Annals of Epidemiology 33 (2019) 64–71

Contents lists available at ScienceDirect

Annals of Epidemiology

Original article

Hours of work and health in Japan

Shohei Okamoto, MA, MMSc *

Graduate School of Economics, Keio University, Tokyo, Japan

ARTICLE INFO

Article history:
Received 13 May 2018
Accepted 2 February 2019
Available online 13 February 2019

Keywords:
Work stress
Health behavior
Health outcome
Socioeconomic
Hours of work
Occupational health

ABSTRACT

Purpose: This article aimed to examine the causal relationships of hours of work with health behaviors and health outcomes.
Method: The data were derived from Japan Household Panel Survey/Keio Household Panel Survey. In total, data from 2677 men and 2170 women were analyzed to show the effects of hours of work on body mass index, smoking, and sleeping hours. To deal with the potential endogeneity of decisions about hours of work, the instrumental variable approach was used.
Results: Hours of work had a negative impact on hours of sleep among men (coefficient [coef.], −0.371; 95% confidence interval [CI], −0.519 to −0.223). Longer hours of work also increased the probability of men being obese (coef., 1.108; 95% CI, 0.234−1.981) and the number of cigarettes they smoked each day (coef., 1.007; 95% CI, 0.037−1.978). For women, longer hours of work increased the probability of being obese (coef., 0.029; 95% CI, 0.009−0.050) and decreased the hours of sleep (coef., −0.416; 95% CI, −0.618 to −0.214).
Conclusions: This article suggests that the health consequences of long hours of work include health behaviors and health outcomes that can lead to higher risks of morbidity and mortality.

Introduction

Long hours of work in Japan

In Japan, working long hours is a serious social issue because there are many problems associated with it, for example, *karoshi* or death from overwork, and mental or physical illnesses including suicide [1]. International comparisons indicate that Japanese workers work longer hours than those in many other countries [2]. Figure 1 shows the proportion of working 49 hours or more per week around the world. In 2015, around 30% of men and 10% of women in Japan worked long hours. As the proportion of part-time workers who have relatively shorter hours of work than that of full-time workers varies, it is difficult to compare hours of work internationally. However, long hours of work were more frequently observed in Japan, whereas the proportion of part-time workers was high. In the last 2 decades, total hours of work in the whole workforce have decreased, but this is a result of the increasing proportion of part-time workers with relatively short hours of work (Fig. 2). The Ministry of Health, Labor and Welfare in Japan publishes the white paper on the topic related to karoshi [1]. There were 840 applications (including 283 deaths) for compensation for industrial accidents due to cerebral and cardiovascular diseases, and 253 (including 92 deaths) were recognized as industrial accidents in 2017. Besides, 1732 (including 221 suicides or attempted suicides) applications were made as industrial accidents due to mental issues, and 506 (including 98 suicides or attempted suicides) were recognized.

In the Labor Standards Act in Japan, statutory hours of work must not be beyond 8 hours per day and 40 hours per week in principle [2,6]. If the notification of agreement on overtime and holiday work between the employer and employees/union, which is called “the 36 Agreement,” is submitted, workers can work longer than these statutory hours of work with extra wage for overtime work. Although the criterion to limit hours of overtime work has been noticed by the governmental minister, there is no punishment for work beyond the criterion and no upper limit for overtime work hours even when the 36 agreement has been made with special clauses regarding necessary overtime work. New

Ethics: Ethical approval was not required because this study used only secondary analysis. The data for this secondary analysis, “the Japan Household Panel Survey and the Keio Household Panel Survey,” were provided by Keio University.

Conflict of interest: The author declares no conflicts of interest associated with this article.

* Corresponding author. Graduate School of Economics, Keio University, 2-15-45 Mita, Minato-ku, Tokyo, Japan. Tel.: +81-45-566-1497; fax: +81-45-566-1487.
E-mail address: shohei@z2.keio.jp.

https://doi.org/10.1016/j.annepidem.2019.02.003
1047-2797/

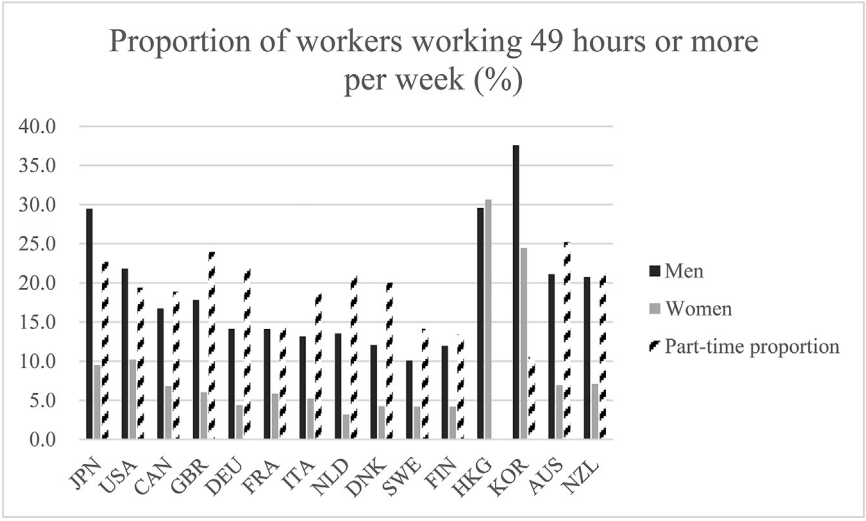

Fig. 1. Proportion of workers working 49 hours or more per week, and part-time employment (%) Created by the author using statistics published by the Japan Institute for Labor Policy and Training and OECD [3,4]. Data from 2015 except USA (2012) and AUS (2014). The proportion of part-time employment in Hong Kong was not available.

legislation that legally decides the upper limit of overtime hours of work with punishment is to be enforced for large enterprises in April 2019 and for small and medium enterprises in April 2020: overtime work within 45 hours per month and 360 hours per year in principle, within 720 hours per year, within 100 hours per month, and within 80 hours per month averagely in special case [6].

