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Original Article

Objective and subjective working hours and their roles on workers' health among Japanese employees

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Abstract: This study investigated the correlation between objective and subjective working hours (OWH and SWH, respectively) and their relation to the workers' health. The study included 6,806 workers of a Japanese company (response rate=86.6%). OWH were collected as the monthly data during fiscal year 2017 from the company record. SWH were self-reported as the weekly data during the past month in November 2017. Both OWH and SWH corresponded to the same period of one month (October 2017). Additionally, the data for the annual health checkup in fiscal year 2017 and self-reported mental health in November 2017 were collected. The results indicated that the longer OWH was related to more underestimation of SWH. The analyses of covariance adjusted for the selected variables showed that irrespective of OWH or SWH, significant relationships were found for stress responses but not for body mass index, aspartate and alanine aminotransferase, fasting blood glucose, hemoglobin A1c, high-density lipoprotein cholesterol, or triglyceride. However, significant relationships with only OWH were noted for systolic and diastolic blood pressure, low-density lipoprotein cholesterol, gamma-glutamyl transpeptidase, and positive work-related state of mind. The present findings show that SWH should be used carefully when assessing the health effects of long working hours.

Key words: Overtime, Exposure assessment, Health checkup, Cardiovascular diseases, Karoshi

Introduction

Long working hours, defined as exceeding 8 h/day at work or greater than 40 h of work a week, are considered to cause workers' physical and psychological health problems, including cardiovascular disease[1, 2], high blood pressure[3, 4], sleep disruption[5], diabates[6, 7], metabolic syndrome[8, 9], fatigue[10], injury[11], depression[12, 13], and other health disorders[14, 15]. In Japan, the issue of long working hours has been seriously discussed since the late 1980s because some workers died after they overworked for some duration. The word "karoshi", death due to overwork, is now common worldwide[16].

The researchers had tried to reveal the causal relationship between long working hours and workers' health problems, but this remains inconclusive. One reason related to various ways in measuring working hours: workers' self-reports[2, 3, 9, 14, 15], time records of workers' workplaces[4, 5], and workers' pay slips[8]. Alternatively, working hours were defined in different units: total weekly or monthly working hours[1–3, 9, 14] and overtime hours[5, 8, 11, 15]. The working

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hours of each employee were likely to be varied, and the total working hours may not be figured out from overtime[17]. In addition, if professionals and managers are not employed by per-hour wages, working hours may not necessarily be considered as a significant issue for them. This attitude may reduce the possibility of accurately recalling their working hours. While most studies relied on subjective working hours (SWH), one study indicated good validity of SWH against the company record of working hours as objective working hours (OWH)[18]. However, the participants included only 164 men who were full-time workers and had not been absent for over 4 d for one month period. Moreover, the relationship between the two indicators of working hours and workers' health were not examined.

While several factors in the workplace affect workers' health, safety, and well-being, the number of working hours can be seen as the most essential. Its accurate measurement becomes the core question accordingly. Thus, in this study, our first aim was to investigate the correlation between OWH and SWH. The second aim was to examine how the relationship between the two indicators of working hours and physical outcomes or both negative and positive aspects of psychological health was comparable. The present study was carried out in an exploratory manner, because of the paucity of studies on the relationship among OWH, SWH, and workers' health.

Methods

Participants

The employees of a Japanese company of the tertiary industry were invited to participate in the National Institute of Occupational Safety and Health, Japan (JNIOSH) cohort study. The company was composed of managerial, sales, customer service, clerical, and product employees and others. Among 7,857 employees, 6,806 agreed to participate (response rate=86.6%). The data on self-reported working hours as SWH, psychological health, and sociodemographic factors were collected using the Web questionnaire in November 2017. In addition, we gathered the information on monthly attendance management as OWH and annual health checkup in fiscal year 2017 (from April 2017 to March 2018) from the personnel department. Consent was obtained from the employees after they were informed of the purposes and procedures of the study. All data was firstly collected by a collaborating employee assistance program (EAP) service provider which conducted the Stress Check Program. The dataset without personal identifiers was transferred to the JNIOSH through a secure information communication technology network. The Ethics Committee of JNIOSH reviewed and approved the study protocol (No. H2812).

Measures

Working hours

For OWH, the monthly total working hours of each employee during fiscal year 2017 were provided from the attendance management data of the company. The attendance management system collected the clock time of both entering and leaving the office using employees' electronic ID card. This determined the official data for attendance and leaving of the employees.

Monthly OWH were divided by four to have the weekly OWH. On the Web questionnaire in November 2017, SWH were determined by using the question "How many hours per week did you work in the last one month?," with seven response options: "1 to 34 h", "35 to 40 h", "41 to 50 h", "51 to 60 h", "61 to 65 h", "66 to 70 h", and "71 h or more". In the present study, OWH in October 2017 were used to correspond to the aforementioned time frame of SWH.

