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Working Hours and Cardiovascular Disease in Korean Workers: A Case-control Study

Inchul JEONG[1,2], Jeongbae RHIE[3], Inah KIM[1,2], Innshil RYU[4], Pil Kyun JUNG[1,2], Yoo Seok PARK[5], Yong-Su LIM[6], Hyoung-Ryoul KIM[7], Shin-Goo PARK[8], Hyoung-June IM[4], Mi-Young LEE[9] and Jong-Uk WON[2,10]

[1]Graduate School of Public Health, Yonsei University, Republic of Korea, [2]Institute for Occupational Health, Yonsei University College of Medicine, Republic of Korea, [3]Department of Occupational and Environmental Medicine, Dangook University College of Medicine, Republic of Korea, [4]Korean Industrial Health Association, Republic of Korea, [5]Department of Emergency Medicine, Yonsei University College of Medicine, Republic of Korea, [6]Department of Emergency Medicine, Gachon University Gil Medical Center, Republic of Korea, [7]Department of Occupational and Environmental Medicine, College of Medicine, The Catholic University of Korea, Republic of Korea, [8]Department of Occupational and Environmental Medicine, Inha University Hospital, Republic of Korea, [9]Occupational Safety and Health Research Institute, Korea Occupational Safety and Health Agency (KOSHA), Republic of Korea and [10]Department of Preventive Medicine, Yonsei University College of Medicine, Republic of Korea

Abstract: Working Hours and Cardiovascular Disease in Korean Workers: A Case-control Study: Inchul JEONG, *et al*. Graduate School of Public Health, Yonsei University, Republic of Korea—Objectives: Long working hours can negatively impact a worker's health. The objective of this study was to examine the association between working hours and cardiovascular diseases (CVDs) and compare the degree of risk based on CVD subtypes in Korean workers. **Methods:** This study was a case-control study of the patients registered in the Occupational Cardiovascular Diseases Surveillance 2010. The cases included 348 patients diagnosed with a CVD (123 cerebral infarction, 69 intracerebral hemorrhage, 57 subarachnoid hemorrhage, 99 acute myocardial infarction). Controls were 769 participants with no history of CVDs matched for gender, age, type of occupation, and region. Participants' working hours in the previous week and the average working hours over the past three months were assessed to examine short-term and long-term effects. **Results:** After adjusting for confounding factors, the odds ratios (ORs) for CVDs in the short-term were 2.66 (95% Confidence interval (CI) :1.78−3.99) for working ≤40 hours, 1.85 (95% CI: 1.22−2.81) for working 50.1−60 hours and 4.23 (95% CI: 2.81−6.39) for working >60 hours compared with the 40.1−50-hour working group. The ORs in the long-term were 2.90 (95% CI: 1.86−4.52) for working ≤40 hours, 1.73 (95% CI: 1.03−2.90) for working 48.1−52 hours and 3.46 (95% CI: 2.38−5.03) for working >52 hours compared with the 40.1−48-hour working group. **Conclusions:** Long working hours are related to an increased risk of CVDs, and the degree of risk differs based on CVD subtype. Short working hours are also related to an increased risk for CVDs. More prospective studies targeting specific disease risks are required.
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Key words: Coronary heart disease, Korea, Occupational disease, Overtime work, Stroke

Working long hours is common in industrialized nations and is increasingly more common in developing countries around the world[1, 2]. Previous studies have described the negative impact on health of long working hours. Occupational injuries and accidents increase with long working hours[3, 4], as do the incidences of sleep disorders, depression, musculoskeletal diseases, and cardiovascular diseases[5–7]. Some studies have also reported that long working hours negatively affect heart rate, heart rate variability, and blood pressure. Other case-control studies and one cohort study have also reported that long working hours can encourage the development of acute myocardial infarction[8–11]. In a recent meta-analysis on long working hours and coronary heart disease, the summary estimate of coronary heart disease risk was 1.59 (95%