Labor economics incentives and sociological reasons affect the existence of long hours of work in the traditional Japanese-style employment practice, which comprises the bulk hiring of new graduates, promotion by seniority, and lifetime employment [7]. In practice, inputs of employees expressed by hours of work and the length of service for the commitment and loyalty to employer rather than outputs tend to be assessed. According to a survey by the Cabinet Office in Japan [8], most Japanese workers associate overtime work with positive opinions, such that they work hard and have a strong sense of responsibility. Besides, the author points out that overtime work arises due to "social overtime work," making workers feel sorry to leave their workplace, leaving their colleagues and boss working. Furthermore, most of the Japanese workers are hired as "generalist" whose job description is vague, and they have heavy workload as they have to play various roles at their workplace, including providing on-the-job-training education for their subordinates. The author also indicates that the stereotype might result in long hours of work particularly for men because it is assumed that masculinity results from performing hard work in the outside world for their family.

Thus, there are histories of long hours of work in Japan, and regulations to protect workers are not sufficient. It is therefore important to take action to reduce long hours of work and prevent potential health problems by expanding literature about Japanese cases. One previous study used a Japanese sample [9], but all participants were employees of one company, which may have affected the external validity. It might be also advisable for East Asian regions, such as South Korea and Hong Kong, where workers have long hours of work (Fig. 1), to make international comparisons and have implications on the current topic.

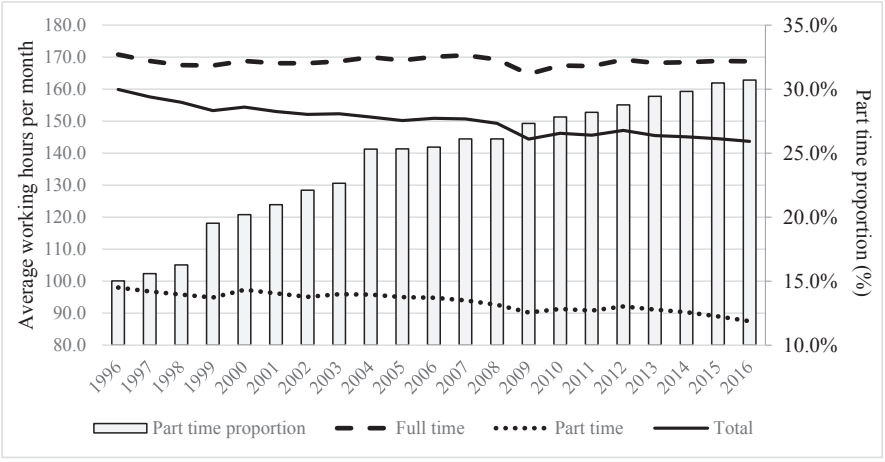

Fig. 2. Average hours worked per month among Japanese workers Created by the author using data from the Japanese Ministry of Health, Labor, and Welfare: Monthly Labor Survey [5]. The method for sampling has been changed since 2004, and results might not be adjusted by appropriately sampling weights. Thus, the interpretation of this figure requires caution.

Related literature and methodological challenges

There have been a number of studies on long hours of work and health in the fields of epidemiology and occupational health. Long hours of work can induce fatigue, brain and heart diseases, and mental illness through increases in workload and distress and decreases in time for recovery from fatigue [10–15]. A classical model of human capital implies that allocating more time for work decreases the available time to maintain health [16]. A few studies have examined the causal relationships between long hours of work and health [9,17–19], but most of those in epidemiology and occupational health have failed to do so. Potential endogeneity caused by the simultaneous equation bias is a methodological challenge because health and labor supply are interdependent, being expressed as a "healthy worker effect" particularly in case where labor supply is affected by their health [20]. Endogeneity and unobserved heterogeneity, which have similar effects to the confounding factors, are rarely addressed in epidemiological and occupational studies, while that is one of the most important concerns in econometric studies, utilizing methods, such as panel data analysis and instrumental variable estimation [21,22]. Thus, many epidemiological and occupational studies fail to identify the causal relationships between long hours of work and health.

It is meaningful to investigate both onset of diseases and health behaviors and health outcome, for example, obesity, smoking, and sleeping hours, in relation to hours of work because diseases such as cancer and cardiovascular diseases that are induced by health behavior, and some health outcomes are likely to occur later in life, including after retirement [23,24]. Some studies have found no clear association between long hours of work and health behavior and health outcomes (i.e. smoking, obesity, alcohol consumption, and exercise) except for reduced sleep, although there were some correlations [11,25,26]. Others have found that long hours of work were associated with poorer lifestyles [9,18,27,28]. Obesity is associated with higher risks of diabetes, vascular disease (i.e. high blood pressure and high cholesterol), and dementia [29–31]. Although the prevalence of obesity in Japan is the lowest among The Organisation for Economic Co-operation and Development (OECD) countries [32], a previous literature reports that the prevalence of overweight and obesity among a sample of 65,095 middle-aged Japanese men and women has increased during the 10-year follow-up [33]. Smoking induces many diseases, such as chronic obstructive pulmonary disease, cardiovascular disease, and lung cancer [34,35]. It is estimated that cigarette smoking is one of the largest mortalities attributable to the preventable risk factors for noncommunicable diseases in Japan [36]. Sleep disturbance is associated with increased risk of depression and cardiovascular and cerebrovascular diseases [37–39]. A report shows that Japanese spend one of their least times on sleeping in the OECD countries [40]. Thus, these health behaviors and health outcomes need to be targeted on to reduce the future incidences of associated diseases [19–24].

