

## SHORT REPORT

# Effects of overtime work on blood pressure and body mass index in Japanese male workers

Koji Wada<sup>1</sup>, Noritada Katoh<sup>2</sup>, Yutaka Aratake<sup>2</sup>, Yasushi Furukawa<sup>3</sup>, Toshio Hayashi<sup>4</sup>, Emi Satoh<sup>2</sup>, Katsutoshi Tanaka<sup>2</sup>, Toshihiko Satoh<sup>5</sup> and Yoshiharu Aizawa<sup>5</sup>

<b>Background</b>	Effects of overtime work on health is a controversial issue.
<b>Aims</b>	To determine the effects of overtime work on blood pressure and body mass index (BMI) for male workers in Japan.
<b>Methods</b>	Participants were 323 male participants of three companies. Data were collected by occupational physicians at periodic physical examinations and additional examinations. The time courses for the development of definite hypertension and an increase in BMI were recorded. The Kaplan–Meier method was used to estimate the cumulative incidence rates of developing definite hypertension and increasing BMI, and the Cox proportional hazard model was used to determine the adjusted relative hazard of overtime work.
<b>Results</b>	The age-adjusted incidence rates of developing definite hypertension and increasing BMI were significantly lower among the participants whose mean overtime was $\geq 50$ h than among those whose mean overtime was $< 50$ h/month (log-rank $P < 0.05$ ). The Cox proportional hazard model indicated that those who worked a mean overtime of $\geq 50$ h/month had lower risks of developing definite hypertension (hazard ratio, 0.36; 95% CI, 0.15–0.88; $P < 0.05$ ) and increasing their BMI (hazard ratio, 0.44; 95% CI, 0.31–0.63; $P < 0.01$ ) after adjusting for age.
<b>Conclusions</b>	The results of this study indicate that workers whose mean overtime was $\geq 50$ h have lower risks of developing definite hypertension and increasing their BMI.
<b>Key words</b>	Body mass index; hypertension; karoshi; overtime.

## Introduction

Recently, ‘karoshi’, death from overtime work, has become a social concern in Japan [1]. Most cases of karoshi are the result of the sudden onset of a fatal cardiovascular or cerebrovascular event. In 2002, the Ministry of Health, Labor and Welfare in Japan announced a comprehensive program for the prevention of health problems due to overwork.

There are controversies over the effects of overtime work on health [2–5]. There are few reports on the direct influence of overtime work on the development of cardiovascular or cerebrovascular diseases. Kawakami *et al.* [6] reported that workers who did overtime work  $> 50$  h/month have higher risk of developing diabetes mellitus.

This epidemiological study was undertaken to determine whether overtime work is directly associated with the development of definite hypertension and increasing body mass index (BMI) for male workers in Japan.

## Methods

The eligible participants were all individuals who completed periodic physical examinations and/or ‘additional’ examinations at least twice between January 2002 and July 2004. Outcomes were compared between those who worked overtime of  $\geq 50$  h and those who worked  $< 50$  h. Normal working hours without overtime were defined as 160 h/month. Mean overtime work per month was calculated.

<sup>1</sup>Department of Occupational Health, Graduate School of Medical Sciences, Kitasato University, Sagamihara, Kanagawa, Japan.

<sup>2</sup>Department of Occupational Mental Health, Graduate School of Medical Sciences, Kitasato University, Sagamihara, Kanagawa, Japan.

<sup>3</sup>Ajinomoto Co., Inc., Kawasaki, Kanagawa, Japan.

<sup>4</sup>Toshiba Human Asset Service Co., Yokohama, Kanagawa, Japan.

<sup>5</sup>Department of Preventive Medicine and Public Health, Kitasato University School of Medicine, Sagamihara, Kanagawa, Japan.

Correspondence to: Koji Wada, Department of Occupational Health, Graduate School of Medical Sciences, Kitasato University, 1-15-1 Kitasato, Sagamihara, Kanagawa 228-8555, Japan. Tel: +81 42 778 9311; fax: +81 42 778 9257; e-mail: kwada-sgy@umin.ac.jp

There are two sources of data for blood pressure and weight: periodic physical examinations and additional examinations. The periodic physical examinations were completed every 6 or 12 months depending on the company. Additional examinations were completed every month an employee exceeded 50 h of overtime work. Consequently, those who had more overtime work had more frequent additional examinations.

Hypertension was defined as a systolic blood pressure  $\geq 140$  mmHg or a diastolic blood pressure  $\geq 90$  mmHg on the basis of World Health Organization criteria [7].

Increasing BMI was defined as an increase in BMI between health examinations. The time courses for the development of definite hypertension and the increase in BMI were recorded.

Differences in baseline characteristics were compared using a *t*-test. Survival curves were constructed by the Kaplan–Meier method [8] with a difference in survival assessed by the log-rank test between the participants who worked a mean overtime of  $\geq 50$  h and those who worked a mean overtime of  $< 50$  h. The Cox proportional hazard model [9] was used to evaluate the associations of working hours with the development of definite hypertension and an increase in BMI. Data were adjusted for age. All analyses were performed using SPSS for Windows, version 10 [10].

## Results

The participants were 360 male workers of three companies (121 of a food company, 150 of an electronics manufacturing company and 89 of a steel engineering company) in the Kanto area, Japan. We excluded 37 participants who were already diagnosed as having hypertension at the baseline from the analyzed population. The overall mean age (SD) of the participants was 34.7 (8.6) years. The participants were followed up for a mean period (SD) of 23.0 (19.3) weeks. Two hundred and four participants (63%) worked a mean overtime of

$\geq 50$  h/month. There were no significant differences in baseline age, blood pressure or BMI between the participants who worked a mean overtime of  $< 50$  h and those who worked a mean overtime of  $\geq 50$  h (Table 1).