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Correspondence to: J.-U. Won, Department of Preventive Medicine, Yonsei University College of Medicine, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-752, Republic of Korea (e-mail: juwon@yuhs.ac)

confidence interval (CI): 1.23–2.07) in the maximally adjusted analysis, and the relative risk in prospective studies was 1.39 (95% CI: 1.12–1.72)[12]. However, the majority of studies have reported minor diseases or preclinical stage cardiovascular diseases as primary outcomes. In studies targeting coronary heart diseases as outcomes, some studies have included only a single type of occupation, and others have been conducted primarily in countries with relatively short working hours.

Korea has some of the longest working hours in the world. According to a survey by the Korean Ministry of Employment and Labor in 2010, the average Korean employee worked 187 hours per month (47 hours per week). A survey by the Organization for Economic Co-operation and Development (OECD) found that the average Korean employee worked 2,193 hours in 2010, the longest among all members of the OECD. Additionally, a 2006 report by the Working Conditions Survey of the Korean Occupational Safety and Health Agency (KOSHA) found that the average work week was 51 hours and that 45% workers worked at least 48 hours. These results are significantly different compared with the results of the European Working Conditions Survey in 2005 (38.6 hours, 15%, respectively)[13–15]. Therefore, exploring the relationship between long working hours and cardiovascular disease in Korea could be meaningful for predicting the health effects of long working hours in developing countries.

Despite these reports, there have been few studies of long working hours and cardiovascular diseases in Korea. To the best of the authors' knowledge, only one study has examined the relationship between overtime work and cardiovascular functions, and no study has evaluated the relationship between working hours and cardiovascular diseases in Korea[16]. Therefore, the objective of this study was to examine the relationship between working hours and the incidence of CVDs independently from known conventional risk factors and to compare the degree of risk based on CVD subtype in Korean workers.

Methods

The occupational cardiovascular disease surveillance

The Korean Center for Disease Control and Prevention conducts cardiovascular disease surveillance. From 2007 to 2010, surveillance was conducted at 25 to 30 emergency rooms of general hospitals, and approximately 15,000 cases of cardiovascular disease per year were registered. The Occupational Cardiovascular Disease Surveillance (OCDS) was conducted by the Occupational Safety and Health Research Institute of KOSHA at three of these hospitals. The two surveillance programs used the same questionnaire; however, the questionnaire used in the Occupational Cardiovascular Disease Surveillance included more questions about working conditions. The target patients for registration were patients with a diagnosis of cerebral infarction, intracerebral hemorrhage, subarachnoid hemorrhage, or acute myocardial infarction (based on the ICD 10th ed.; I63, I61, I60, and I21, respectively) between the ages of 20 and 65 who visited the emergency rooms of participating university hospitals. The survey was completed in the emergency room or in the ward by trained interviewers (nurses or emergency medical technicians) after acute treatment, and all nonfatal cases were registered. Data analyzed in this study were collected between November 2009 and October 2010.

Study subjects

In this case-control study, data from the OCDS 2010 were used. A total of 824 cases were registered in the OCDS 2010, and cases from only two hospitals (711 cases) were used in this study because region-matched controls for the cases of one hospital were not available. Among the 711 cases across the two hospitals, 301 cases were not appropriate for the study because 237 of the cases were in patients who were unemployed, 61 cases were recurrent events and three cases had incorrect diagnoses. Therefore, 410 cases were regarded as appropriate candidates for this study; however, an additional 62 cases were excluded due to missing information about working hours. Finally, 348 cases remained as the case group (99 cases of acute myocardial infarction, 57 cases of subarachnoid hemorrhage, 69 cases of intracerebral hemorrhage, and 123 cases of cerebral infarction).

