Work Hours, Sleep Sufficiency, and Prevalence of Depression Among Full-Time Employees: A Community-Based Cross-Sectional Study

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Objective: Depression due to long work hours and sleep deprivation is a major occupational health concern. The extent to which work hours and sleep are associated with depression was investigated in employees of small- and medium-scale businesses in the Japanese city of Yashio, Saitama, and in the Ohta ward of Tokyo, a suburb of Tokyo, controlling for various potential confounders.

Method: In this cross-sectional study, a total of 2,643 full-time employees (1,928 men and 715 women), aged 18–79 years (mean = 45 years), in 296 small- and medium-scale businesses were surveyed from August 2002 to December 2002 using a self-administered questionnaire evaluating work hours, sleep status, and covariates including sociodemographic and socioeconomic factors, health behaviors, biological factors, medication usage, and occupational factors. Depression was assessed using the Center for Epidemiologic Studies Depression Scale. Prevalence of depression by work hours, sleep status, and covariates was analyzed by χ^2 test. Risk of depression by work hours, sleep status, and both combined was estimated by multivariate logistic regression analysis.

Results: Participants working > 10 hours per day, sleeping < 6 hours per day, and reporting insufficient sleep were, respectively, 37%, 43%, and 97% more likely to be depressed than those working 6 to 8 hours per day, sleeping 6 to < 8 hours per day, and reporting sufficient sleep ($P < .05$). Participants working > 10 hours per day or > 8 to 10 hours per day with < 6 hours per day of sleep showed a 41%–169% higher prevalence of depression versus those working 6 to 8 hours per day with 6+ hours per day of sleep ($P < .05$). Participants reporting insufficient sleep in 3 work-hour categories (6 to 8, > 8 to 10, and > 10 hours per day) showed a 62%–179% increase in the prevalence of depression versus those working 6 to 8 hours per day and reporting sufficient sleep ($P < .05$). No significant effects on depression were found for subjects in any work-hour category with 6+ hours of sleep or with subjective sufficient sleep.

Conclusions: Depression associated with long work hours is primarily a result of sleep deprivation. Greater attention should be paid to management of sleep deprivation to prevent workplace depression.

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Depression is one of the most common and most costly mental health disorders, contributing to work impairment and reduced productivity and affecting a large number of working people.[1] The most recent nationally representative population data on major depressive disorder (MDD) in the United States estimated that the prevalence of lifetime and 12-month MDD was 16.2% and 6.6%, respectively.[2] According to a report[3] that addressed the economic impact of depression in the United States, the yearly cost was estimated at $83.1 billion in 2000. Of this total cost, up to $51.5 billion (62%) was associated with depression in the workplace.

Some epidemiologic studies have indicated that long work hours/overtime work is an important risk factor for depression.[4–12] For example, a large cross-sectional study[5] of 10,442 employees in Norway reported that men and women who worked overtime (41+ hours per week) experienced, respectively, a 42% and 61% increased prevalence of depression compared to those working 40 hours or less. Other studies,[13–20] however, have failed to confirm such a relationship. A population-based survey[13] in Stockholm (N = 352) revealed that frequent overtime was associated with a 10% increase in subclinical depression in women and a 40% decrease in men, as compared with women and men who worked overtime less frequently.

To the best of my knowledge, there are 17 studies[4–20] to date that have examined the relationship between work hours and depression, and, of these reports, 9 found significant positive associations,[4–12] while 8 reported insignificant relationships.[13–20] The discrepancy in the results may be partly explained by the following reasons. First, most of the studies, and particularly those that yielded insignificant findings, had small sample sizes (< 500 participants).[8,9,11,15–17,19,20] Second, some of the results were based on a survey of a single organization or a specific occupation, which may be biased by organizational culture or work condition norms, eg, a ceiling or flooring effect of work hours and depression outcomes.[4,7–9,11,14,15,17,19] 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 depression.[21,22] By contrast, employees who had already developed depression or who had subclinical depression status may have worked lesser hours to reduce their burden. Both of these factors can cause selection biases leading toward underestimation of the association. Finally, and most importantly, long work hours result in a short sleeping time or insufficient sleep[23–26] (which is also known to cause cardiovascular problems and metabolic syndrome[27]), and it is not well established whether depression is the direct result of excessive work hours or

For Clinical Use

- Long work hours (> 10 hours per day) combined with either subjective insufficient sleep or short sleep (< 6 hours per day) can be related to depression.
- Clinicians should ask depressed persons about not only daily sleep hours or perceived sleep sufficiency but also the number of daily work hours.
- To prevent workplace depression, it would seem to be of crucial importance to offer referrals for help with sleep management and treatment for employees who are working many hours and are sleep deprived and for those who are suffering from chronic sleep debt regardless of work hours.

sleep deprivation, or whether depression and excessive work hours or sleep deprivation exert a synergistic effect. Several prospective[28,29] and cross-sectional studies[30–32] reported a strong association between sleep deprivation and depression. Thus, it seems important to examine the combined effects of work hours and sleep deprivation on depression, which has not been systematically investigated to date.

