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ORIGINAL ARTICLE

Investigating the associations between work hours, sleep status, and self-reported health among full-time employees

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Abstract
Objectives The extent to which work hours and sleep are associated with self-rated health (SRH) was investigated in full-time employees of small- and medium-scale businesses (SMBs) in a suburb of Tokyo.
Methods A total of 2,579 employees (1,887 men and 692 women), aged 18–79 (mean 45) years, in 296 SMBs were surveyed using a self-administered questionnaire from August to December 2002. Work hours, sleep, and SRH were evaluated.
Results Compared with those working 6–8 h/day, participants working >8 to 10 h/day and >10 h/day had significantly higher odds of suboptimal SRH [adjusted odds ratio (aOR) 1.36 and 1.87, respectively]. Similarly, compared with those sleeping 6+ h/day and sufficient sleep, participants with short sleep (<6 h/day) and insufficient sleep had increased odds of suboptimal SRH (aOR 1.65 and aOR 2.03, respectively). Combinations of the longest work hours with short sleep (aOR 3.30) or insufficient sleep (aOR 3.40) exerted synergistic negative associations on SRH.
Conclusions This study suggests that long work hours and poor sleep and its combination are associated with suboptimal SRH.

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Introduction

Self-rated health (SRH) or perceived health has become an increasingly common measure used in population surveys. It is often based on a simple question where people are asked to rate their current overall health, typically on a four or five-point scale ranging from "very good" to "very poor". Despite its simplicity, responses to this question have proven to be a robust predictor of important endpoints such as functional disability (Svedberg et al. 2006; Idler et al. 2000), morbidity (Vahtera et al. 2010), and mortality (Kawada 2003; Khang and Kim 2010). SRH has also been shown to be a stronger predictor of these endpoints than physician-observed medical records (Jylha 2009). Due to a strong predictive validity, SRH has often been used as a health indicator in occupational health research. In a national representative survey of US working adults, occupational prestige was found to be strongly associated with SRH (Fujishiro et al. 2010). High job stress such as high effort–reward imbalance, high job insecurity, and poor labor market chances predicted a decline in SRH (Rugulies et al. 2008; Niedhammer et al. 2004).

Long work hours/excessive overtime has been indicated to exert an adverse effect on health and it is considered to be a major occupational health concern. According to the most recent review regarding long work hours and health (van der Hulst 2003), six studies have investigated the association between work hours and self-assessed health status. Of these reports, two found significant associations between long work hours and poor self-assessed heath

(Ettner and Grzywacz 2001; Jex and Bliese 1999) while four reported insignificant associations (Baldwin et al. 1997; Tyssen et al. 2000; Steptoe et al. 1998; Borg and Kristensen 1999). More recently, a population survey in Poland ($n = 598$) reported that people working >42 h/week had 80% increase of suboptimal SRH compared to those working 40–42 h/week (Kaleta et al. 2006). Similarly, using a nationally representative sample of US working adults ($n = 1{,}744$) reported that those working 70+ h/week had 94% increased risk of suboptimal SRH, while working 49–69 h/week showed 46% decrease of suboptimal SRH compared to those working 35–40 h/week (reference group) (Grosch et al. 2006). A prospective study of Dutch working population ($n = 649$) reported that high levels of overtime predicted lower levels of SRH after 2 years of observation (Taris et al. 2011). In light of these two latter findings, it seems that particularly excessive overtime work is detrimental to health while a moderate level of overtime work may not be too harmful.

An important issue remains to be resolved in the link between work hours and health is that long work hours/overtime results in a short sleeping time or insufficient sleep (Basner et al. 2007; Virtanen et al. 2009a; Caruso 2006) which may reduce time for recovery. And as a consequence, it is not well established whether a poor rating of health is the direct result of excessive work hours or sleep deprivation, or if they exert an additive or synergistic association. The Whitehall II cohort study reported that working more than 55 h/week, compared with working 35–40 h/week was associated with 1.98 times higher odds for shortened sleep hours (>7 h/day) in their cross-sectional assessment, while repeated exposure to long work hours was associated with up to 3.24 times higher odds for shortened sleep (Virtanen et al. 2009a). It has also been reported that people with poor sleep or short sleep tend to report suboptimal SRH compared to those with good sleep habits (Steptoe et al. 2006; Hasson et al. 2006). Thus, it seems important to examine the combined associations of work hours and sleep on SRH, which has not been systematically investigated to date.

The current study was therefore designed to clarify the association of work hours and sleep on SRH among 3,693 Japanese full-time workers from 329 small and medium-scale businesses (SMBs) comprising various industry sectors and occupations. Our purpose was to investigate the following three research questions:

1. Are long work hours independently related to suboptimal SRH?
2. Are short sleep hours and subjective insufficient sleep, respectively, related to suboptimal SRH?
3. Are long work hours and sleep deprivation yield interactive associations with suboptimal SRH?