Health checkup

The annual health checkup was conducted in fiscal year 2017. The indicators addressed here included sex, age, body mass index (BMI), blood pressure (systolic/diastolic), liver function [aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transpeptidase (GGT)], fasting blood glucose, hemoglobin A1c (HbA1c), high-density/low-density lipoprotein (HDL/LDL) cholesterol, and triglyceride.

Stress responses and positive work-related state of mind

Psychological health was examined from both positive and negative aspects. The questionnaire was conducted at Stress Check Program conducted in November 2017 administered by the EAP service provider. The work-related physical and psychological stress responses were assessed using the corresponding subscales of the Brief Job Stress Questionnaire (BJSQ)[19]. The questions in BJSQ asked participants about the last one month. BJSQ included the stress responses subscales of anger, anxiety, depression, fatigue, and physical complaint.

Positive mental health is assessed commonly by the Japanese version of Utrecht Work Engagement Scale (UWES-J)[20] in Japan. The condition of the use of this scale does not permit commercial use. Therefore, the EAP

service provider developed the similar scale based on the UWES-J. The scale of positive state of mind consists of 8 items with two subscales: (1) self-motivated action (e.g., I study and collect information on my work at my initiative" and "I work with inventive approach") and (2) positive emotion (e.g., "I really enjoy my work" and "I feel my peek energy when I work"). The subscales had a significant correlation with UWES-J. The validity research was conducted for 2,064 workers in 2017 through an Internet survey conducted by the EAP service provider. The cross-correlation values were as follows: self-motivated action for vigor, dedication, and absorption were 0.4, 0.5, and 0.4, respectively, and positive emotion for these were 0.6, 0.7, and 0.6. The questions were also about the last one month. Both BJSQ and positive work-related state of mind were scored on a four-point Likert scale ranging from 1 ("almost never") to 4 ("almost always"). Then, the subscale scores were calculated by the average of the total scores of each item. Cronbach's alpha for each subscale ranged from 0.81 to 0.95.

Sociodemographic factors

On the Web questionnaire conducted in November 2017 along with the Stress Check Program, employment type, job category, and work pattern were measured.

Statistical analyses

First, the characteristics of the participants and the distribution of OWH and SWH were examined by gender. Second, SWH and OWH were classified into four categories: ≥1 to 35 h/wk, ≥35 to 50 h/wk, ≥50 to 60 h/wk, and ≥60 h/wk. Because the number of employees in the OWH ≥35 to 40 h/wk group was very small (2.2% of total OWH), ≥35 to 40 h/wk were included in the ≥35 to 50 h/wk. In a similar way, the number of workers in the 61 h to 65 h and 71 h or more groups was insufficient; thus, they were included in the ≥61 h group. The Japanese Ministry of Health, Labour and Welfare has limited extra working hours less than 45 h/month, the ≥35 to 50 h/wk group was chosen as the reference group (to match OWH with SWH categories, we were unable to define a 35 to 45h/w category). Then the χ^2 test was used to calculate the differences in the sociodemographic factors and percentage of participants with different working hours. After the simple correlational analyses, the correlation between OWH and SWH were examined according to sex (men/women) and job category (managers/nonmanagerial). In addition, the relationship between the two working hours and physical or psychological indicators was determined using the analyses of covariance (ANCOVA), adjusted for sex, age, employment type, job category, and work pattern. The Bonferroni method was also used for multiple comparisons, and the results related to reference group (≥35 to 50 h/week) were noted. P values<0.05 were considered statistically significant (two-tailed test). Cases with missing values were excluded listwise from the analysis. Furthermore, all analyses were performed using IBM SPSS Statistics ver. 24.

Results

Characteristics of participants

Table 1 presents the characteristics of the participants. Their total number was 6,806 (4,448 men and 2,358 women). The mean age was 37.6 (SD=9.9) for men and 36.0 (SD=11.4) for women, respectively. More than half of participants were daytime full-time employees. OWH data was available from 6,701 participants, and SWH data for all the participants. The health checkup data analyzed ranged 5,501–5,547, with 3,598–3,624 (fasting blood glucose) and 3,903–3,933 (HbA1c). The Stress Check Program data was analyzed for 6,701–6,806 participants. The main reason for the reduced numbers was due to missing values (listwise deletion). The smaller numbers for fasting blood glucose and HbA1c resulted from the notification that testing for these two markers can be omitted among employees under 35 yr old and 36–39 yr old on the basis of doctor's judgment.

The descriptive statistics on SWH and OWH are shown in Table 2. Over half of the workers (56.7%) were categorized into the 50 to 60 h/wk group according to OWH, whereas only one-fifth (10.3%) reported the same range of working hours according to SWH. Indeed, approximately half of the participants (49.1%) reported working 40 to 50 h/wk.