The current study was therefore designed to examine the effects of work hours and sleep on depression among 3,693 Japanese full-time workers from 390 small- and medium-scale businesses representing various industry sectors and occupations. My purpose was to clarify the following 3 research questions: (1) Are long work hours independently related to depression? (2) Is sleep deprivation, as represented by short sleep and subjective insufficient sleep, independently related to depression? and (3) Are long work hours and sleep deprivation together related to depression? If so, which factor is mainly related to depression?

METHOD

Study Population

The study design was cross-sectional, and data were collected between August 2002 and December 2002 using a self-rated questionnaire (A.N., T. Ikeda, PhD, unpublished questionnaire, April 2002; available upon request from the author). The study sample consisted of full-time employees of small- and medium-scale businesses with 1 to 158 workers in the Japanese city of Yashio, Saitama, and in the Ohta ward of Tokyo, a suburb 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-scale businesses. About 20% of the small- and medium-scale businesses in both areas were selected (weighted by distribution of industry sector types), resulting in 329 small- and medium-scale businesses from Yashio and 61 from the Ohta ward. An occupational health nurse or physician contacted each representative of the company to request participation in the questionnaire survey. Among these businesses, 248 in Yashio and 52 in Ohta agreed to participate. Questionnaires were distributed during visits to each business and were given to 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 (response rate of 78.1%). Those who had missing responses for sex, age, work hours, and sleep status were eliminated from the analyses (n = 81). Similarly, those who had 6 or more missing responses on the Center for Epidemiologic Studies Depression Scale (CES-D) (see Measurements section for detail) and those who had been diagnosed with MDD or anxiety disorders were excluded from the analysis (n = 64). In addition, those who reported working < 6 hours per day or > 20 hours per day (n = 94) or who were < 18 years old (n = 2) were excluded. Since missing responses totaled less than 5% for all the covariates in this study, missing value analysis was performed using IBM SPSS Statistics 17.0 software (SPSS Inc, Chicago, Illinois).[33] The expectation-maximization method of imputing missing values was utilized. Data on a total of 2,643 participants (1,928 men and 715 women) aged 18–79 years (mean = 45 years) were used in the final analyses. The study was approved by the Medical Ethics Committee of the University of Tokyo, Japan. Written informed consent was obtained from all participants.

Measurements

Work hours. Work hours were assessed by an open-ended question: How many hours do you usually work in a typical working day?

Sleep status. The following 2 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 hours, 5 to < 6 hours, 6 to < 7 hours, 7 to < 8 hours, 8 to < 9 hours, or 9+ hours) and (2) Do you think your daily sleep is sufficient? (very insufficient, somewhat insufficient, fairly sufficient, or very sufficient).

Our previous study confirmed a strong convergent and discriminant validity, as well as a high level of test-retest stability over 1 year, for these questions.[34]

Depression. Depression was measured using a Japanese version of the CES-D.[35] The 20-item depressive symptom scale measures the level of depressive symptoms experienced in the past week. The CES-D cut-off score is 16, which differentiates between those exhibiting high levels of depressive symptoms (score ≥ 16) and those with lower levels of such symptoms (score < 16).[36] In addition, I adopted a more stringent cutoff score (≥ 25) to differentiate severe, definite depression.[30,37] To examine the association between sleep parameters and CES-D score, I excluded 1 sleep question ("my sleep was restless") from the 20 items, and the total CES-D score was calculated on the basis of the following formula: CES-D score = (sum of 19 item scores) × (20/19) × (19/number of answered questions). This method, as

Table 1. Characteristics of the Study Participants by Prevalence of Depression as Defined by the Center for Epidemiologic Studies Depression Scale (CES-D) Score (N = 2,643)