Methods

Study population

The study sample consisted of full-time employees of SMBs with 1–158 workers in the city of Yashio, Saitama, and in the Ohta ward of Tokyo. Yashio has the highest percentage of manufacturing plants in Saitama prefecture. The ward of Ohta, which is a so-called "industrial area", is unique for its number of small and medium-sized businesses. We randomly selected 329 businesses from Yashio and 61 from the Ohta ward depending on the distribution of types of businesses in each city. An occupational health nurse/physician contacted representative of each enterprise by telephone to request participation in the questionnaire survey. Among these businesses, 248 in Yashio and 52 in Ohta agreed to participate. Questionnaires were distributed to all employees during visits to each factory; 2,591 employees in Yashio and 1,102 employees in Ohta ($n = 3{,}693$). Finally, responses were obtained from 2,884 employees (2,022 men and 862 women) from 296 businesses, representing a response rate of 78.1%. Those who had missing responses to sex, age, work hours, sleep hours, subjective sleep sufficiency, SRH, and physical/psychological disorders were eliminated from the analyses ($n = 209$). Similarly, those who reported working less than 6 h/day or more than 20 h/day ($n = 94$) or were less than 18 years old ($n = 2$) were excluded. Since there were less than 5% missing responses for all the covariates in this study, missing value analysis was performed (van Ginkel and van der Ark 2005). The 'expectation–maximization method' of imputing missing values was utilized. Data on a total of 2,579 participants (1,887 men and 692 women) were used in the final analyses.

The questionnaire elicited information on sociodemographic and socioeconomic factors, lifestyle, and occupational factors. Selected characteristics of the study population by SRH are shown in Table 1. The study was approved by the Medical Ethical Committee of The University of Tokyo.

Measures

Work hours were assessed by an open-ended question: How many hours do you usually work in a typical working day? Work hours were classified into three groups, i.e., 6–8 h/day, >8 to 10 h/day, and >10 h/day.

The following two questions about daily sleep hours and subjective sleep sufficiency during the previous 1-year period were included in the questionnaire:

1. On average, how much sleep at night do you usually get? (<5 h/5 to <6 h/6 to <7 h/7 to <8 h/8 to <9 h/9+ h)

Table 1 Selected characteristics of the study participants by self-rated health in a suburb of Tokyo, Japan, 2002

Characteristics	Total (*N*)	Self-rated health[a]		p[b]
		Optimal [*n* (%)]	Suboptimal [*n* (%)]	
Number of participants	2,579	1,690 (65.5)	889 (34.5)	
Sociodemographic and socioeconomic factors				
Sex				0.886
Men	1,887	1,235 (65.4)	652 (34.6)	
Women	692	455 (65.8)	237 (34.2)	
Age group (years)				0.334
18–29	423	275 (65.0)	148 (35.0)	
30–39	570	370 (64.9)	200 (35.1)	
40–49	437	275 (62.9)	162 (37.1)	
50–59	771	506 (65.6)	265 (34.4)	
60+	378	264 (69.8)	114 (30.2)	
Marital status				0.028
Married	1,748	1,175 (67.2)	573 (32.8)	
Single	663	408 (61.5)	255 (38.5)	
Separated/divorced/widowed	168	107 (63.7)	61 (36.3)	
Highest education				0.035
Junior high school	525	363 (69.1)	162 (30.9)	
High school	1,275	748 (58.7)	423 (33.2)	
Vocational/junior college	366	254 (69.4)	112 (30.6)	
College/graduate school	413	258 (62.5)	155 (37.5)	
Health indicators				
Smoking				0.013
Lifetime nonsmoker	1,056	723 (68.5)	333 (31.5)	
Former smoker	256	172 (67.2)	84 (32.8)	
Current smoker	1,267	795 (62.7)	472 (37.3)	
Alcohol consumption (g ethanol/day)				0.393
Non-drinker (0.0)	827	532 (64.3)	295 (35.7)	
0.01–4.9	415	285 (68.7)	130 (31.3)	
5.0–14.9	528	342 (64.8)	186 (35.2)	
15.0–24.9	397	252 (63.5)	145 (36.5)	
25.0 and over	412	279 (67.7)	133 (32.3)	
Caffeine intake (cups of coffee or tea/day)				0.319
Almost none	234	159 (67.9)	75 (32.1)	
1 cup	446	297 (66.6)	149 (33.4)	
2 cups	770	501 (65.1)	269 (34.9)	
3–5 cups	931	616 (66.2)	315 (33.8)	
6 cups or more	198	117 (59.1)	81 (40.9)	
Body mass index (in quintiles)				0.186
1st quintile (less than 20.1)	503	311 (61.8)	192 (38.2)	
2nd quintile (20.1 to <21.8)	492	330 (67.1)	162 (32.9)	
3rd quintile (21.8 to <23.2)	544	369 (67.8)	175 (32.2)	
4th quintile (23.2 to <25.2)	531	356 (67.0)	175 (33.0)	
5th quintile (25.2 or higher)	509	324 (63.7)	185 (36.3)	
Physical/psychological disorders				<0.001
Absent	1,973	1,381 (70.0)	592 (30.0)	
Present	606	309 (51.0)	297 (49.0)	