OWH/SWH and sociodemographic factors

Table 3 shows the results of the χ^2 test. As for OWH, a total of 1,124 men and 1,096 women worked ≥35 to 50 h/wk (reference group). The number of employees who worked >1 h/wk was 105 (they may be absent for some reasons in October 2017), so the total number of OWH was 6,701. The number of both job categories (managers and nonmanagerial) in the OWH 50 h to 60 h/wk group was the relative majority. As for SWH, both managers and nonmanagerial in the 35 to 50 h/wk group was the majority. Moreover, sex, age, and job categories were statistically significant throughout the working hour categories (p<0.001), as shown in Table 3.

Table 1. Characteristics of age, employment type, job category, and work pattern

	Men (n=4,448)		Women (n=2,358)		Total (n=6,806)	
	N	(%)[a]	N	(%)	N	(%)
Age (yr)						
≤29	988	(22.2)	887	(37.6)	1,875	(27.5)
30–39	1,751	(39.4)	662	(28.1)	2,413	(35.5)
40–49	1,160	(26.1)	453	(19.2)	1,613	(23.7)
≥50	549	(12.3)	356	(15.1)	905	(13.3)
M ± SD	37.6 ± 9.9		36.0 ± 11.4		37.05 ± 10.5	
Employment type						
Full-time employee	4,130	(92.9)	1,610	(68.3)	5,740	(84.3)
Contract employee	125	(2.8)	209	(8.9)	334	(4.9)
Fixed-term employee	67	(1.5)	11	(0.5)	78	(1.1)
Temporary staff	2	(0.0)	6	(0.3)	8	(0.1)
Part-timer	89	(2.0)	341	(14.5)	430	(6.3)
Others	35	(0.8)	181	(7.7)	216	(3.2)
Job category						
Manager	1,242	(27.9)	89	(3.8)	1,331	(19.6)
Ordinaly employee	3,206	(72.1)	2,269	(96.2)	5,475	(80.4)
Work pattern						
Daytime, fixed time	3,603	(81.0)	1,747	(74.1)	5,350	(78.6)
Variable work hours	495	(11.1)	355	(15.1)	850	(12.5)
Daytime, flexible-hours system	155	(3.5)	34	(1.4)	189	(2.8)
Discretionary labor system	32	(0.7)	8	(0.3)	40	(0.6)
2-shift system (with night shift)	40	(0.9)	54	(2.3)	94	(1.4)
2-shift system (without night shift)	17	(0.4)	32	(1.4)	49	(0.7)
3-shift system	31	(0.7)	46	(2.0)	77	(1.1)
Only evening shift	4	(0.1)	4	(0.2)	8	(0.1)
Only night shift	10	(0.2)	7	(0.3)	17	(0.2)
Others	61	(1.4)	71	(3.0)	132	(1.9)

[a]: Figures do not always add up to 100% due to rounding data.

M: mean; SD: standard deviation.

Correlation between OWH and SWH

Table 4 shows the results of the correlation between OWH and SWH. The "underestimation" means the percentage of workers who answered less than OWH; for example, in all employees in the OWH ≥60 h/week group, the number of workers who subjectively answered the same hour category was 40 (10.9%), so the underestimation of the OWH 60 h/week group was 89.0%. Additionally, three patterns were searched: all employees, men and women, and managerial and nonmanagerial positions. In contrast, the percentage of overestimation ranged from about 2% to 30% at most.

Annual health checkup data related to OWH and SWH

Irrespective of OWH or SWH, BMI, AST, ALT, fasting blood glucose, HbA1c, HDL cholesterol, and triglyceride had no significant relationship with working hours (Table 5). Furthermore, systolic and diastolic blood pressure, GGT, and LDL cholesterol had significant relationships with OWH but none with SWH. The employees with OWH ≥35 to 50 h/week showed significantly higher systolic blood pressure than those with OWH ≥1 to 35 h/week. The OWH ≥50 to 60 h/week group showed significantly higher LDL cholesterol than the OWH ≥35 to 50 h/week group. On the other hand, those with shorter OWH ≥1 to 35 or ≥35 to 50 h/week had significantly higher GGT or diastolic blood pressure, respectively.