Over the studied time courses, 23 participants developed definite hypertension and 135 showed an increase in BMI. The median time for the development of definite hypertension was 26 weeks and that for the increase in BMI was 26 weeks for the participants who worked a mean overtime of  $\geq 50$  h/month. The median time for the development of definite hypertension was 11 weeks and that for an increase in BMI was 10.5 weeks for the participants who worked a mean overtime of  $< 50$  h/month.

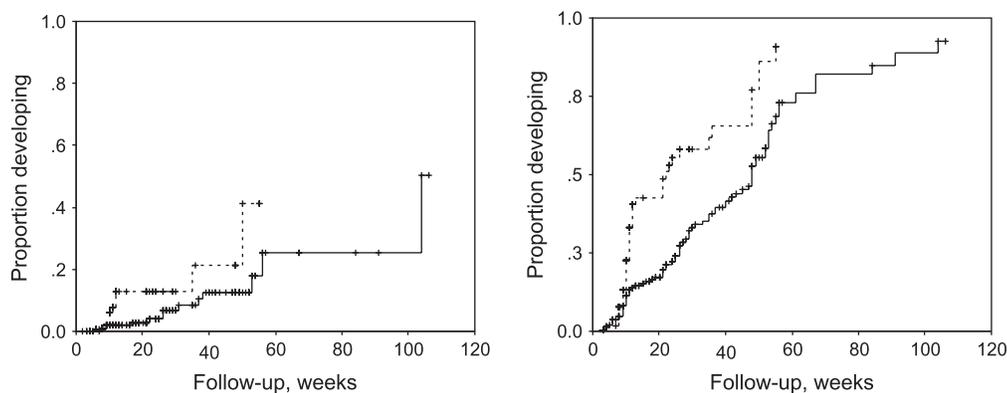
The stratified Kaplan–Meier survival estimates are shown in Figure 1. Survival rate differed between the participants whose mean overtime was  $\geq 50$  h and those whose mean overtime was  $< 50$  h/month in terms of the development of definite hypertension and an increase of their BMI (log-rank test  $P < 0.05$ ).

The evaluation using the Cox proportional hazard model indicated that the participants whose mean overtime work was  $\geq 50$  h/month had lower risks of developing definite hypertension (hazard ratio, 0.36; 95% CI, 0.15–0.88;  $P < 0.05$ ) and increasing their BMI (hazard ratio, 0.44; 95% CI, 0.31–0.63;  $P < 0.01$ ) after adjusting for age (Table 2).

**Table 1.** Baseline characteristics of participants who did overtime for  $\geq 50$  h and for  $< 50$  h/month<sup>a</sup>

Variables	$\geq 50$ h ( <i>n</i> = 204)	$< 50$ h ( <i>n</i> = 119)	<i>P</i> value
Age, year	35.0 $\pm$ 8.7	34.2 $\pm$ 8.4	0.52
Blood pressure			
Systolic pressure	121.8 $\pm$ 12.4	122.6 $\pm$ 14.1	0.37
Diastolic pressure	74.2 $\pm$ 11.4	73.4 $\pm$ 12.5	0.24
BMI	23.2 $\pm$ 3.0	23.3 $\pm$ 3.3	0.79

<sup>a</sup>Values given as mean  $\pm$  SD.



**Figure 1.** Kaplan–Meier survival curve. Left: definite hypertension, right: an increase in BMI. Overtime  $< 50$  h, overtime  $\geq 50$  h. The pluses on the plots are censored observations.

**Table 2.** Cox regression model for definite hypertension and an increase in BMI with age and overtime work

Variables	$\beta$	Hazard ratio	95% CI
Definite hypertension			
Age, year	0.03	1.04	0.99–1.08
Overtime work $\geq 50$ h	-1.01	0.36	0.15–0.88
An increase in BMI			
Age, year	-0.01	0.99	0.97–1.01
Overtime work $\geq 50$ h	-0.82	0.44	0.31–0.63

## Discussion

In this study, we found that mean monthly overtime work of  $\geq 50$  h was negatively associated with the development of definite hypertension and an increase in BMI. Workers who worked overtime of  $\geq 50$  h had more frequent examinations and these examinations were staggered, hence the greater variability in the timing of the observations. In comparison, the workers who worked  $< 50$  h of overtime underwent a periodic health examination, thereby resulting in more clustered observations.

Findings on the effect of overtime work on hypertension are inconsistent across other studies [2–5]. Hayashi *et al.* [2] showed an increase in blood pressure among workers whose mean overtime was 84–96 h as compared with those working 25–43 mean hours of overtime per month. Our results are well in line with those of Nakanishi *et al.* [3], which indicated that overtime work is negatively associated with the development of hypertension during a 5-year follow-up.

Nakamura *et al.* [4] showed that working overtime is associated with increasing BMI as determined by correlation analysis. To the best of our knowledge, our study is the first to assess the effect of overtime work on BMI by survival analysis.

This study had a few limitations. First, we only assessed mean overtime hours per month and age. Differences in job-related strain, occupations and lifestyle among workers should be studied in future studies. Second, we did not consider working hours before the start of this study. Some participants might have become used to working overtime. Third, we were able to assess only men, even though these are not specific problems to men. Fourth, the follow-up time was not sufficiently long

to accurately assess the development of hypertension even though we focused on the trend of blood pressure. Further study should be carried out with more variables and for longer periods to assess the effects of overtime work on hypertension.

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## Conflicts of interest

None declared.

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