Characteristic	n (%)	CES-D Score ≥ 16, % (95% CI)	*P* Value (χ^2 test)	CES-D Score ≥ 25, % (95% CI)	*P* Value (χ^2 test)
Total participants	2,643 (100)	30.7 (29.0–32.5)	NA	12.3 (11.0–13.5)	NA
Sociodemographic and socioeconomic factors					
Sex			.242		.587
Male	1,928 (72.9)	30.1 (28.0–32.1)		12.1 (10.6–13.5)	
Female	715 (27.1)	32.4 (29.0–35.9)		12.9 (10.4–15.3)	
Age group, y			< .001		< .001
18–29	428 (16.2)	42.5 (37.8–47.2)		21.0 (17.2–24.9)	
30–39	573 (21.7)	34.7 (30.8–38.6)		13.4 (10.6–16.2)	
40–49	446 (16.9)	26.2 (22.2–30.3)		9.0 (6.3–11.6)	
50–59	800 (30.3)	27.3 (24.2–30.3)		9.6 (7.6–11.7)	
60–79	396 (15.0)	24.2 (20.0–28.5)		10.4 (7.4–13.4)	
Marital status			< .001		< .001
Married	1,790 (67.7)	26.6 (24.6–28.7)		10.0 (8.6–11.4)	
Single	678 (25.7)	40.1 (36.4–43.8)		18.1 (15.2–21.0)	
Separated/divorced/widowed	175 (6.6)	36.0 (28.9–43.1)		13.1 (8.1–18.1)	
Highest education			.009		.002
Junior high school	552 (20.9)	26.3 (22.6–29.9)		10.1 (7.6–12.7)	
High school	1,306 (49.4)	32.1 (29.6–34.6)		13.0 (11.2–14.8)	
Vocational/junior college	369 (14.0)	35.5 (30.6–40.4)		16.8 (13.0–20.6)	
College/graduate school	416 (15.7)	28.1 (23.8–32.4)		8.9 (6.2–11.6)	
Number of children in the household			.466		.581
0	1,384 (52.4)	30.9 (28.4–33.3)		12.5 (10.8–14.2)	
1	753 (28.5)	32.0 (28.7–35.3)		12.9 (10.5–15.3)	
2	380 (14.4)	29.5 (24.9–34.1)		11.6 (8.4–14.8)	
3+	126 (4.8)	25.4 (17.8–33.0)		8.7 (3.8–13.7)	
Household financial situation			.003		.022
Very comfortable/comfortable	199 (7.5)	25.6 (19.6–31.7)		9.0 (5.1–13.0)	
Just getting by	1,306 (49.4)	28.5 (26.0–30.9)		11.1 (9.4–12.8)	
Finding it difficult/very difficult	1,138 (43.1)	34.2 (31.4–36.9)		14.2 (12.2–16.3)	
Health indicators					
Smoking status			< .001		.001
Lifetime nonsmoker	1,088 (41.2)	28.7 (26.0–31.4)		10.1 (8.3–11.9)	
Former smoker	260 (9.8)	20.8 (15.8–25.7)		7.7 (4.5–10.9)	
Current smoker (> 0 to ≤ 10 cigarettes per day)	218 (8.2)	32.6 (26.3–38.8)		13.3 (8.8–17.8)	
Current smoker (> 10 to ≤ 20 cigarettes per day)	718 (27.2)	35.7 (32.2–39.2)		15.5 (12.8–18.1)	
Current smoker (> 20 cigarettes per day)	359 (13.6)	33.1 (28.3–38.0)		15.3 (11.6–19.0)	
Drinking habits			< .001		.033
Nondrinker	851 (32.2)	30.2 (27.1–33.3)		12.8 (10.6–15.1)	
Occasional drinker (> 0 to ≤ 3 times per week)	647 (24.5)	36.6 (32.9–40.3)		14.7 (12.0–17.4)	
Frequent drinker (≥ 4 times per week)	1,145 (43.3)	27.8 (25.2–30.4)		10.6 (8.8–12.3)	
Caffeine intake (cups of coffee or tea per day)			.935		.616
Almost none	244 (9.2)	31.6 (25.7–37.4)		12.3 (8.2–16.4)	
1–2	1,245 (47.1)	30.4 (24.4–32.7)		12.9 (11.1–14.8)	
3+	1,154 (43.7)	30.8 (28.3–34.8)		11.6 (9.8–13.5)	
Body mass index (calculated as kg/m^2)			< .001		.003
< 20.0	467 (17.7)	38.8 (34.3–43.2)		16.3 (12.9–19.6)	
≥ 20.0 to < 22.5	853 (32.3)	30.2 (27.2–33.3)		13.5 (11.2–15.8)	
≥ 22.5 to < 25.0	766 (29.0)	27.8 (24.6–31.0)		10.6 (8.4–12.8)	
≥ 25.0	557 (21.1)	28.7 (25.0–32.4)		9.5 (7.1–12.0)	
Number of physical/psychological symptoms[a]			.135		.326
None	2,021 (76.5)	29.7 (27.7–31.7)		11.8 (10.4–13.2)	
1	530 (20.1)	34.2 (30.1–38.2)		14.2 (11.2–17.1)	
2+	92 (3.5)	32.6 (23.0–42.2)		13.0 (6.2–19.9)	
Use of medication[b]			.099		.815
No	2,280 (86.3)	30.1 (28.2–32.0)		13.7 (12.3–15.1)	
Yes	363 (13.7)	34.4 (29.6–39.3)		14.2 (10.4–17.9)	
Occupational factors					
Job type			.320		.005
Managerial/clerical	687 (26.0)	33.6 (30.1–37.2)		13.2 (10.7–15.8)	
Sales/service	188 (7.1)	27.1 (20.8–33.5)		5.3 (2.1–8.5)	
Technical	98 (3.7)	32.7 (23.4–41.9)		6.1 (1.4–10.9)	
Production/manufacturing	1,128 (42.7)	29.7 (27.0–32.4)		12.4 (10.5–14.3)	
Other	542 (20.5)	30.1 (26.2–33.9)		14.4 (11.4–17.3)	