This study therefore aimed to verify the causal relationship between hours of work and health behaviors and health outcomes in Japan by using an econometric model. This study is expected to contribute to the literature in two ways. First, the causal relationship between hours of work and health behaviors has not been well investigated by the fields of epidemiology and occupational health because most studies in epidemiology and occupational health have not attempted to overcome the empirical challenges of causal inference. Second, this study used a representative sample of the Japanese population. As mentioned earlier, long hours of work is a serious issue in Japan, and differences in the effects of long hours of work on health behavior and health outcomes may be observed [11].

Study population and method

Data

Data were drawn from the Japan Household Panel Survey (JHPS) and the Keio Household Panel Survey (KHPS) conducted by Keio University in Japan annually. KHPS started in 2004 with a sample of 4000 Japanese men and women aged 20–69 years, dropping to 1400 people in 2007 and 1000 in 2012, and data from 14 waves (most recently 2017) are available. JHPS began in 2009 with a sample of 4000 Japanese men and women aged 20 years and over, and data from nine waves (to 2017) are available. Respondents were selected by stratified two-stage random sampling from areas across Japan. Both surveys include a wide range of questions, aiming to investigate various social, economic, and health issues.

Outcomes related to health behavior

JHPS and KHPS contain various items related to respondents' health. This study analyzed health outcomes related to health behaviors and health outcomes that increase the risks of future morbidity and mortality to detect the effect of hours of work, which was already mentioned earlier. The variables used were body mass index (BMI), smoking, and hours of sleep (self-reported). BMI was calculated as body weight (in kilograms) divided by the square of body height (in meters). Not all waves asked about height, so information from a previous or later wave was used where necessary. Obesity (BMI $\geq$ 30.0 kg per m^2) was set as a binary outcome. Smoking was measured in two ways: whether respondents smoked or not and the number of cigarettes smoked per day. Respondents were asked to estimate their hours of sleep.

Estimation and identification strategy

To analyze the effect of hours of work on health, the following model (1) was used:

$$y_{it} = \alpha\, Hours\ of\ Work_{it} + \beta X_{it} + \mu_i + \varepsilon_{it},\ i = 1, \ldots, N,\quad t = 1, \ldots T_i \tag{1}$$

where y_{it} denotes health outcomes for individual i in survey wave t (unbalanced panel). *Hours of Work* is defined as the average hours of work per week for respondents in paid work. This was obtained in each wave by asking the following: "On average, how long do you work each week, including overtime?" Those who were not in paid work were excluded from the analyses because the reason for not working might be health related. Those who worked on average more than 18 hours per day were also excluded in case they were misreporting their situation (thus, $0 < Hours\ of\ Work_{it} < 126$) [9]. X_{it} is a vector of control variables that affect health outcomes, which were used for the previous work: respondents' age, marital status, home ownership, and living in a large city [19]. Marital status was a binary variable with a value of one if a respondent was married. Home ownership was also a binary variable, taking a value of one for respondents owning their own house. Living in a large city was given a value of one for respondents living in a city with a population of more than 50,000 or in particular districts in Tokyo. μ_i is an individual time invariant fixed effect (e.g. educational attainment, the number of children), and ε_{it} is an error term.

There is potential endogeneity between hours of work and health because workers might reduce their hours of work if they have any problem with their health. The instrumental variable approach was used for causal inference, finding a variable correlated with hours of work but not related to respondents' health

outcomes. The following model (2) is assumed to explain the respondents' hours of work:

$$Hours\ of\ Work_{it} = \gamma \frac{\sum Hours\ of\ Work_{Industry,\ Full,t} - Hours\ of\ Work_{it}}{N_{Industry,\ Full,\ t} - 1} + \delta X_{it} + e_{it} \quad (2)$$

where $Hours\ of\ Work_{Industry,\ Full,t}$ denotes average hours of work for the respondents, by employment pattern (full- or part-time), and industry defined using similar categorization to the International Standard Industrial Classification of All Economic Activities. $N_{Industry,\ Full,\ t}$ denotes the sample size by industry and employment status. Thus, the instrument variable indicates the average hours of work by employment pattern and industry excluding a respondent himself/herself. The variable is suitable to represent hours of work for a respondent because employment status (full- or part-time) affects hours of work [41]. Industry can also affect hours of work because working style can vary across industries and sectors [41]. X_{it} includes the same control variables as in Equation (1).

The instrumental variable estimation was carried out separately for men and women. Those aged 60 years and over were excluded because around 80% of enterprises in Japan set 60 years as the retirement age, although some people continue to work after this age [42]. The final numbers of sample sizes are 8471 person-year (2677 individuals) for men and 6613 person-year (2170 individuals) for women. Another estimation with the lagged independent variable was used to check whether hours of work have any time-lagged effects on health behaviors because the effects of hours of work on health might not appear immediately. The endogeneity of hours of work and health can be a problem, but some studies have suggested that hours of work may be exogenous because employees cannot always choose how long they work [9,43]. This study evaluated whether hours of work can be regarded as exogenous using the Durbin–Wu–Hausman test. All analyses used Stata version 15.1. Table 1 shows the descriptive statistics of outcomes and independent variables.

Results

Table 2 shows the results of the first stage estimation, which indicates that the instrument is relevant to hours of work [11,44]. Table 3 shows the results of the second stage analysis. Endogeneity needs to be considered for BMI and being obese for men according to the results of the Durbin–Wu–Hausman test. For these outcomes, results from the instrumental variable approach are more reliable than those using standard ordinary least squares method [45].