Stress responses and positive work-related state of mind related to OWH and SWH

Both OWH and SWH showed a significant relationship with anger, anxiety, fatigue, and physical complaint, and only SWH showed a significant relationship with depression (Table 6): the stress response levels were found to

Table 2. Descriptive statistics on objective and subjective working hours

	Objective working hours									Subjective working hours					
	Men		Women		Total		Mean[b]	(*SD*)	Min	Max	Men		Women		Total	
	N	(%)[a]	*N*	(%)	*N*	(%)					*N*	(%)	*N*	(%)	*N*	(%)
≥1 to 35 h/w	80	(1.8)	238	(10.3)	318	(4.7)	25.4	(6.5)	2.0	34.99	609	(13.7)	575	(24.4)	1,184	(17.4)
≥35 to 40 h/w	29	(0.7)	119	(5.1)	148	(2.2)	37.6	(1.3)	35.2	39.99	736	(16.5)	645	(27.4)	1,381	(20.3)
≥40 to 50 h/w	1,095	(25.0)	977	(42.1)	2,072	(30.9)	47.2	(2.3)	40.0	49.99	2,387	(53.7)	957	(40.6)	3,344	(49.1)
≥50 to 60 h/w	2,844	(64.9)	953	(41.1)	3,797	(56.7)	54.0	(2.6)	50.0	59.98	567	(12.7)	136	(5.8)	703	(10.3)
≥60 to 65 h/w	262	(6.0)	27	(1.2)	289	(4.3)	62.0	(1.4)	60.0	64.98	100	(2.2)	21	(0.9)	121	(1.8)
≥65 to 70 h/w	68	(1.6)	6	(0.3)	74	(1.1)	66.9	(1.4)	65.1	69.83	29	(0.7)	8	(0.3)	37	(0.5)
≥70 h/w	3	(0.1)	-	(0.0)	3	(0.0)	70.1	(0.0)	70.1	70.14	20	(0.4)	16	(0.7)	36	(0.5)
Total	4,381	(100)	2,320	(100)	6,701	(100)	50.7	(7.8)	2.0	70.15	4,448	(100)	2,358	(100)	6,806	(100)

[a]: Figures do not always add up to 100% due to rounding data.

[b]: hours/w

SD: standard deviation; Min: minimum.

Table 3. Results of the χ^2 tests in OWH/SWH

Objective working hours per week[a]	≥1 to 35 h/w	(*N*=318)	≥35 to 50 h/w	(*N*=2,220)	≥50 to 60 h/w	(*N*=3,797)	≥60 h/w	(*N*=366)	*p*[d]
	N	(%)[b]	*N*	(%)	*N*	(%)	*N*	(%)	
Gender									<0.001
Men	80	(−25.2)	1,124	(−50.6)	2,844	(−74.9)	333	(−91.0)	
Women	238	(−74.8)	1,096	(−49.4)	953	(−25.1)	33	(−9.0)	
Age (yr)									<0.001
≤29	25	(−7.9)	647	(−29.1)	1,179	(−31.1)	11	(−3.0)	
30–39	87	(−27.4)	675	(−30.4)	1,437	(−37.8)	188	(−51.4)	
40–49	91	(−28.6)	508	(−22.9)	836	(−22.0)	141	(−38.5)	
≥50	115	(−36.2)	390	(−17.6)	345	(−9.1)	26	(−7.1)	
Job type									
Manager	6	(−1.9)	267	(−12.0)	764	(−20.1)	260	(−71.0)	<0.001
Nonmanagerial	312	(−98.1)	1,953	(−88.0)	3,033	(−79.9)	106	(−29.0)	
Subjective working hours per week[c]	≥1 to 35 h/w	(*N*=1,184)	≥35 to 50 h/w	(*N*=4,725)	≥50 to 60 h/w	(*N*=703)	≥60 h/w	(*N*=194)	*p*
	N	(%)	*N*	(%)	*N*	(%)	*N*	(%)	
Gender									<0.001
Men	609	(−51.4)	3,123	(−66.1)	567	(−80.7)	149	(−76.8)	
Wemen	575	(−48.6)	1,602	(−33.9)	136	(−19.3)	45	(−23.2)	
Age (yr)									<0.001
≤29	331	(−28.0)	1,365	(−28.9)	138	(−19.6)	41	(−21.1)	
30–39	409	(−34.5)	1,653	(−35.0)	276	(−39.3)	75	(−38.7)	
40–49	238	(−20.1)	1,103	(−23.3)	219	(−31.2)	53	(−27.3)	
≥50	206	(−17.4)	604	(−12.8)	70	(−10.0)	25	(−12.9)	
Job type									<0.001
Manager	112	(−9.5)	851	(−18.0)	298	(−42.4)	70	(−36.1)	
Nonmanagerial	1,072	(−90.5)	3,874	(−82.0)	405	(−57.6)	124	(−63.9)	

[a]: By the personnel records of October, 2017.

[b]: Figures do not always add up to 100% due to rounding data.

[c]: By answers to the questionnaire about last month (conducted in November, 2017).

[d]: p-value of χ^2-test for categorical variables.

OWH: objective working hours; SWH: subjective working hours.