(continued)

Table 1 (continued). Characteristics of the Study Participants by Prevalence of Depression as Defined by the Center for Epidemiologic Studies Depression Scale (CES-D) Score (N = 2,643)

Characteristic	n (%)	CES-D Score ≥ 16, % (95% CI)	*P* Value (χ^2 test)	CES-D Score ≥ 25, % (95% CI)	*P* Value (χ^2 test)
Occupational factors (continued)					
Industry sector			.204		.440
Ceramic/clay/stone	49 (1.9)	30.6 (17.7–43.5)		18.4 (7.5–29.2)	
Textile	54 (2.0)	29.6 (17.5–41.8)		7.4 (0.4–14.4)	
Papermaking	150 (5.7)	38.0 (30.2–45.8)		16.7 (10.7–22.6)	
Printing	45 (1.7)	42.2 (27.8–56.7)		15.6 (5.0–26.1)	
Chemical	353 (13.4)	29.5 (24.7–34.2)		11.9 (8.5–15.3)	
Leather	21 (0.8)	47.6 (26.3–69.0)		19.0 (2.3–35.8)	
Metalworking	1,125 (42.6)	28.9 (26.2–31.5)		12.2 (10.3–14.1)	
Food	142 (5.4)	33.1 (25.4–40.8)		8.5 (3.9–13.0)	
Machinery	397 (15.0)	30.2 (25.7–34.7)		12.3 (9.1–15.6)	
Other	307 (11.6)	32.2 (27.0–37.5)		11.7 (8.1–15.3)	
Work schedule			.065		.007
Nonshift daytime	2,407 (91.1)	30.2 (28.4–32.0)		11.8 (10.5–13.0)	
Shift work (rotating shift/night shift/evening shift)	236 (8.9)	36.0 (29.9–42.1)		17.8 (12.9–22.7)	
Size of company by number of employees (in quintiles)			.946		.128
1–8	469 (17.7)	30.1 (25.9–34.2)		10.7 (7.9–13.5)	
9–18	548 (20.7)	31.2 (27.3–35.1)		11.5 (8.8–14.2)	
19–31	547 (20.7)	29.6 (25.8–33.4)		10.6 (8.0–13.2)	
32–61	561 (21.2)	31.7 (27.9–35.6)		14.8 (11.9–17.7)	
62+	518 (19.6)	30.9 (26.9–34.9)		13.7 (10.7–16.7)	
Job control (in tertiles)			.602		.965
High	872 (33.0)	31.1 (28.0–34.1)		12.3 (10.1–14.4)	
Medium	895 (33.9)	29.5 (26.5–32.5)		12.5 (10.3–14.7)	
Low	876 (33.1)	31.6 (28.5–34.7)		12.1 (9.9–14.3)	
Quantitative workload (in tertiles)			< .001		< .001
Low	992 (37.5)	24.5 (21.8–27.2)		7.7 (6.0–9.3)	
Medium	862 (32.6)	29.8 (26.8–32.9)		13.0 (10.7–15.2)	
High	789 (29.9)	39.5 (36.1–43.0)		17.4 (14.7–20.0)	