Table 2
Results of the first stage analysis[†]

Variables	Men	Women
Mean hours of work	0.215**	0.192**
	(0.125 to 0.305)	(0.089 to 0.294)
Age	0.219**	−0.313**
	(0.079 to 0.358)	(−0.450 to −0.175)
Married	−4.556**	2.254
	(−7.174 to −1.937)	(−1.184 to 5.691)
House ownership	−4.641**	−1.329
	(−7.557 to −1.725)	(−3.692 to 1.033)
Living in a large city	4.499	−2.315
	(−0.511 to 9.508)	(−5.868 to 1.238)
Constant	20.618**	52.549**
	(12.748 to 28.488)	(44.599 to 60.500)
Observations	8471	6613
Number of individuals	2677	2170
Weak identification test: F-value	16.45	26.61

**$P < .01$, *$P < .05$.
[†] Numbers are coefficients with 95% confidence intervals obtained by using robust standard errors in parentheses.

Causal impacts of hours of work on health behaviors and health outcomes were observed as follows. For men, hours of work had a negative impact on hours of sleep (coefficient [coef.], −0.371; 95% confidence intervals [CI], −0.519 to −0.223). Longer hours of work increased the probability of being obese (coef., 1.108; 95% CI, 0.234–1.981) and the number of cigarettes smoked each day (coef., 1.007; 95% CI, 0.037–1.978). For women, longer hours of work increased the probability of being obese (coef., 0.029; 95% CI, 0.009–0.050) and sleeping less (coef., −0.416; 95% CI, −0.618 to −0.214).

Lagged model for hours of work

As the effects of hours of work on health might not appear immediately, the estimations were also carried out with a lagged variable for hours of work in the previous year. Endogeneity needed to be considered for obesity in men and hours of sleep for women (Table 4). The only significant finding was that men who had worked longer hours the previous year were likely to sleep less (coef., −0.168; 95% CI, −0.317 to −0.018). No other outcomes for men or women were linked to hours of work in the previous year.

Discussion

This study aimed to verify the causal relationship of hours of work with health behaviors and health outcomes in Japan by using an econometric model. The analyses using the instrumental

Table 1
Descriptive statistics

Variables	Men ($n = 8471$)		Women ($n = 6613$)	
	Mean	Std. Dev.	Mean	Std. Dev.
BMI	26.31	5.12	21.22	4.01
Obesity	0.21	0.41	0.03	0.17
Smoke or not	0.39	0.49	0.15	0.36
The number of cigarettes smoked per day	7.42	10.81	2.02	5.57
Hours of sleep	6.35	1.06	6.27	1.02
Hours of work (per week)	47.04	15.99	31.60	16.37
Instrument (mean hours of work by industry and employment status)	41.57	6.97	33.95	7.66
Age	43.71	9.61	43.62	9.70
Married	0.76	0.43	0.71	0.46
House ownership	0.77	0.42	0.77	0.42
Living in a large city	0.22	0.41	0.21	0.41

Table 3
Results of estimation[†]