Table 1 continued

Characteristics	Total (*N*)	Self-rated health[a]		p[b]
		Optimal [*n* (%)]	Suboptimal [*n* (%)]	
Occupational factors				
Job type				0.942
Managerial/clerical	674	443 (65.7)	231 (34.3)	
Sales/service	185	125 (67.6)	60 (32.4)	
Technical	96	61 (63.5)	35 (36.5)	
Production/manufacturing	1,104	717 (64.9)	387 (35.1)	
Other	520	344 (66.2)	176 (33.8)	
Work schedule				0.174
Non-shift daytime	2,359	1,555 (65.9)	804 (34.1)	
Shift work (rotating shift/night shift/evening shift)	220	135 (61.4)	85 (38.6)	
Job control (in tertiles)				0.075
High	852	581 (68.2)	271 (31.8)	
Medium	874	572 (65.4)	302 (34.6)	
Low	853	537 (63.0)	316 (37.0)	

[a] Self-rated health was dichotomized into optimal (good or very good) and suboptimal (poor or very poor) health

[b] Chi-squared test (comparison within self-rated health groups)

2. Do you think your daily sleep is sufficient? (very insufficient/somewhat insufficient/fairly sufficient/very sufficient)

A strong convergent and discriminant validity as well as a high level of test–retest stability over 1 year for these questions has been reported (Nakata et al. 2008).

SRH was assessed with a question: How would you describe your health during the past 1-year period? (very good/good/poor/very poor).

We dichotomized SRH into suboptimal (poor or very poor) and optimal (good or very good). Similar use of SRH is common in studies of this (Jylha et al. 2006; Nakata et al. 2009). Test–retest over 1 year using a similar SRH question (Nakata et al. 2010) in white-collar workers ($n = 109$) revealed a high reliability of this scale ($r = 0.457$, $p < 0.001$). Validity was estimated by calculating Spearman's rank correlation coefficients with covariates in the present sample. The results showed that all correlations were in the expected direction indicating a high convergent validity (Table 2).

Covariates

Covariates considered included age, educational level (junior high school, high school, vocational/junior college, college/university), marital status (married, single, separated/divorced/widowed), number of children in the household (0, 1, 2, 3+ children), household financial situation (very comfortable/comfortable, just getting by, finding it difficult/very difficult), smoking (lifetime

Table 2 Spearman's rank correlation coefficients between self-rated health and covariates in a suburb of Tokyo, Japan, 2002

Variable	Self-rated health[a]	
Sex (1 = men, 2 = women)	0.008	NS
Age (in years) (continuous)	−0.017	NS
Educational Level (1 = junior high school 4 = college/university)	0.022	NS
Household financial situation (1 = very comfortable, 5 = very difficult)	0.114	***
Smoking (1 = lifetime non, 2 = former, 3 = current)	0.049	*
Alcohol consumption (g ethanol/day) (continuous)	−0.010	NS
BMI (continuous)	−0.018	NS
Presence of disorders (0 = no, 1 = yes)	0.168	***
Job type (1 = managerial/clerical, 5 = other)	−0.007	NS
Industry sector (1 = ceramic/clay/stone, 10 = other)	−0.012	NS
Job control (continuous)	−0.063	**

NS non significant

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[a] Self-rated health (1 = very good, 4 = very poor)

nonsmoker, former smoker, current smoker), alcohol consumption (g ethanol/day), caffeine intake (cups of coffee or tea per day), height, weight, self-reported illness, job type (managerial/clerical, sales/service, technical, production manufacturing), industry sector (ceramic/clay/stone, textile, papermaking, printing, chemical, leather, metalworking, food, machinery, other), work schedule (non-shift daytime, rotating shift/night shift/evening shift), and company size by number of employees (in quintiles), and job control (high, medium, low). Alcohol consumption was estimated by asking subjects about the usual number of alcoholic drinks consumed per day and the number of occasions in a week that alcoholic drinks were consumed and the responses were categorized into five groups. Gross liquor consumption was converted to net ethanol intake. Information on height and weight were obtained to assess body mass index (BMI), calculated as weight (kg) divided by height (m) squared, and divided into quintiles.