Table 4. Correlation between OWH and SWH

				Objective working hours										
				≥1 to 35 h/w		Under-estimation (%)[c]	≥ 35 to 50 h/w		Under-estimation (%)	≥ 50 to 60 h/w		Under-estimation (%)	≥ 60 h/w		Under-estimation (%)
				N	(%)[a]		N	(%)		N	(%)		N	(%)	
Subjective working hours	All employees		≥1 to 35 h/w	245	(77.0)[b]	-	360	(16.2)		537	(14.1)		22	(6.0)	
			≥35 to 50 h/w	62	(19.5)		1,736	(78.2)	16.2	2,717	(71.6)		155	(42.3)	
			≥50 to 60 h/w	5	(1.6)		95	(4.3)		433	(11.4)	85.7	149	(40.7)	
			≥60 h/w	6	(1.9)		29	(1.3)		110	(2.9)		40	(10.9)	89.0
	Sex	Men	≥1 to 35 h/w	55	(68.8)	-	132	(11.7)		401	(14.1)		16	(4.8)	
			≥35 to 50 h/w	23	(28.8)		913	(81.2)	11.7	2,007	(70.6)		143	(42.9)	
			≥50 to 60 h/w	1	(1.3)		62	(5.5)		348	(12.2)	84.7	138	(41.4)	
			≥60 h/w	1	(1.3)		17	(1.5)		88	(3.1)		36	(10.8)	89.1
		Women	≥1 to 35 h/w	190	(79.8)	-	228	(20.8)		136	(14.3)		6	(18.2)	
			≥35 to 50 h/w	39	(16.4)		823	(75.1)	20.8	710	(74.5)		12	(36.4)	
			≥50 to 60 h/w	4	(1.7)		33	(3.0)		85	(8.9)	88.8	11	(33.3)	
			≥60 h/w	5	(2.1)		12	(1.1)		22	(2.3)		4	(12.1)	87.9
	Job category	Manegerial	≥1 to 35 h/w	2	(33.3)	-	29	(10.9)		66	(8.6)		14	(5.4)	
			≥35 to 50 h/w	4	(66.7)		215	(80.5)	10.9	513	(67.1)		100	(38.5)	
			≥50 to 60 h/w	0	(0.0)		18	(6.7)		155	(20.3)	75.7	116	(44.6)	
			≥60 h/w	0	(0.0)		5	(1.9)		30	(3.9)		30	(11.5)	88.5
		Nonmanegerial	≥1 to 35 h/w	243	(77.9)	-	331	(16.9)		471	(15.5)		8	(7.5)	
			≥35 to 50 h/w	58	(18.6)		1,521	(77.9)	16.9	2,204	(72.7)		55	(51.9)	
			≥50 to 60 h/w	5	(1.6)		77	(3.9)		278	(9.2)	88.2	33	(31.1)	
			≥60 h/w	6	(1.9)		24	(1.2)		80	(2.6)		10	(9.4)	90.5

[a]: Figures do not always add up to 100% due to rounding data.

[b]: Shaded areas indicate that OWH and SWH are matched.

c: OWH is used for reference. The rate shows the percentage of workers who answered less than OWH.

OWH: objective working hours; SWH: subjective working hours.