Variables	BMI		Obesity		Smoke dummy		Smoking amount		Sleeping hours	
	FE	FE + IV	FE	FE + IV	FE	FE + IV	FE	FE + IV	FE	FE + IV
Men										
Hours of work/100	0.115 (−0.247 to 0.478)	5.301 (−0.311 to 10.912)	−0.022 (−0.061 to 0.017)	1.108* (0.234 to 1.981)	0.021 (−0.027 to 0.069)	−0.117 (−0.845 to 0.611)	1.007* (0.037 to 1.978)	−4.757 (−22.412 to 12.898)	−0.371** (−0.519 to −0.223)	−2.43 (−4.952 to 0.092)
Age	0.249** (0.217 to 0.282)	0.266** (0.237 to 0.296)	0.014** (0.011 to 0.017)	0.018** (0.014 to 0.022)	−0.013** (−0.017 to −0.010)	−0.014** (−0.017 to −0.011)	−0.342** (−0.413 to −0.272)	−0.362** (−0.444 to −0.280)	−0.008* (−0.016 to −0.001)	−0.015** (−0.026 to −0.004)
Married	0.385 (−0.224 to 0.994)	0.255 (−0.249 to 0.758)	−0.008 (−0.070 to 0.055)	−0.036 (−0.096 to 0.024)	0.006 (−0.055 to 0.068)	0.010 (−0.039 to 0.059)	0.991 (−0.219 to 2.201)	1.136* (0.044 to 2.228)	0.101 (−0.069 to 0.271)	0.152 (−0.016 to 0.320)
House ownership	0.039 (−0.341 to 0.420)	0.115 (−0.200 to 0.431)	0.025 (−0.014 to 0.064)	0.042* (0.000 to 0.083)	−0.019 (−0.071 to 0.032)	−0.021 (−0.064 to 0.021)	−0.168 (−1.144 to 0.808)	−0.252 (−1.044 to 0.539)	−0.065 (−0.182 to 0.053)	−0.095 (−0.215 to 0.026)
Living in a large city	0.864** (0.289 to 1.439)	0.987** (0.522 to 1.453)	0.036 (−0.034 to 0.106)	0.063 (−0.002 to 0.129)	0.020 (−0.035 to 0.075)	0.017 (−0.030 to 0.063)	0.221 (−1.069 to 1.510)	0.083 (−0.924 to 1.090)	0.020 (−0.161 to 0.201)	−0.029 (−0.218 to 0.160)
Constant	14.858** (13.421 to 16.295)	11.671** (7.225 to 16.117)	−0.416** (−0.559 to −0.274)	−1.111** (−1.732 to −0.490)	0.980** (0.835 to 1.125)	1.065** (0.592 to 1.538)	21.246** (18.232 to 24.259)	24.788** (12.021 to 37.556)	6.862** (6.513 to 7.211)	8.127** (6.476 to 9.779)
Endogeneity test	$P = .0471$*		$P = .0025$**		$P = .7082$		$P = .5153$		$P = .0851$	
Observations	8471									
Number of id	2677									
Women										
Hours of work/100	0.129 (−0.301 to 0.558)	−1.236 (−5.781 to 3.309)	0.029** (0.009 to 0.050)	−0.014 (−0.284 to 0.255)	0.005 (−0.032 to 0.041)	0.198 (−0.230 to 0.626)	0.137 (−0.508 to 0.782)	3.190 (−4.022 to 10.402)	−0.416** (−0.618 to −0.214)	−2.558* (−4.974 to −0.142)
Age	−0.032* (−0.062 to −0.001)	−0.029* (−0.053 to −0.005)	0.001 (−0.001 to 0.002)	0.001 (−0.000 to 0.002)	−0.004** (−0.007 to −0.002)	−0.005** (−0.007 to −0.003)	−0.067** (−0.105 to −0.029)	−0.073** (−0.106 to −0.041)	−0.015** (−0.023 to −0.006)	−0.011* (−0.019 to −0.002)
Married	0.543* (0.093 to 0.992)	0.479* (0.093 to 0.865)	0.004 (−0.002 to 0.009)	0.002 (−0.011 to 0.014)	−0.028 (−0.075 to 0.020)	−0.019 (−0.058 to 0.021)	−0.411 (−1.354 to 0.532)	−0.269 (−0.989 to 0.451)	−0.003 (−0.185 to 0.179)	−0.103 (−0.303 to 0.097)
House ownership	0.494* (0.057 to 0.931)	0.429* (0.044 to 0.815)	−0.009 (−0.020 to 0.002)	−0.011 (−0.030 to 0.009)	−0.016 (−0.059 to 0.027)	−0.007 (−0.049 to 0.035)	−0.567 (−1.385 to 0.251)	−0.422 (−1.173 to 0.330)	0.121 (−0.046 to 0.289)	0.019 (−0.170 to 0.209)
Living in a large city	−0.319 (−1.135 to 0.497)	−0.258 (−0.863 to 0.348)	−0.005* (−0.011 to −0.000)	−0.004 (−0.016 to 0.009)	0.030 (−0.005 to 0.066)	0.022 (−0.015 to 0.058)	0.633* (0.118 to 1.148)	0.496 (−0.056 to 1.047)	0.107 (−0.124 to 0.338)	0.203 (−0.055 to 0.462)
Constant	21.860** (20.544 to 23.176)	22.251** (20.443 to 24.059)	−0.002 (−0.061 to 0.057)	0.011 (−0.094 to 0.115)	0.361** (0.250 to 0.472)	0.306** (0.148 to 0.464)	5.505** (3.617 to 7.393)	4.629** (1.970 to 7.288)	6.940** (6.533 to 7.346)	7.554** (6.646 to 8.462)
Endogeneity test	$P = .5488$		$P = .7503$		$P = .3625$		$P = .3957$		$P = .0618$	
Observations	6613									
Number of id	2170									

**$P < .01$, *$P < .05$.
[†] Numbers are coefficients with 95% confidence intervals obtained by using robust standard errors in parentheses.

Table 4
Results of estimation: Lagged model for hours of work[†]

