karoshi), and preventive measures. Ind Health 2006; 44: 537–40.
4) Kuroda S. Do Japanese work shorter hours than before? Measuring trends in market work and leisure using 1976–2006 Japanese time-use survey. Journal of the Japanese and International Economies 2010; 24: 481–502.
5) International Labor Organinzation (ILO). Working time around the world: Trends in working hours, laws, and policies in a global comparative perspective. 2007.
6) van der Hulst M. Long workhours and health. Scand J Work Environ Health 2003; 29: 171–88.
7) Ministry of Health, Labour and Welfare. General Survey on Working Conditions. [Online]. 2010 [cited 2012 Feb 2]; Available from: URL: http://www.mhlw.go.jp/english/database/db-l/general-survey.html
8) Examination Committee of Criteria for 'Obesity Disease' in Japan; Japan Society for the Study of Obesity. New criteria for 'obesity disease' in Japan. Circ J 2002; 66: 987–92.
9) Whitworth JA; World Health Organization, International Society of Hypertension Writing Group. 2003 World Health Organization (WHO)/International Society of Hypertension (ISH) statement on management of hypertension. J Hypertens 2003; 21: 1983–92.
10) Ogihara T, Kikuchi K, Matsuoka H, et al. The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2009). Hypertens Res 2009; 32: 3–107.
11) Japan Atherosclerosis Society. Diagnostic criteria for dyslipidemia. Executive summary of Japan Atherosclerosis Society (JAS) guideline for diagnosis and prevention of atherosclerotic cardiovascular diseases for Japanese. J Atheroscler Thromb 2007; 14: 155–8.
12) Committee of the Japan Diabetes Society on the diagnostic criteria of diabetes mellitus. Report of the Committee on the classification and diagnostic criteria of diabetes mellitus. Diabetes Res Clin Pract 2002; 55: 65–85.
13) Definition and the diagnostic standard for metabolic syndrome—Committee to evaluate diagnostic standards for metabolic syndrome. Nihon Naika Gakkai Zasshi 2005; 94: 794–809.
14) Nakamura K, Shimai S, Kikuchi S, et al. Increases in body mass index and waist circumference as outcomes of working overtime. Occup Med (Lond) 1998; 48: 169–73.
15) Nakanishi N, Nakamura K, Ichikawa S, Suzuki K, Tatara K. Relationship between lifestyle and serum lipid and lipoprotein levels in middle-aged Japanese men. Eur J Epidemiol 1999; 15: 341–8.
16) Yang H, Schnall PL, Jauregui M, Su TC, Baker D. Work hours and self-reported hypertension among working people in California. Hypertension 2006; 48: 744–50.
17) Chandola T, Brunner E, Marmot M. Chronic stress at work and the metabolic syndrome: prospective study. BMJ 2006; 332: 521–5.
18) Russek HI, Zohman BL. Relative significance of heredity, diet and occupational stress in coronary heart disease of young adults; based on an analysis of 100 patients between the ages of 25 and 40 years and a similar group of 100 normal control subjects. Am J Med Sci 1958; 235: 266–77.

19) Buell P, Breslow L. Mortality from coronary heart disease in California men who work long hours. J Chronic Dis 1960; 11: 615–26.
20) Liu Y, Tanaka H. Fukuoka Heart Study Group. Overtime work, insufficient sleep, and risk of non-fatal acute myocardial infarction in Japanese men. Occup Environ Med 2002; 59: 447–51.
21) Hayashi T, Kobayashi Y, Yamaoka K, Yano E. Effect of overtime work on 24-hour ambulatory blood pressure. J Occup Environ Med 1996; 38: 1007–11.
22) Iwasaki K, Sasaki T, Oka T, Hisanaga N. Effect of working hours on biological functions related to cardiovascular system among salesmen in a machinery manufacturing company. Ind Health 1998; 36: 361–7.
23) Artazcoz L, Cortès I, Borrell C, Escribà-Agüir V, Cascant L. Gender perspective in the analysis of the relationship between long workhours, health and health-related behavior. Scand J Work Environ Health 2007; 33: 344–50.
24) Park J, Kim Y, Cho Y, et al. Regular overtime and cardiovascular functions. Ind Health 2001; 39: 244–9.
25) Pimenta AM, Beunza JJ, Bes-Rastrollo M, et al. Work hours and incidence of hypertension among Spanish university graduates: the Seguimiento Universidad de Navarra prospective cohort. J Hypertens 2009; 27: 34–40.
26) Nakanishi N, Yoshida H, Nagano K, Kawashimo H, Nakamura K, Tatara K. Long working hours and risk for hypertension in Japanese male white collar workers. J Epidemiol Community Health 2001; 55: 316–22.
27) Wada K, Katoh N, Aratake Y, et al. Effects of overtime work on blood pressure and body mass index in Japanese male workers. Occup Med (Lond) 2006; 56: 578–80.
28) Davila EP, Florez H, Trepka MJ, et al. Long work hours is associated with suboptimal glycemic control among US workers with diabetes. Am J Ind Med 2011; 54: 375–83.
29) Gump BB, Matthews KA. Are vacations good for your health? The 9-year mortality experience after the multiple risk factor intervention trial. Psychosom Med 2000; 62: 608–12.