Table 5. Relations between OWH/SWH and health checkup data

	Objective working hours	*N*	Adjusted mean[a] (*SE*)	*p*-values, hours[b]	Multiple comparison[c]	Subjective working hours	*N*	Adjusted mean[a] (*SE*)	*p*-values, hours
BMI	≥1 to 35 h/w	39	23.2 (0.61)	0.77		≥1 to 35 h/w	780	23.4 (0.14)	0.09
	≥35 to 50 h/w	1,716	23.2 (0.10)			≥35 to 50 h/w	4,006	23.2 (0.06)	
	≥50 to 60 h/w	3,414	23.2 (0.07)			≥50 to 60 h/w	607	22.9 (0.16)	
	≥60 h/w	343	23.0 (0.22)			≥60 h/w	154	23.0 (0.31)	
Systolic blood pressure	≥1 to 35 h/w	39	110.7 (2.40)	<0.01	1<2[d]	≥1 to 35 h/w	780	116.5 (0.54)	0.29
	≥35 to 50 h/w	1,715	117.2 (0.37)			≥35 to 50 h/w	4,005	116.8 (0.24)	
	≥50 to 60 h/w	3,414	116.5 (0.26)			≥50 to 60 h/w	607	115.5 (0.62)	
	≥60 h/w	343	114.8 (0.85)			≥60 h/w	154	117.1 (1.21)	
Diastolic blood pressure	≥1 to 35 h/w	39	68.5 (1.76)	<0.01	2>4	≥1 to 35 h/w	780	70.9 (0.39)	0.13
	≥35 to 50 h/w	1,715	72.0 (0.27)			≥35 to 50 h/w	4,005	71.6 (0.17)	
	≥ 50 to 60 h/w	3,414	71.2 (0.19)			≥50 to 60 h/w	607	70.7 (0.45)	
	≥60 h/w	343	70.0 (0.62)			≥60 h/w	154	72.3 (0.89)	
AST	≥1 to 35 h/w	39	26.0 (1.97)	0.38		≥1 to 35 h/w	779	23.4 (0.46)	0.14
	≥35 to 50 h/w	1,712	22.7 (0.31)			≥35 to 50 h/w	4,000	22.7 (0.20)	
	≥50 to 60 h/w	3,411	22.6 (0.21)			≥50 to 60 h/w	607	21.8 (0.53)	
	≥60 h/w	343	22.3 (0.70)			≥60 h/w	154	21.9 (1.04)	
ALT	≥1 to 35 h/w	39	27.4 (3.77)	0.50		≥1 to 35 h/w	779	27.9 (0.89)	0.18
	≥35 to 50 h/w	1,712	26.0 (0.59)			≥35 to 50 h/w	4,000	26.8 (0.39)	
	≥50 to 60 h/w	3,410	27.0 (0.41)			≥50 to 60 h/w	606	25.0 (1.02)	
	≥60 h/w	343	27.4 (1.33)			≥60 h/w	154	27.5 (1.99)	
GGT	≥1 to 35 h/w	39	63.8 (8.38)	<0.01	1>2	≥1 to 35 h/w	779	39.1 (1.91)	0.51
	≥35 to 50 h/w	1,711	40.5 (1.30)			≥35 to 50 h/w	3,999	40.5 (0.84)	
	≥50 to 60 h/w	3,411	39.9 (0.90)			≥50 to 60 h/w	607	39.4 (2.19)	
	≥60 h/w	343	33.2 (2.96)			≥60 h/w	154	34.5 (4.29)	
Fasting blood glucose	≥1 to 35 h/w	20	99.1 (4.38)	0.28		≥1 to 35 h/w	512	92.5 (0.88)	0.93
	≥35 to 50 h/w	1,139	92.9 (0.60)			≥35 to 50 h/w	2,644	92.3 (0.39)	
	≥50 to 60 h/w	2,260	92.0 (0.42)			≥50 to 60 h/w	372	93.1 (1.04)	
	≥60 h/w	179	92.2 (1.52)			≥60 h/w	96	92.6 (2.03)	
HbA1c	≥1 to 35 h/w	35	5.6 (0.11)	0.44		≥1 to 35 h/w	488	5.5 (0.03)	0.93
	≥35 to 50 h/w	1,175	5.5 (0.02)			≥35 to 50 h/w	2,825	5.5 (0.01)	
	≥50 to 60 h/w	2,364	5.5 (0.01)			≥50 to 60 h/w	494	5.5 (0.03)	
	≥60 h/w	329	5.4 (0.04)			≥60 h/w	126	5.5 (0.06)	
HDL cholesterol	≥1 to 35 h/w	39	55.4 (2.20)	0.55		≥1 to 35 h/w	777	57.9 (0.49)	0.71
	≥35 to 50 h/w	1,709	58.3 (0.34)			≥35 to 50 h/w	3,994	58.3 (0.22)	
	≥ 50 to 60 h/w	3,405	58.3 (0.24)			≥50 to 60 h/w	605	58.3 (0.57)	
	≥60 h/w	342	57.8 (0.78)			≥60 h/w	154	57.4 (1.11)	
LDL cholesterol	≥1 to 35 h/w	39	110.2 (4.73)	<0.01	2<3	≥1 to 35 h/w	779	114.2 (1.07)	0.40
	≥35 to 50 h/w	1,712	112.3 (0.73)			≥35 to 50 h/w	3,997	114.3 (0.47)	
	≥50 to 60 h/w	3,407	115.3 (0.51)			≥50 to 60 h/w	606	114.6 (1.23)	
	≥60 h/w	343	116.5 (1.67)			≥60 h/w	154	118.5 (2.40)	
Triglyceride	≥1 to 35 h/w	39	128.1 (14.72)	0.27		≥1 to 35 h/w	779	113.3 (3.38)	0.89
	≥35 to 50 h/w	1,713	116.9 (2.29)			≥35 to 50 h/w	4,000	114.2 (1.48)	
	≥50 to 60 h/w	3,410	112.2 (1.59)			≥50 to 60 h/w	607	113.1 (3.87)	
	≥60 h/w	343	110.4 (5.20)			≥60 h/w	154	119.4 (7.57)	

[a]: adjusted for sex, age, employment type, job category, and work pattern.

[b]: ANCOVA p-values for hours

[c]: Bonfferoni method.

[d]: 1; ≥1 to 35 h/w, 2; ≥35 to 50 h/w, 3; ≥50 to 60 h/w, 4; ≥60 h/w, and reference group is 2.