The control group was recruited at four occupational health institutes at university hospitals from November 2010 to October 2011. Controls were matched with cases based on gender, age (up to 5 years older or younger), type of occupation (white collar or blue collar), and region, using a frequency matching method. Workers were contacted through a group occupational health service or health examination[17]. Three times the number of workers as cases were invited to participate in the study, and 845 of them (80.9%) consented. Of this group, 76 participants were excluded due to a history of cardiovascular disease (n=18) and missing information (n=58). Therefore, the final control group consisted of 769 participants. A questionnaire including the same questions as those used for the OCDS was developed to assess the characteristics of the participants. Participants completed the questionnaire under the supervision of a healthcare professional. This study was approved by the Institutional Review Board of the Yonsei University Health System (IRB No. 4-2010-0651), and informed

consent was obtained from all participants.

Sociodemographic and risk factors

The survey and questionnaire consisted of questions assessing sociodemographic factors (e.g., age, gender, body mass index, type of occupation, and level of education), lifestyle habits (e.g., smoking, alcohol intake and exercise) and medical history (e.g., hypertension and diabetes).

Body mass index (BMI) was calculated as weight divided by height squared and classified as normal (less than 25 kg/m^2) or overweight/obese (≥25 kg/m^2). Occupations were categorized as white collar or blue collar based on the occupation that the participant had primarily held throughout the past year. Level of education was categorized as high school (12 years or less) or more than a high school level of education (more than 12 years). For lifestyle habits, exercise was defined as regular exercise during leisure-time, current smoking was defined as smoking within the past year, and heavy alcohol intake was defined as intake of more than 40 g per day for men and 20 g per day for women.

Assessment of working hours

Working hours of subjects were investigated to examine the short-term and long-term effects. "Short-term working hours" was defined as the working hours of the previous week, and "long-term working hours" was defined as the average weekly working hours for the past three months. Participants were asked, "how many hours did you work last week?" and "how many hours per week did you work in the last three months?". Six possible answers (≤40, 40.1–45, 45.1–50, 50.1–55, 55.1–60, >60) were presented for the former, and five possible answers (≤40, 40.1–44, 44.1–48, 48.1–52, >52) were presented for the latter. In addition, the respondents were allowed to enter their working hours in person. Responses to each question were grouped by the time of analysis.

Statistical methods

In order to compare the characteristics of the case and control groups, chi-square tests and *t*-tests were used for categorized variables and continuous variables, respectively. A multivariate logistic regression analysis was conducted with CVDs as the dependent variable and short-term and long-term working hours as the independent variable. In the case of short-term working hours, the group working 40.1–50 hours was used as a reference, and in the case of long-term working hours, the group working 40.1–48 hours was used as a reference. Level of education, hypertension, diabetes, exercise, BMI, smoking and level of alcohol intake were used as covariates. Variables used for matching (age, gender and type of occupation) were not included in the multivariate logistic regression model. All statistical tests were two-tailed, and *p*-values of less than 0.05 were regarded as statistically significant. All statistical analyses were conducted with the SAS software package version 9.2 (SAS Institute, Cary, NC, USA).

Results

General characteristics

The general characteristics of the case group and the control group are shown in Table 1. The average ages in the case group and control group were 49.8 (± 8.3) and 49.5 (± 7.9) years, respectively. The proportion of current smokers was higher in the case group, and the proportions of participants diagnosed with hypertension and diabetes were also higher in the case group. However, no significant differences were found between the two groups regarding education level, alcohol consumption and obesity.

Working hours

Table 2 shows the distributions of short-term and long-term weekly working hours for the case and control groups. For short-term working hours, a majority of the 106 participants (30.5%) worked more than 60 hours. In the control group, a majority of the participants (401, 52.2%) worked 40.1–50 hours. For long-term working hours, a majority of the participants in the case group (48.1%) worked more than 52 hours; however, in the control group, the majority (45.9%) worked 40.1–48 hours.