Variables	BMI		Obesity		Smoke dummy		Smoking amount		Sleeping hours	
	FE	FE + IV	FE	FE + IV	FE	FE + IV	FE	FE + IV	FE	FE + IV
Men										
Hours of work/100	0.066 (−0.286 to 0.418)	60.537 (−229.902 to 350.976)	−0.000 (−0.037 to 0.037)	7.939 (−30.210 to 46.088)	0.005 (−0.040 to 0.049)	1.649 (−8.723 to 12.020)	0.330 (−0.663 to 1.323)	−20.628 (−193.598 to 152.342)	−0.168* (−0.317 to −0.018)	−21.122 (−121.049 to 78.806)
Age	0.256** (0.223 to 0.290)	0.485 (−0.611 to 1.580)	0.014** (0.011 to 0.017)	0.044 (−0.100 to 0.188)	−0.014** (−0.018 to −0.011)	−0.008 (−0.047 to 0.031)	−0.363** (−0.437 to −0.290)	−0.441 (−1.100 to 0.217)	−0.009* (−0.017 to −0.002)	−0.089 (−0.465 to 0.288)
Married	0.506 (−0.077 to 1.089)	−2.658 (−17.687 to 12.372)	0.009 (−0.052 to 0.069)	−0.400 (−2.373 to 1.574)	0.012 (−0.051 to 0.075)	−0.072 (−0.611 to 0.467)	1.310* (0.071 to 2.549)	2.556 (−6.492 to 11.603)	0.068 (−0.115 to 0.252)	1.123 (−4.061 to 6.307)
House ownership	0.017 (−0.372 to 0.405)	0.322 (−1.770 to 2.414)	0.026 (−0.014 to 0.066)	0.060 (−0.215 to 0.336)	−0.024 (−0.078 to 0.030)	−0.013 (−0.094 to 0.068)	−0.163 (−1.183 to 0.856)	−0.226 (−1.569 to 1.118)	−0.033 (−0.154 to 0.088)	−0.142 (−0.869 to 0.585)
Living in a large city	0.972** (0.400 to 1.544)	1.938 (−2.726 to 6.603)	0.052 (−0.018 to 0.122)	0.167 (−0.449 to 0.783)	0.025 (−0.028 to 0.078)	0.065 (−0.105 to 0.235)	0.365 (−0.731 to 1.461)	0.357 (−2.499 to 3.213)	0.079 (−0.109 to 0.267)	−0.219 (−1.832 to 1.394)
Constant	14.479** (12.992 to 15.966)	−9.754 (−104.304 to 84.796)	−0.452** (−0.599 to −0.305)	−4.551 (−19.996 to 10.894)	1.020** (0.869 to 1.171)	−0.858 (−8.638 to 6.923)	22.162** (19.061 to 25.264)	10.306 (−67.817 to 88.429)	6.797** (6.427 to 7.167)	17.398 (−22.700 to 57.496)
Endogeneity test	$P = .0535$		$P = .0014^{**}$		$P = .4758$		$P = .4348$		$P = .2985$	
Observations	8006									
Number of id	2559									
Women										
Hours of work/100	0.368 (−0.101 to 0.837)	0.973 (−6.284 to 8.229)	−0.014 (−0.036 to 0.007)	−0.188 (−0.694 to 0.318)	0.007 (−0.028 to 0.043)	0.210 (−0.543 to 0.963)	−0.069 (−0.727 to 0.589)	−2.750 (−14.283 to 8.782)	−0.193 (−0.389 to 0.003)	−4.588 (−9.306 to 0.130)
Age	−0.032 (−0.066 to 0.002)	−0.033* (−0.061 to −0.005)	0.001 (−0.000 to 0.003)	0.001 (−0.000 to 0.003)	−0.004** (−0.007 to −0.002)	−0.005** (−0.007 to −0.002)	−0.068** (−0.109 to −0.026)	−0.069** (−0.109 to −0.029)	−0.011* (−0.020 to −0.002)	−0.004 (−0.016 to 0.008)
Married	0.631* (0.147 to 1.116)	0.652** (0.188 to 1.116)	0.002 (−0.004 to 0.008)	−0.005 (−0.025 to 0.016)	−0.023 (−0.069 to 0.023)	−0.011 (−0.063 to 0.042)	−0.360 (−1.314 to 0.594)	−0.053 (−0.953 to 0.847)	0.005 (−0.177 to 0.187)	−0.176 (−0.440 to 0.088)
House ownership	0.438 (−0.016 to 0.892)	0.451* (0.050 to 0.852)	−0.007 (−0.014 to 0.001)	−0.013 (−0.035 to 0.008)	−0.011 (−0.055 to 0.032)	−0.004 (−0.052 to 0.045)	−0.372 (−1.175 to 0.431)	−0.477 (−1.327 to 0.373)	0.142 (−0.029 to 0.313)	0.006 (−0.240 to 0.253)
Living in a large city	−0.255 (−1.122 to 0.612)	−0.288 (−0.905 to 0.329)	−0.004 (−0.010 to 0.001)	−0.006 (−0.015 to 0.004)	0.031 (−0.009 to 0.072)	0.036 (−0.009 to 0.082)	0.711* (0.122 to 1.299)	0.574 (−0.040 to 1.188)	0.069 (−0.195 to 0.332)	0.065 (−0.245 to 0.375)
Constant	21.753** (20.323 to 23.183)	22.474** (19.095 to 25.853)	−0.012 (−0.072 to 0.048)	0.034 (−0.162 to 0.231)	0.351** (0.242 to 0.460)	0.276 (−0.013 to 0.566)	5.346** (3.518 to 7.175)	5.820* (1.326 to 10.313)	6.662** (6.242 to 7.081)	8.676** (6.360 to 10.992)
Endogeneity test	$P = .9072$		$P = .8957$		$P = .6631$		$P = .9748$		$P = .0007^{**}$	
Observations	6000									
Number of id	2021									

$^{**}P < .01$, $^{*}P < .05$.
[†] Numbers are coefficients with 95% confidence intervals obtained by using robust standard errors in parentheses.

variable approach suggest that longer hours of work have a negative impact on health behaviors and health outcomes among men and women, resulting in more smoking for men and fewer hours of sleep and an increased probability of being obese for both men and women. Analyses using hours of work in the previous year, designed to capture potential lag effects on health, were largely not significant, and did not report the results of the basic models.

The results from the analyses are similar to the previous studies approaching causal relationships. A study using a Japanese sample from a specific company reported that longer hours of work increased the probability of being obese [9]. This study had the same result but used a more representative sample of Japanese people and panel data, allowing adjustment of time-invariant factors, such as educational attainment and the number of children. A study in Australia found a nonlinear relationship between hours of work and health measured by some items from the 36-Item Short Form Health Survey [19]. This study also found that longer hours of work resulted in poorer health in both men and women. A study in France on a new policy about hours of work reported that restricting hours of work reduced the probability of smoking [18].

There are few studies that have approached causal inference on the relationships between hours of work and health. This study has therefore added to the literature on this issue. Being obese, smoking more, and sleeping fewer hours may not immediately cause ill-health but being continuously exposed to these risk factors increases the risk in the longer term. Furthermore, as mentioned earlier, hours of work in Japan are likely to be longer than in many other countries. Only one previous study used a Japanese sample, and the generalizability of its results is unknown because all the participants were from a single company. Other studies have been conducted in Australia [19] and France [18], where hours of work were shorter than in Japan. In this study, the mean hours of work per week were 47.04 for men and 31.60 for women. In the study in the Japanese company, the average daily hours of work were 8.59, but men and women were not considered separately [9]. In the Australian study [21], the average hours per week were 28.05 for men and 16.44 for women [19]. In the French study, which only studied men and excluded anyone who worked less than 35 hours per week, the treated group worked 40.40 hours per week and the control group 42.25 hours, although this is not directly comparable because of the exclusions [18]. The relationships identified in this study were consistent with the Australian and French studies, although the Japanese groups worked longer hours.