Participants were asked if they were treated for any of the following diseases: hypertension, hyperlipidemia, diabetes mellitus, major depression, menopausal syndrome, or other disorders. If the subjects reported 'other disorders', they were asked to specify the condition. Subjects reported various disorders including cardiovascular disease, cancer, gout, liver disease, renal disease, peptic ulcer, cerebrovascular disease, hyperuricemia, severe allergy, panic disorder, hyperthyroidism, prostatomegaly, rheumatism, musculoskeletal disorders, and gynecologic diseases. If participants reported one or more disorders, they were coded as '1' and if not coded as '0' and included as a covariate in the statistical analyses. Company size was assessed by the number of people working at the participants' office or factory, and divided into quintiles for statistical analyses. Job control was evaluated by the Japanese version of the National Institute for Occupational Safety and Health (NIOSH) Generic Job Stress Questionnaire (GJSQ), which is a well-established means of measurement (Nakata et al. 2007; Hurrell and McLaney 1988). Job control measures how much the worker feels that tasks, workplace setting, and decisions at work are controllable and is assessed based on 16 items. Items are rated on a five-point scale ranging from 1 (very little) to 5 (very much). Internal consistency (Cronbach's α) for this scale was 0.96.

Statistical analyses

Relationship between work hours and SRH, sleep status, and covariates was analyzed by Chi-squared test. The risk of suboptimal SRH by work hours, sleep hours, subjective sleep sufficiency was estimated by univariate and multivariate logistic regression with ORs and 95% CIs as measures of association. Combined associations of work hours and sleep variables (sleep hours or subjective sleep sufficiency) on SRH were also examined by a multivariate logistic regression. They were divided into two sets of six groups as follows: three groups of work hours (6 to <8 h/day, >8 to 10 h/day, or >10 h/day) × two groups of sleep hours (less than 6 h or 6+ h) or × two groups of sleep sufficiency (very sufficient/sufficient or insufficient/very sufficient). The interactive associations of work hours and sleep status on SRH were also examined in the multivariate logistic regression analyses. Adjustments for covariates were made in a stepwise fashion. The first model included sociodemographic and socioeconomic factors as covariates (model 1). Model 2 included health behaviors and physical factors in addition to model 1 covariates. And finally, occupational factors were included in addition to model 2 covariates (model 3). The significance level for all statistical analyses was $p < 0.05$ (two-tailed test). Data were analyzed using SAS statistical software version 9.2 (SAS Institute, Cary, NC, USA).

Results

Descriptive statistics for participants stratified by SRH are shown in Table 1. Being single, higher educational status, current smoking, and suffering from physical/psychological disorders were significantly related to suboptimal SRH.

Relationship between work hours, sleep hours, and sleep sufficiency with SRH are show in Table 3. Long work hours, short sleep hours and insufficient sleep were all related to higher prevalence of suboptimal SRH.

Associations of work hours, sleep hours, and subjective sleep sufficiency with SRH as estimated by stepwise logistic regression analyses are shown in Table 4. Participants working more than 10 h/day or >8 to 10 h/day had significantly higher odds of suboptimal SRH than those working 6–8 h/day (reference category). Similarly, participants sleeping less than 6 h/day had significantly higher odds of suboptimal SRH compared to those sleeping 6+ h/day (reference category). Subjective sleep sufficiency was strongly associated with suboptimal SRH. When subjective sleep sufficiency was categorized into two groups (very sufficient/sufficient, insufficient/very insufficient), those in the 'insufficient/very insufficient' group had significantly higher odds of suboptimal SRH than the 'very sufficient/sufficient' group.

The combined associations of work hours and sleep variables on SRH are shown in Table 5. As compared to a reference group that had a 6–8 h/day work hours and 6+ h/day sleep hours, the odds of suboptimal SRH were significantly higher among participants with any combination of work hours and sleep hours, except a combination of more than 10 h/day work hours and 6+ h/day sleep hours.

Table 3 Relationship between work hours and sleep status with self-rated health in a suburb of Tokyo, Japan, 2002

Characteristics	Total (*N*)	Self-rated health[a]		p^b
		Optimal [*n* (%)]	Suboptimal [*n* (%)]	
Number of participants	2,579	1,690 (65.5)	889 (34.5)	
Work hours/day				<0.001
6 to 8	1,189	825 (69.4)	364 (30.6)	
>8 to 10	1,040	665 (63.9)	375 (36.1)	
>10	350	200 (57.1)	150 (42.9)	
Sleep hours/day				<0.001
6+	1,010	582 (57.6)	428 (42.4)	
<6	1,569	1,108 (70.6)	461 (29.4)	
Subjective sleep sufficiency				<0.001
Very sufficient/sufficient	1,354	987 (72.9)	367 (27.1)	
Insufficient/very insufficient	1,225	703 (57.4)	522 (42.6)	

[a] Self-rated health was dichotomized into optimal (good or very good) and suboptimal (poor or very poor) health