Risk factors affecting cardiovascular diseases

The results of the multivariate logistic regression analysis showed that in the short term, the odds ratios (ORs) of CVD risk were 2.66 (95% CI: 1.78–3.99) for working 40 hours or less, 1.85 (95% CI: 1.22–2.81) for working 50.1–60 hours and 4.23 (95% CI: 2.81–6.39) for working more than 60 hours compared with the 40.1–50-hour working group. For long-term working hours, ORs were 2.90 (95% CI: 1.86–4.52) for working 40 hours or less, 1.73 (95% CI: 1.03–2.90) for working 48.1–52 hours, and 3.46 (95% CI: 2.38–5.03) for working more than 52 hours compared with the 40.1–48-hour working group. In both the short-term and long-term analyses, the ORs for each group were significantly increased. For long working hours, as working hours increased, ORs also increased in a linear manner. For short working hours, ORs were also significantly increased both in the short term and long term (Table 2).

Table 3 shows a comparison of cases versus controls based on disease type. For short-term work-

Table 1. General characteristics of the study subjects

	Case (n=348)	Control (n=769)	*p* value[a]
	%	%	
Age (years)	49.8 ± 8.3[b]	49.5 ± 7.9[b]	0.515
Gender (male)	82.8	82.8	1.000
Job (blue collar)	74.7	74.1	0.892
Education (>12 years)	30.7	35.0	0.185
Smoking status (current)	56.4	40.9	<0.001
Alcohol intake (heavy)	15.9	12.0	0.098
Exercise (yes)	23.7	63.0	<0.001
Overweight or obese	34.4	30.8	0.269
Hypertension	35.3	30.8	0.006
Diabetes	15.9	8.3	<0.001

[a] Chi-square test for categorical variables and *t*-test for a continuous variable; [b] Mean ± SD. SD, Standard deviation. Heavy alcohol intake: alcohol intake of greater than 40 g per day for men, 20 g per day for women. Exercise: regular exercise during leisure time. Overweight or obese: body mass index of equal or greater than 25 kg/m^2. Hypertension, diabetes: lifetime hypertension and diabetes diagnosed by a physician.

Table 2. Odds ratios for cardiovascular disease in relation to working hours

	Case	Control	Crude	Adjusted[a]
	n (%)	n (%)	OR (95% CI)	OR (95% CI)
Short-term working hours[b]				
40 h or less	81 (23.3)	130 (16.9)	2.69 (1.88–3.84)	2.66 (1.78–3.99)
40.1–50 h	93 (26.7)	401 (52.2)	1.00	1.00
50.1–60 h	68 (19.5)	145 (18.9)	2.02 (1.40–2.92)	1.85 (1.22–2.81)
More than 60 h	106 (30.5)	93 (12.1)	4.92 (3.43–7.03)	4.23 (2.81–6.39)
Long-term working hours[c]				
40 h or less	68 (19.9)	112 (14.6)	3.06 (2.06–4.55)	2.90 (1.86–4.52)
40.1–48 h	70 (20.5)	353 (45.9)	1.00	1.00
48.1–52 h	39 (11.4)	102 (13.3)	1.93 (1.23–3.02)	1.73 (1.03–2.90)
More than 52 h	164 (48.1)	202 (26.3)	4.09 (2.95–5.69)	3.46 (2.38–5.03)

[a] Multiple logistic regression analysis. Adjusted for level of education, current smoking, level of alcohol intake, exercise, body mass index, hypertension and diabetes. [b] Working hours of the previous week. [c] The average weekly working hours for the past three months. OR, odds ratio; 95% CI, 95% confidence interval.

ing hours, the ORs of acute myocardial infarction and cerebral infarction were significantly higher across all groups, and they increased with working hours for those working more than 50 hours. For subarachnoid hemorrhage and intracerebral hemorrhage, ORs were significantly higher for those working more than 60 hours, but the relationship was not significant for those working 40 hours or less and those working 50.1–60 hours. For the long-term working hours, the ORs of acute myocardial infarction, intracerebral hemorrhage and cerebral infarction were significantly increased in the group working 40 hours or less or more than 52 hours. However, the risk of subarachnoid hemorrhage was not significantly correlated with long-term working hours.