SE: standard error; OWH: objective working hours; SWH: subjective working hours; BMI: body mass index; AST: aspartate aminotransferase; ALT: alanine aminotransferase; GGT: gamma-glutamyl transpeptidase; HbA1c: hemoglobin A1c; HDL: high-density lipoprotein cholesterol; LDL: low-density lipoprotein cholesterol.

be greater as the working hours got longer. Furthermore, among the groups, the OWH ≥35 to 50 h/wk group had the lowest score of positive work-related state of mind, while the OWH ≥60 group had the highest. Contrarily, no significant result was observed for the relationship between SWH and positive work-related state of mind.

Discussion

In this study, we aimed to examine the correlation between OWH and SWH among Japanese employees of the tertiary industry. The results showed that as the OWH got longer, the workers tended to underestimate their working hours; this pattern of relationship was consistent in sex or job positions. In addition, the relationship between the annual health checkup data and OWH or SWH was determined; subsequently, 4 out of 11 parameters (systolic and diastolic blood pressure, GGT, and LDL cholesterol) were significantly related to OWH, but these parameters were not significantly related to SWH. For the psychological outcomes, the similar pattern of relationship between OWH and SWH was observed for stress responses except for depression. Both OWH and SWH showed that the longer working hours categories had negative stress responses. However, a U-shaped relationship was found in positive work-relate state of mind with only OWH.

We found in the present study that as OWH became longer, SWH got shorter. The observed discrepancy may have resulted from the recall bias when responding to the SWH question. We supposed that the gap between OWH and SWH would be different between men and women or managers and nonmanagerial positions because of some different types of wage patterns (e.g., postage system, hourly pay conversion, or ability pay). However, almost no difference between sex or job categories was found. The current findings would have reflected the general atmosphere or organizational climate and culture in Japan, i.e., subordinates usually go home after their bosses leave their offices[21, 22]. However, overtime work presently receives considerable attention in the workplaces. Following the national policy of the Work Style Reform, a number of companies have begun to reduce overtime[23, 24]. Therefore, the workers possibly hesitated to answer they worked long hours because they disobey the instruction not to do overtime, and they felt anxious that their answers may be revealed to their employer. Another factor may be related to the matter of category boundary. The response options for SWH had 5- or 10-h intervals. If the workers with OWH >50 h/wk would have the attitude of underestimation, they were more likely to report shorter SWH, resulting in lower categories of SWH. For example, an employee with OWH 52 h/week (categorized in the 50 to 60 h/wk group) may have preferred to report 48 h/wk, that is, categorized in the 40 to 50 h/wk group of SWH.

Systolic and diastolic blood pressure, LDL cholesterol, and GGT were found to have a significant relationship with OWH but none with SWH. In this study, systolic blood pressure increased among the employees with OWH ≥35 h/w or longer and LDL cholesterol increased as OWH got longer. These results are consistent with those in the previous studies[4, 14]. Lower diastolic blood pressure in the OWH ≥60 h/w group than in the OWH ≥35 to 50 h/w group is similar to the previous cross-sectional finding of decreased prevalence of hypertension associated with self-reported long working hours[3]. However, the GGT data was difficult to be interpret, and this may be related to the particular characteristics of the OWH ≥1 to 35 h group, such as very small number (n=39) and some workers with extremely high values.

For working hours and workers' mental health, the higher levels of stress responses with longer OWH and SWH were observed. These results are consistent with the previous findings[12, 13]. Despite of the parallel relationships between stress responses and two indicators of working hours, positive work-related state of mind had a significant relationship with only OWH. The employees with the longest and shortest OWH showed a high level of positive work-related state of mind. This relationship was curvilinear, like a U-shaped curve. The scales of positive work-related state of mind were formed on the bases of work engagement. Engaged workers are characterized as those working in demanding jobs with good mental health[25]. Empirically, work engagement and overtime are positively related to each other[26], and workers with no overtime also showed a higher level of work engagement than those with a low degree of overtime[27]. These facts can explain the curvilinear relationship. However, notably, the employees with longer OWH also reported higher levels of stress responses. In a recent study, the relationship between work engagement and psychological distress was U-shaped curvilinear, and the favorable effect of work engagement may have an upper limit in the short run[28]. Furthermore, a very high level of engagement was reported to have negative effects on the psychological health[28].