[b] Chi-squared test or Fischer's exact test (comparison within self-rated health groups)

Table 4 Association of work hours, sleep hours, and sleep sufficiency with self-rated health in a suburb of Tokyo, Japan, 2002

Suboptimal self-rated health	Model 1[a]		Model 2[b]		Model 3[c]	
Variables	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Work hours/day		<0.001		<0.001		<0.001
6 to 8	1.00 (reference)		1.00 (reference)		1.00 (reference)	
>8 to 10	1.33 (1.10, 1.60)		1.33 (1.09, 1.61)		1.36 (1.11, 1.66)	
>10	1.80 (1.38, 2.35)		1.75 (1.34, 2.30)		1.87 (1.41, 2.49)	
Sleep hours/day		<0.001		<0.001		<0.001
6+	1.00 (reference)		1.00 (reference)		1.00 (reference)	
<6	1.67 (1.41, 1.98)		1.62 (1.36, 1.94)		1.65 (1.38, 1.98)	
Subjective sleep sufficiency		<0.001		<0.001		<0.001
Very sufficient/sufficient	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Insufficient/very insufficient	1.95 (1.64, 2.32)		1.97 (1.65, 2.36)		2.03 (1.69, 2.44)	

OR odds ratio, *CI* confidence interval

[a] Adjusted for sex, age group, educational level, marital status, number of children in the household, and household financial situation

[b] Adjusted for sex, age group, educational level, marital status, number of children in the household, household financial situation, smoking, drinking, caffeine intake, BMI (in quintiles), and physical/psychological disorders (presence/absence)

[c] Adjusted for sex, age group, educational level, marital status, number of children in the household, household financial situation, smoking, drinking, caffeine intake, BMI (in quintiles), physical/psychological disorders (presence/absence), job type, industry sector, work schedule, company size (in quintiles), and job control (high/medium/low)

Similarly, any combinations of work hours with insufficient sleep were significantly associated with suboptimal SRH compared to a reference group with 6–8 h/day work hours and sufficient sleep. No significant interactive associations of work hours and sleep variables on SRH were found in different multivariate logistic regression models.

Discussion

The purpose of the present study was to clarify the associations of work hours and sleep with SRH in a large number of employees at SMBs. The results revealed the following: (a) long work hours (>8 to 10 and more than 10 h/day) were significantly associated with suboptimal SRH; (b) short sleep (less than 6 h/day) and subjective insufficient sleep were both significantly related to suboptimal SRH; and (c) combination of longest work hours with short sleep or insufficient sleep had a highest odds of suboptimal SRH. The results suggest that long work hours and poor sleep are both associated with suboptimal SRH, but it exerted a stronger association when long work hours and poor sleep were combined.

Table 5 Combined associations of work hours and sleep variables on suboptimal self-rated health in a suburb of Tokyo, Japan, 2002

Combinations	*n* (%)	Model 1[a]		Model 2[b]		Model 3[c]	
		OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Work hours and sleep hours[d]			<0.001		<0.001		<0.001
Work 6 to 8 h/day with sleep 6+ h/day	791 (30.7)	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Work 6 to 8 h/day with sleep <6 h/day	398 (15.4)	1.52 (1.17, 1.98)		1.44 (1.10, 1.88)		1.45 (1.10, 1.90)	
Work >8 to 10 h/day with sleep 6+ h/day	642 (24.9)	1.34 (1.06, 1.70)		1.33 (1.04, 1.69)		1.36 (1.06, 1.74)	
Work >8 to 10 h/day with sleep <6 h/day	398 (15.4)	1.88 (1.44, 2.46)		1.84 (1.40, 2.42)		1.93 (1.45, 2.55)	
Work >10 h/day with sleep 6+ h/day	136 (5.3)	1.12 (0.74, 1.71)		1.06 (0.69, 1.63)		1.11 (0.72, 1.71)	
Work >10 h/day with sleep <6 h/day	214 (8.3)	3.02 (2.17, 4.21)		2.92 (2.08, 4.10)		3.30 (2.31, 4.71)	
Work hours and subjective sleep sufficiency[e]			<0.001		<0.001		<0.001
Work 6 to 8 h/day with sufficient sleep	709 (27.5)	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Work 6 to 8 h/day with insufficient sleep	480 (18.6)	1.71 (1.32, 2.21)		1.76 (1.35, 2.28)		1.81 (1.38, 2.36)	
Work >8 to 10 h/day with sufficient sleep	532 (20.6)	1.22 (0.94, 1.58)		1.23 (0.94, 1.61)		1.26 (0.96, 1.67)	
Work >8 to 10 h/day with insufficient sleep	508 (19.7)	2.28 (1.75, 2.95)		2.31 (1.77, 3.02)		2.45 (1.86, 3.23)	
Work >10 h/day with sufficient sleep	113 (4.4)	1.21 (0.76, 1.92)		1.19 (0.74, 1.91)		1.29 (0.80, 2.08)	
Work >10 h/day with insufficient sleep	237 (9.2)	3.07 (2.21, 4.25)		3.03 (2.17, 4.23)		3.40 (2.38, 4.83)	