There are several mechanisms that long hours of work decrease sleep and increase obesity and smoking. Working more hours reduces the time available for other activities, including recovery from fatigue and activities to maintain and improve health [16]. Long hours of work were observed to have a significant effect on sleep, and one reason might be that those who worked longer hours tended to consume more caffeine [27] and had less time to rest. Long hours of work may lead to weight gain and increased smoking by increasing stress because stress is associated with eating behavior and induced obesity [44,46,47]. Long hours of work may also delay meals and lead to late-night eating, which increases the probability of being obese and can also result in sleep disturbance [48,49]. Less time to invest in personal health, through activities such as exercise, can also result in obesity [48–50].

This research had some obvious limitations. First, previous research has suggested that there may be a nonlinear relationship between hours of work and health behaviors [19], but this was beyond the scope of this study. Further research is therefore needed on this. Second, this study examined the causal relationship of hours of work with health behavior and health outcomes. Future research should investigate whether health behaviors linked to hours of work increase the risk of associated diseases and mortality, with a longer follow-up until postretirement. Third, outcomes used in the study were obtained from self-reported questionnaire. Therefore, the interpretation of results requires caution as the accuracy of outcome measurement may not be sufficiently reliable.

In conclusion, this study suggests that hours of work have causal impacts on health behaviors and health outcomes, such as smoking, obesity, and time spent sleeping, among a sample in Japan. Long hours of work may therefore both cause ill-health directly and result in health behaviors that can lead to higher risks of morbidity and mortality in the future.

Acknowledgments

The author is grateful to Prof. Mauricio Avendano, Department of Global Health & Social Medicine, for his helpful comments and support. The author thanks the Panel Data Research Center at Keio University for providing the Japan Household Panel Survey and Keio Household Panel Survey.

Funding: This research is supported in part by “Doctorate Student Grant-in-Aid Program, Keio University,” and “the Keio Economic Society”.

References

[1] Ministry of Health, Labour and Welfare. White Paper on Prevention of Karoshi 2017. https://www.mhlw.go.jp/wp/hakusyo/karoushi/17/index.html. 2018. https://www.mhlw.go.jp/wp/hakusyo/karoushi/18/index.html. Japan
[2] The Japan Institute for Labour Policy and Training. Databook of International Labour Statistics. https://www.jil.go.jp/kokunai/statistics/databook/2018/documents/Databook.pdf; 2018 (in Japanese).
[3] The Japan Institute for Labour Policy and Training. Working hours and labor hours system. http://www.jil.go.jp/kokunai/statistics/databook/2018/ch6.html. [Accessed 18 January 2019] (in Japanese).
[4] OECD. Part-time employment rate (indicator). 2019. https://doi.org/10.1787/f2ad596c-en [Accessed 12 January 2019].
[5] Ministry of Health, Labour and Welfare. Monthly Labour Survey. https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00450071&tstat=000001011791&cycle=1&tclass1=000001035519&second2=1 [Accessed 18 January 2018].
[6] Ministry of Health Labor and Welfare. Law on legisration to promote work style reform. https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000148322_00001.html. [Accessed 18 January 2018] (in Japanese).
[7] Ono H. Why do the Japanese work long hours? Sociological Perspectives on Long Working Hours in Japan. Jpn J Labour Stud 2016;58(12):15–27 (in Japanese).
[8] Cabinet Office. Individuals and corporates survey on work-life balance. http://wwwa.cao.go.jp/wlb/research/wlb_h2511/9_insatsu.pdf. [Accessed 18 January 2019] (in Japanese).
[9] Suzuki W. Obesity and long workhours. J Depart Econ Gakushuin Univ 2011;48(3):193–211.
[10] Iwasaki K. Long hours of work and health problems. Jpn J Labour Stud [Nihon rodo kenkyu zasshi] 2008;575:39–48.
[11] van der Hulst M. Long workhours and health. Scand J Work Environ Health 2003;29(3):171–88.
[12] Bassanini A, Caroli E. Is work bad for health? The role of constraint versus choice. Ann Econ Stat 2015;(119/120):13–37.
[13] Kivimäki M, Jokela M, Nyberg ST, Singh-Manoux A, Fransson EI, Alfredsson L, et al. Long working hours and risk of coronary heart disease and stroke: a systematic review and meta-analysis of published and unpublished data for 603 838 individuals. The Lancet 2015;386(10005):1739–46.
[14] Kivimaki M, Kawachi I. Work Stress as a Risk Factor for Cardiovascular Disease. Curr Cardiol Rep 2015;17(9):630.
[15] Kivimaki M, Nyberg ST, Batty GD, Kawachi I, Jokela M, Alfredsson L, et al. Long working hours as a risk factor for atrial fibrillation: a multi-cohort study. Eur Heart J 2017;38(34):2621–8.
[16] Grossman M. On the concept of health capital and the demand for health. J Polit Economy 1972;80(2):223–55.
[17] Tamakoshi A, Yatsuya H, Lin YS, Tamakoshi K, Kondo T, Suzuki S, et al. BMI and all-cause mortality among Japanese older adults: findings from the Japan Collaborative Cohort Study. Obesity 2010;18(2):362–9.
[18] Berniell I, Bietenbeck J. The Effect of Working Hours on Health. IZA Discussion paper series. Bonn: The IZA - Institute of Labor Economics; 2017. ZA DP No. 10524.
[19] Kajitani S, McKenzie C, Sakata K. Use it Too Much and Lose Everything? The Effects of Hours of Work on Health. Panel Data Res Cent Keio Univ Discussion paper series. Tokyo: Keio University; 2017. DP2016-009.