Discussion

This study was a case-control study that investigated the relationship between working hours and the risk of CVDs in Korean workers. In order to examine the long-term and short-term effects of participants' working hours on CVD risk, working hours

Table 3. Odds ratios for specific diseases in relation to working hours

	AMI (n=99)	SAH (n=57)	ICH (n=69)	CI (n=123)
	OR[a] (95% CI)	OR[a] (95% CI)	OR[a] (95% CI)	OR[a] (95% CI)
Short-term working hours[b]				
40 h or less	4.54 (2.39–8.63)	2.15 (0.96–4.82)	1.66 (0.76–3.64)	2.46 (1.24–4.88)
40.1–50 h	1.00	1.00	1.00	1.00
50.1–60 h	2.11 (1.03–4.33)	1.19 (0.49–2.89)	1.73 (0.81–3.69)	2.40 (1.25–4.60)
More than 60 h	4.50 (2.23–9.08)	2.84 (1.26–6.41)	2.74 (1.30–5.79)	6.10 (3.33–11.2)
Long-term working hours[c]				
40 h or less	4.25 (2.15–8.40)	0.95 (0.35–2.61)	2.96 (1.19–7.41)	3.49 (1.64–7.40)
40.1–48 h	1.00	1.00	1.00	1.00
48.1–52 h	0.96 (0.36–2.57)	1.43 (0.54–3.76)	1.88 (0.65–5.49)	2.78 (1.25–6.17)
More than 52 h	3.29 (1.76–6.17)	1.55 (0.77–3.13)	4.18 (1.95–8.98)	5.17 (2.78–9.63)

[a] Multiple logistic regression analysis. Adjusted for age, gender, type of occupation, level of education, current smoking, level of alcohol intake, exercise, body mass index, hypertension and diabetes. [b] Working hours of the previous week. [c] The average weekly working hours for the past three months. AMI, acute myocardial infarction; SAH, subarachnoid hemorrhage; ICH, intracerebral hemorrhage; CI, cerebral infarction.

of the previous week and average weekly working hours of the past three months were used. Even after adjusting for conventional risk factors such as hypertension, diabetes, smoking and exercise, for short-term working hours, the OR was 1.85 for those working 50.1–60 hours, which increased to 4.23 when working more than 60 hours compared with the 40.1–50-hour working group. For long-term working hours, the OR was 1.73 when working 48.1–52 hours, which increased to 3.46 when working more than 52 hours compared with the 40.1–48-hour working group. Furthermore, even for those working 40 hours or less, the ORs were 2.66 and 2.90 for the short and long terms, respectively.

In the Whitehall II cohort study, 3–4 hours of overtime work a day (working 55–60 hours a week) was associated with a hazard ratio of 1.9 (95% CI: 1.17–3.06) for incident coronary death and nonfatal myocardial infarction compared with those not working overtime, after adjusting for sociodemographic factors and conventional risk factors[10]. This result is similar to our findings for the group of working 50.1–60 hours in the short-term and 48.1–52 hours in the long-term. In a case-control study from Japan, working 7–9 hours a day (35–45 hours a week) was used as the reference versus working less than 7 hours or more than 11 hours per day. The ORs for the risk of acute myocardial infarction were 2.83 (95% CI: 1.52–5.28) when working less than 7 hours a day (working less than 35 hours a week) and 2.94 (95% CI: 1.39–6.25) when working more than 11 hours a day (working 55 hours a week) after adjusting for other risk factors, and these results are similar to those found in the present study[18].