OR odds ratio, *CI* confidence interval

[a] Adjusted for sex, age group, educational level, marital status, number of children in the household, and household financial situation

[b] Adjusted for sex, age group, educational level, marital status, number of children in the household, household financial situation, smoking, drinking, caffeine intake, BMI (in quintiles), and physical/psychological disorders (presence/absence)

[c] Adjusted for sex, age group, educational level, marital status, number of children in the household, household financial situation, smoking, drinking, caffeine intake, BMI (in quintiles), physical/psychological disorders (presence/absence), job type, industry sector, work schedule, company size (in quintiles), and job control (high/medium/low)

[d] Interactions of work hours and sleep hours were not significant for models 1–3

[e] Interactions of work hours and sleep sufficiency were not significant for models 1–3

Combinations of longest work hours with poor sleep habits yielded a strong negative association on SRH, suggesting that employees working long and having poor sleep are at a high risk of developing future health condition. However, the results also suggest that even though employees are not working too long (6–8 h/day) but are suffering from poor sleep, they have more chance to develop suboptimal SRH (Table 5). On the contrary, the association between work hours and suboptimal SRH was weak when participants were under good sleep condition, suggesting that poor sleep is the main factor contributing to suboptimal SRH. The methodology outlined in this study may help to more precisely elucidate the relationship between work hours and health by taking sleep status into consideration.

The present study found a significant association between short sleep and suboptimal SRH; insufficient sleep was also significantly correlated with suboptimal SRH. A large cross-sectional study of sleep hours and SRH in young adults reported that short sleep (less than 7 h/day) was associated with a significant increase of suboptimal SRH compared to those sleeping 7–8 h/day, but long sleep (8+ h/day) did not show significant association with SRH (Steptoe et al. 2006). Authors considered that the absence of an association between longer sleep and suboptimal SRH may attributable to the fact that participants were young (university students) who typically sleep longer than older individuals without pathological sign. A community-based study in Canada reported that suboptimal SRH was more frequent in participants who slept for either more or less than 7–8 h/day (Segovia et al. 1989), indicating a U-shaped relationship. In addition, a 12-month prospective study of IT and media workers found that baseline sleep quality was the second strongest predictor of future SRH (Hasson et al. 2006). These findings together with our results indicate that sleep status is a crucial factor affecting SRH.

Long work hours have been reported to be associated with various health issues including cardiovascular disease (Liu and Tanaka 2002), hypertension (Yang et al. 2006), diabetes (Kawakami et al. 1999), depression (Kleppa et al. 2008), anxiety (Kleppa et al. 2008), fatigue (Grosch et al. 2006), psychological symptoms (Sekine et al. 2009), and reduced cognitive function (Virtanen et al. 2009b) that may contribute to poor rating of health. A study in Norway reported that men and women who worked overtime (41+ h/week) had a 35 and 44% increase, respectively, in the prevalence of anxiety disorders compared to those

working 40 h or less (Kleppa et al. 2008). Similarly, in the same study, men and women who worked overtime had a 61 and 41% increase, respectively, of depression. A cross-cultural study of civil servants in Britain, Finland, and Japan reported that subjects with long work hours (more than 11 h/day) had significantly worse mental functioning (as measured by Short Form-36) as compared with work hours of 7–9 h/day in Japanese men (OR 2.07) and women (OR 3.43), although employees in Britain and Finland did not show significant impact of work hours on mental health (ORs of 0.81–1.28) (Sekine et al. 2009). A prospective study of long work hours and cognitive function revealed that working more than 55 h/week, as compared to ≤40 h/week, was associated with lower vocabulary test scores at both baseline and follow-up (Virtanen et al. 2009b). On the other hand, there are reports that failed to find a significant association of long work hours and health outcomes such as hypertension (Wada et al. 2006; Nakanishi et al. 2001) and SRH, as stated earlier. In addition to considering sleep as an important factor on the relationship between work hours and health, following factors may also need to be taken into account in future studies. First, a bias which can be caused by organizational culture or work condition norms, e.g., a ceiling or flooring effect of work hours and health outcomes, leading to underestimation of the associations. Second, as pointed out by van der Hulst, earlier studies have not controlled for essential confounders (van der Hulst 2003). Third, the association may be attenuated by the fact that some employees voluntarily work longer for their own benefit or preferences or they are tolerant of long work hours without suffering from health issues (healthy survivor effect). By contrast, employees who had already developed ill health or had subclinical status may have worked lesser hours to reduce their burden. Both of these factors can cause selection biases leading toward underestimation of the association.