Limitations

The present study has several limitations. First, we examined just only one company in Japan. The current

Table 6. Relations between OWH/SWH and psychological outcomes

	Objective working hours	*N*	Adj. mean[a]	(*SE*)	*p*-values	Multiple comparison[b]	Subjective working hours	*N*	Adj. mean	(*SE*)	*p*-values	Multiple comparison
Anger	≥1 to 35 h/w	318	1.85	(0.05)	< 0.001	1 < 2[c]	≥1 to 35 h/w	1,184	2.00	(0.02)	<0.001	2 < 3, 4
(α=0.91)	≥35 to 50 h/w	2,220	2.02	(0.02)		2 < 3, 4	≥35 to 50 h/w	4,725	2.05	(0.01)		
	≥50 to 60 h/w	3,797	2.10	(0.01)			≥50 to 60 h/w	703	2.23	(0.03)		
	≥60 h/w	366	2.27	(0.04)			≥60 h/w	194	2.28	(0.06)		
Anxiety	≥1 to 35 h/w	318	1.91	(0.05)	< 0.001	2 < 3, 4	≥1 to 35 h/w	1,184	2.00	(0.02)	<0.001	2 < 3, 4
(α=0.85)	≥35 to 50 h/w	2,220	2.02	(0.02)			≥35 to 50 h/w	4,725	2.07	(0.01)		
	≥50 to 60 h/w	3,797	2.12	(0.01)			≥50 to 60 h/w	703	2.26	(0.03)		
	≥60 h/w	366	2.33	(0.04)			≥60 h/w	194	2.30	(0.06)		
Depression	≥1 to 35 h/w	318	1.69	(0.04)	0.14		≥1 to 35 h/w	1,184	1.72	(0.02)	<0.001	2 < 3
(α=0.89)	≥35 to 50 h/w	2,220	1.77	(0.01)			≥35 to 50 h/w	4,725	1.77	(0.01)		
	≥50 to 60 h/w	3,797	1.79	(0.01)			≥50 to 60 h/w	703	1.88	(0.03)		
	≥60 h/w	366	1.82	(0.04)			≥60 h/w	194	1.88	(0.05)		
Fatigue	≥1 to 35 h/w	318	1.72	(0.06)	< 0.001	1 < 2	≥1 to 35 h/w	1,184	1.91	(0.03)	<0.001	1 < 2
(α=0.90)	≥35 to 50 h/w	2,220	1.98	(0.02)		2 < 3, 4	≥35 to 50 h/w	4,725	2.01	(0.01)		2 < 3, 4
	≥50 to 60 h/w	3,797	2.06	(0.01)			≥50 to 60 h/w	703	2.25	(0.03)		
	≥60 h/w	366	2.26	(0.05)			≥60 h/w	194	2.28	(0.06)		
Physical complaint	≥1 to 35 h/w	318	1.64	(0.04)	< 0.001	1 < 2	≥1 to 35 h/w	1,184	1.70	(0.02)	<0.001	1 < 2
(α=0.86)	≥35 to 50 h/w	2,220	1.76	(0.01)			≥35 to 50 h/w	4,725	1.75	(0.01)		2 < 3 ,4
	≥50 to 60 h/w	3,797	1.76	(0.01)			≥50 to 60 h/w	703	1.84	(0.02)		
	≥60 h/w	366	1.81	(0.03)			≥60 h/w	194	1.87	(0.04)		
Positive work-related state of mind[d]	≥1 to 35 h/w	318	2.54	(0.04)	< 0.001	2 < 3, 4	≥1 to 35 h/w	1,184	2.52	(0.02)	0.94	---
	≥35 to 50 h/w	2,220	2.47	(0.01)			≥35 to 50 h/w	4,725	2.51	(0.01)		
(self-motivated action α=0.81)	≥50 to 60 h/w	3,797	2.52	(0.01)			≥50 to 60 h/w	703	2.50	(0.02)		
(positive emotion α=0.94)	≥60 h/w	366	2.62	(0.03)			≥60 h/w	194	2.50	(0.04)		

[a]: adjusted for sex, age, employment type, job category, and work pattern.

[b]: Bonfferoni method.

[c]: 1; ≥1 to 35 h/w, 2; ≥35 to 50 h/w, 3; ≥50 to 60 h/w, 4; ≥60 h/w, and reference group is 2.

[d]: Positive work-related state of mind was calculated by average of total scores of self-motivated action and positive emotion.

SE: standard error; OWH: objective working hours; SWH: subjective working hours.

project has been recruiting other companies to participate in the study. We expect to see how these results would be applicable to the other sets of employees' data. Second, working hours and health-related variables were evaluated at a specific point in time on a cross-sectional design, and their causal relationships cannot be determined. Third, only five variables, sex, age, employment type, job category, and work pattern were controlled for ANCOVA. Thus, other confounding factors (e.g., smoking, alcohol use, sleep, physical activity, and family history of diseases)[3, 4] need to be addressed properly in future study.

Conclusions

Comparing OWH with SWH during one month in a certain company in Japan, we found that as OWH became longer, the workers tended to underestimate their working hours. In addition, some physical health indicators and positive work-related state of mind were significantly related to OWH but not to SWH. Therefore, given the discrepancy between OWH and SWH, SWH should be used carefully as an exposure factor in examining workers' health.

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