The mechanisms by which long working hours increase the risk of CVD have been explained previously in detail. One possible explanation is that the risk of CVD increases when working long hours because sleep duration decreases, and therefore time for recovery also decreases, creating poor lifestyle habits[19]. Another possible mechanism is that long working hours increase job-related stress[20]. This is supported by other studies that have described the impact of sleep deficiency and poor recovery on the risk of acute myocardial infarction[9, 21, 22] and on the occurrence of stroke[23].

In the present study, both excessive working hours and short working hours showed higher odds ratios for CVDs. One possible explanation for this is that participants included in the group working 40 hours or less had reduced their working hours due to poor health, which would cause additional stress and possibly accelerate the occurrence of CVDs. Another possible explanation is the presence of psychological stress due to job insecurity or lower socioeconomic status in the group working 40 hours or less, because most regular workers work more than 40 hours a week and most workers in Korea working 40 hours or less are non-regular workers. Therefore, we found a U-shaped relationship between working hours and the risk of CVDs, which converges with findings from a previous study[18].

In the analysis stratified by disease, each disease showed different odds ratios. Since the mechanism of each disease is different, the risk-factor profile differs as well[24]. Most cases of subarachnoid hemorrhage, unlike other CVDs, are caused by rupture of an intracranial aneurysm. One study found no association

between job-related stress and subarachnoid hemorrhage[25, 26].

Previous studies investigating the impact of long working hours on health used time standards for normal working hours and long working hours that differed from those used in this study. A cohort study conducted in the UK defined long working hours as working 55–60 hours a week, and studies in Japan defined long working hours as working more than 55 hours or working 61 hours or more[6, 9, 18]. Another study defined long working hours as working 45 hours or more a week[27]. However, in this study targeting Korean workers, the proportion of workers who worked more than 60 hours a week was higher than in other studies. Therefore, in the studies that define long working hours as working a relatively short period time, the risk of working 60 hours or more a week could be underrated. It is believed that in countries with extremely long working hours, such as South Korea, more attention should be paid to the regulation of working hours.

This study included cerebrovascular diseases as well as acute myocardial infarction, which was the main subject of previous studies. One strength of our study is that we conducted a disease-specific analysis, which found differing odds ratio across types of disease. However, this study has several limitations. First, there is a possibility of bias regarding working hours. In the case of short-term working hours, the possibility of recall bias is low; however, in the case of long-term working hours, possible recall bias could have impacted our results. Information bias is also possible, as some participants in the case group may have overreported their working hours. In order to reduce information bias, participants in the case group were told that the survey was not related to compensation; however, the possibility of information bias cannot be fully excluded. Second, there is a possibility of selection bias arising from the characteristics of the nonparticipants. In order to minimize bias, cases and controls were matched based on their age, gender, type of occupation, and region, which are factors that can influence results. The effect due to selection bias may not be significant, because the proportion of control participants working long hours did not differ greatly from nationally representative data. The proportions of workers who worked more than 48 hours per week were 37 and 42.4% based on the Korean Working Conditions Surveys of 2006 and 2010, respectively, and 29.5% worked more than 52 hours according to the fourth Korean National Health and Nutrition Examination Survey (2007–2009)[28, 29]. In this study, the proportions of controls who worked more than 48 hours or 52 hours was 39.9 and 26.3%, respectively. Third, the risk of CVDs was higher in the group working 40 hours or less. This may be because workers with a high risk may have already shortened their working hours; however, such an effect may not be large, as CVDs occur abruptly and risk factors for CVDs are not usually factors that limit working hours. Lastly, information about participants in this study was obtained only via questionnaire. However, this study used the ICD-10 codes for the diagnosis of all CVDs, which was done as accurately as possible.

In conclusion, this case-control study found that working hours beyond the normal recommendation is a risk factor for CVDs that is independent of other risk factors. We also found that short working hours were also associated with an increased risk of CVDs. Furthermore, the degree of risk differed according to the subtype of CVD. More prospective studies regarding the association of working hours with each type of CVD are required.

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