A principal strength of this study is that it explored not only the individual association of work hours and sleep with SRH, but also evaluated the combined associations of work hours and sleep status on SRH in a fairly large number of full-time employees of SMBs composed of various industry sectors and occupations. In addition, the analyses have adjusted for a number of covariates in a stepwise fashion to clarify how these covariates contribute to the relationship between work hours, sleep, and SRH. Also, participants working <6 h/day and 20+ h/day were excluded to minimize selection bias leading to underestimation.

There are a number of limitations to this study. First, the study was cross-sectional in nature; thus, no causal interpretations can be made. Second, work hours and sleep status were assessed by self-report rather than through the use of objective measures such as recording for work hours and sleep polysomnography. Third, response bias may have occurred if non-respondents differed from respondents; in particular, those who worked extremely long hours may have had less time available to respond to the questionnaire. Finally, although we adjusted for a variety of confounding variables, we could not exclude the possibility that unmeasured factors, such as diet, physical exercise, and usage of psychoactive medication may explain the present findings.

In conclusion, this study found individual associations of work hours, sleep duration, and subjective sleep sufficiency with SRH. However, when the combined associations of work hours and sleep on SRH were tested, short sleep/insufficient sleep turned out to be the dominant factor related to suboptimal SRH. Furthermore, a combination of longest work hours with short sleep/insufficient sleep exerted a strongest association on suboptimal SRH. Further studies are needed to determine whether reducing work hours and obtaining better sleep contributes to improvement of SRH.

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Conflict of interest The author declares that he has no competing interests.

References

Baldwin PJ, Dodd M, Wrate RW (1997) Young doctors' health—I. How do working conditions affect attitudes, health and performance? Soc Sci Med 45(1):35–40

Basner M, Fomberstein KM, Razavi FM, Banks S, William JH, Rosa RR, Dinges DF (2007) American time use survey: sleep time and its relationship to waking activities. Sleep 30(9):1085–1095

Borg V, Kristensen TS (1999) Psychosocial work environment and mental health among travelling salespeople. Work Stress 13(2):132–143

Caruso CC (2006) Possible broad impacts of long work hours. Ind Health 44(4):531–536

Ettner SL, Grzywacz JG (2001) Workers' perceptions of how jobs affect health: a social ecological perspective. J Occup Health Psychol 6(2):101–113

Fujishiro K, Xu J, Gong F (2010) What does "occupation" represent as an indicator of socioeconomic status? Exploring occupational prestige and health. Soc Sci Med 71(12):2100–2107

Grosch JW, Caruso CC, Rosa RR, Sauter SL (2006) Long hours of work in the US: associations with demographic and organizational