[20] Kamimura K. Effect of health condition on labour hour -In case of youth-. J Personal Finance Econ 2012;36:73–84.
[21] Zohoori N, Savitz DA. Econometric approaches to epidemiologic data: relating endogeneity and unobserved heterogeneity to confounding. Ann Epidemiol 1997;7(4):251–7.
[22] Greenland S. An introduction to instrumental variables for epidemiologists. Int J Epidemiol 2000;29(4):722–9.
[23] Siegel RL, Miller KD, Jemal A. Cancer statistics, 2018. CA Cancer J Clin 2018;68(1):7–30.
[24] Kannel WB, McGee DL. Diabetes and cardiovascular disease: The framingham study. JAMA 1979;241(19):2035–8.
[25] Bannai A, Tamakoshi A. The association between long working hours and health: a systematic review of epidemiological evidence. Scand J Work Environ Health 2014;40(1):5–18.
[26] Nie P, Otterbach S, Sousa-Poza A. Long work hours and health in China. China Econ Rev 2015;33:212–29.
[27] Maruyama S, Morimoto K. Effects of long workhours on life-style, stress and quality of life among intermediate Japanese managers. Scand J Work Environ Health 1996;22(5):353–9.
[28] Yu J. Relationship between long working hours and metabolic syndrome among Korean workers. Asian Nurs Res (Korean Soc Nurs Sci) 2017;11(1):36–41.
[29] Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. JAMA 2003;289(1):76–9.
[30] Kivipelto M, Ngandu T, Fratiglioni L, Viitanen M, Kareholt I, Winblad B, et al. Obesity and vascular risk factors at midlife and the risk of dementia and Alzheimer disease. Arch Neurol 2005;62(10):1556–60.
[31] Hubert HB, Feinleib M, Mcnamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular-disease - a 26-year follow-up of participants in the Framingham Heart-Study. Circulation 1983;67(5):968–77.
[32] OECD. Obesity Update 2017. 2017. Paris.
[33] Matsushita Y, Takahashi Y, Mizoue T, Inoue M, Noda M, Tsugane S, et al. Overweight and obesity trends among Japanese adults: a 10-year follow-up of the JPHC Study. Int J Obes (Lond) 2008;32(12):1861–7.
[34] Zaher C, Halbert R, Dubois R, George D, Nonikov D. Smoking-related diseases: the importance of COPD. Int J Tuberc Lung Dis 2004;8(12):1423–8.
[35] Gandini S, Botteri E, Iodice S, Boniol M, Lowenfels AB, Maisonneuve P, et al. Tobacco smoking and cancer: a meta-analysis. Int J Cancer 2008;122(1):155–64.
[36] Ikeda N, Inoue M, Iso H, Ikeda S, Satoh T, Noda M, et al. Adult mortality attributable to preventable risk factors for non-communicable diseases and injuries in Japan: a comparative risk assessment. Plos Med 2012;9(1):e1001160.
[37] Foley D, Ancoli-Israel S, Britz P, Walsh J. Sleep disturbances and chronic disease in older adults: results of the 2003 National Sleep Foundation Sleep in America Survey. J Psychosom Res 2004;56(5):497–502.
[38] Nagai M, Hoshide S, Kario K. Sleep duration as a risk factor for cardiovascular disease- a review of the recent literature. Curr Cardiol Rev 2010;6(1):54–61.
[39] Eguchi K, Hoshide S, Ishikawa S, Shimada K, Kario K. Short sleep duration is an independent predictor of stroke events in elderly hypertensive patients. J Am Soc Hypertens 2010;4(5):255–62.
[40] OECD. Society at a Glance 2009: OECD Social Indicators. Paris: OECD Publishing; 2009.
[41] Ministry of Health, Labour and Welfare. Measures for long workhours. 2017. https://www.mhlw.go.jp/seisakunitsuite/bunya/koyou_roudou/roudoukijun/shigoto/it/pdf/seminar_02.pdf. Japan.
[42] Ministry of Health, Labour and Welfare. General Survey on Working Conditions, 2016. 2016. https://www.mhlw.go.jp/toukei/itiran/roudou/jikan/syurou/16/index.html. Japan.
[43] Chou SY, Grossman M, Saffer H. An economic analysis of adult obesity: results from the behavioral risk factor surveillance system. J Health Econ 2004;23(3):565–87.
[44] Torres SJ, Nowson CA. Relationship between stress, eating behavior, and obesity. Nutrition 2007;23(11-12):887–94.
[45] Davidson R, MacKinnon JG. Econometric Theory and Methods. New York: Oxford University Press; 2004.
[46] Cohen S, Lichtenstein E. Perceived stress, quitting smoking, and smoking relapse. Health Psychol 1990;9(4):466–78.
[47] Steptoe A, Wardle J, Pollard TM, Canaan L, Davies GJ. Stress, social support and health-related behavior: a study of smoking, alcohol consumption and physical exercise. J Psychosom Res 1996;41(2):171–80.
[48] Gallant AR, Lundgren J, Drapeau V. The night-eating syndrome and obesity. Obes Rev 2012;13(6):528–36.
[49] Stunkard AJ. Eating patterns and obesity. Psychiatr Q 1959;33(2):284–95.
[50] Centers for Disease Control NCfCDP, Health P. Physical activity and good nutrition: essential elements to prevent chronic diseases and obesity 2003. Nutr Clin Care 2003;6(3):135–8.