characteristics, psychosocial working conditions, and health. Am J Ind Med 49(11):943–952
Hasson D, Arnetz BB, Theorell T, Anderberg UM (2006) Predictors of self-rated health: a 12-month prospective study of IT and media workers. Popul Health Metr 4:8
Hurrell JJ, Jr, McLaney MA (1988) Exposure to job stress—a new psychometric instrument. Scand J Work Environ Health 14(Suppl 1):27–28
Idler EL, Russell LB, Davis D (2000) Survival, functional limitations, and self-rated health in the NHANES I Epidemiologic Follow-up Study, 1992. First National Health and Nutrition Examination Survey. Am J Epidemiol 152(9):874–883
Jex SM, Bliese PD (1999) Efficacy beliefs as a moderator of the impact of work-related stressors: a multilevel study. J Appl Psychol 84(3):349–361
Jylha M (2009) What is self-rated health and why does it predict mortality? Towards a unified conceptual model. Soc Sci Med 69(3):307–316
Jylha M, Volpato S, Guralnik JM (2006) Self-rated health showed a graded association with frequently used biomarkers in a large population sample. J Clin Epidemiol 59(5):465–471
Kaleta D, Makowiec-Dabrowska T, Dziankowska-Zaborszczyk E, Jegier A (2006) Physical activity and self-perceived health status. Int J Occup Med Environ Health 19(1):61–69
Kawada T (2003) Self-rated health and life prognosis. Arch Med Res 34(4):343–347
Kawakami N, Araki S, Takatsuka N, Shimizu H, Ishibashi H (1999) Overtime, psychosocial working conditions, and occurrence of non-insulin dependent diabetes mellitus in Japanese men. J Epidemiol Community Health 53(6):359–363
Khang YH, Kim HR (2010) Self-rated health and mortality: gender- and age-specific contributions of explanatory factors in South Korea. Int J Public Health 55(4):279–289
Kleppa E, Sanne B, Tell GS (2008) Working overtime is associated with anxiety and depression: the Hordaland Health Study. J Occup Environ Med 50(6):658–666
Liu Y, Tanaka H (2002) Overtime work, insufficient sleep, and risk of non-fatal acute myocardial infarction in Japanese men. Occup Environ Med 59(7):447–451
Nakanishi N, Yoshida H, Nagano K, Kawashimo H, Nakamura K, Tatara K (2001) Long working hours and risk for hypertension in Japanese male white collar workers. J Epidemiol Community Health 55(5):316–322
Nakata A, Takahashi M, Ikeda T, Haratani T, Hojou M, Araki S (2007) Perceived job stress and sleep-related breathing disturbance in Japanese male workers. Soc Sci Med 64(12):2520–2532
Nakata A, Takahashi M, Haratani T, Ikeda T, Hojou M, Fujioka Y, Araki S (2008) Association of active and passive smoking with sleep disturbances and short sleep duration among Japanese working population. Int J Behav Med 15(2):81–91
Nakata A, Takahashi M, Swanson NG, Ikeda T, Hojou M (2009) Active cigarette smoking, secondhand smoke exposure at work and home, and self-rated health. Public Health 123(10):650–656
Nakata A, Takahashi M, Otsuka Y, Swanson NG (2010) Is self-rated health associated with blood immune markers in healthy individuals? Int J Behav Med 17(3):234–242
Niedhammer I, Tek ML, Starke D, Siegrist J (2004) Effort–reward imbalance model and self-reported health: cross-sectional and prospective findings from the GAZEL cohort. Soc Sci Med 58(8):1531–1541
Rugulies R, Aust B, Burr H, Bultmann U (2008) Job insecurity, chances on the labour market and decline in self-rated health in a representative sample of the Danish workforce. J Epidemiol Community Health 62(3):245–250
Segovia J, Bartlett RF, Edwards AC (1989) The association between self-assessed health status and individual health practices. Can J Public Health 80(1):32–37
Sekine M, Chandola T, Martikainen P, Marmot M, Kagamimori S (2009) Socioeconomic inequalities in physical and mental functioning of British, Finnish, and Japanese civil servants: role of job demand, control, and work hours. Soc Sci Med 69(10):1417–1425
Steptoe A, Wardle J, Lipsey Z, Mills R, Oliver G, Jarvis M, Kirschbaum C (1998) A longitudinal study of work load and variations in psychological well-being, cortisol, smoking, and alcohol consumption. Ann Behav Med 20(2):84–91
Steptoe A, Peacey V, Wardle J (2006) Sleep duration and health in young adults. Arch Intern Med 166(16):1689–1692
Svedberg P, Bardage C, Sandin S, Pedersen NL (2006) A prospective study of health, life-style and psychosocial predictors of self-rated health. Eur J Epidemiol 21(10):767–776
Taris TW, Ybema JF, Beckers DG, Verheijden MW, Geurts SA, Kompier MA (2011) Investigating the associations among overtime work, health behaviors, and health: a longitudinal study among full-time employees. Int J Behav Med (in press)
Tyssen R, Vaglum P, Gronvold NT, Ekeberg O (2000) The impact of job stress and working conditions on mental health problems among junior house officers. A nationwide Norwegian prospective cohort study. Med Educ 34(5):374–384
Vahtera J, Westerlund H, Ferrie JE, Head J, Melchior M, Singh-Manoux A, Zins M, Goldberg M, Alexanderson K, Kivimaki M (2010) All-cause and diagnosis-specific sickness absence as a predictor of sustained suboptimal health: a 14-year follow-up in the GAZEL cohort. J Epidemiol Community Health 64(4):311–317
van der Hulst M (2003) Long work hours and health. Scand J Work Environ Health 29(3):171–188
van Ginkel JR, van der Ark LA (2005) SPSS syntax for missing value imputation in test and questionnaire data. Appl Psychol Meas 29(2):152–153
Virtanen M, Ferrie JE, Gimeno D, Vahtera J, Elovainio M, Singh-Manoux A, Marmot MG, Kivimaki M (2009a) Long working hours and sleep disturbances: the Whitehall II prospective cohort study. Sleep 32(6):737–745
Virtanen M, Singh-Manoux A, Ferrie JE, Gimeno D, Marmot MG, Elovainio M, Jokela M, Vahtera J, Kivimaki M (2009b) Long working hours and cognitive function: the Whitehall II Study. Am J Epidemiol 169(5):596–605
Wada K, Katoh N, Aratake Y, Furukawa Y, Hayashi T, Satoh E, Tanaka K, Satoh T, Aizawa Y (2006) Effects of overtime work on blood pressure and body mass index in Japanese male workers. Occup Med (Lond) 56(8):578–580
Yang H, Schnall PL, Jauregui M, Su TC, Baker D (2006) Work hours and self-reported hypertension among working people in California. Hypertension 48(4):744–750