[a]Physical/psychological symptoms include hypertension, hyperlipidemia, diabetes mellitus, menopausal syndrome, and other disorders including cardiovascular disease, stomach/duodenal ulcer, cancer, arrhythmia, gout, hyperuricemia, renal disease, liver disease, stroke, gynecologic diseases, hyperthyroidism, peptic ulcer, severe allergy, hernia, back pain, rheumatoid arthritis, and panic disorder.
[b]Medications include aspirin, acetaminophen, β-blockers, cold/flu medicine, antihypertensives, naproxen, corticosteroids, and ibuprofen.
Abbreviation: NA = not applicable.

described by Kaneita et al,[30] was used if there were 5 or fewer missing responses on the CES-D. The internal consistency of the CES-D for the study sample was 0.84.

Covariates. Covariates that were considered included sociodemographic and socioeconomic factors, health behaviors, biological factors, medication usage, and occupational factors (Table 1). Information on height and weight was obtained to assess body mass index, calculated as weight in kilograms divided by height in meters squared; body mass index was divided into 4 groups for this study. Job control and quantitative workload were evaluated with the Japanese version of the Generic Job Stress Questionnaire (for English version developed by the National Institute for Occupational Safety and Health, see reference 38), which is a well-established means of measurement.[39–41] Job control is a measure of how much the worker feels that tasks, workplace setting, and decisions at work are controllable and is assessed on the basis of 16 items, while quantitative workload is an estimate of how much work must be done on a daily basis and is based on 4 items. Internal consistency (Cronbach α) for these scales was 0.96 and 0.88, respectively.

Participants were asked if they were being treated for any of the following disorders/symptoms: hypertension, hyperlipidemia, diabetes mellitus, MDD, menopausal syndrome, or other. If the participants reported "other" disorders, they were asked to specify the conditions. Participants reported various disorders as listed on the bottom of Table 1. The numbers of disorders among the participants were counted and were included as a covariate.

Statistical Analyses

Prevalence of depression by work hours, sleep status, and covariates was analyzed by χ^2 test. The risk of depression by work hours and sleep status was estimated by multivariate logistic regression, with odds ratios and 95% confidence intervals as measures of association. Combined effects of work hours and sleep status were also examined by a similar analytic method. These variables were divided into 2 sets of 6 groups as follows: 3 groups of work hours (6 to 8 hours per day, > 8 to 10 hours per day, or > 10 hours per day) × 2 groups of sleep hours (< 6 hours or 6+ hours) or × 2 groups of subjective sleep sufficiency (very sufficient/sufficient or insufficient/very insufficient). Adjustments for covariates were made in a stepwise fashion. Model 1 did not adjust for confounders (crude OR). Model 2 adjusted for sociodemographic and socioeconomic factors. Model 2 was then further adjusted for health behaviors and biological factors to create Model 3 and, finally, for occupational factors to create Model 4. Quantitative workload was left out of all multivariate logistic regression analyses because of a strong

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Table 2. Prevalence of Depression by Work Hours, Sleep Hours, and Subjective Sleep Sufficiency (N = 2,643)

Variable	n (%)	CES-D Score ≥ 16, % (95% CI)	*P* Value (χ^2 test)	CES-D Score ≥ 25, % (95% CI)	*P* Value (χ^2 test)
Work hours per day			.021		.089
6 to 8	1,213 (45.9)	29.4 (26.9–32.0)		11.3 (9.5–13.1)	
> 8 to 10	1,079 (40.8)	30.1 (27.4–32.9)		12.3 (10.4–14.3)	
> 10	351 (13.3)	37.0 (32.0–42.1)		15.7 (11.9–19.5)	
Sleep hours per day			< .001		< .001
< 5	237 (9.0)	44.7 (38.4–51.1)		21.9 (16.7–27.2)	
5 to < 6	791 (29.9)	34.4 (31.1–37.7)		14.2 (11.7–16.6)	
6 to < 7	1,048 (39.7)	28.0 (25.2–30.7)		10.5 (8.6–12.4)	
7 to < 8	443 (16.8)	24.6 (20.6–28.6)		8.4 (5.8–10.9)	
8 to < 9	103 (3.9)	25.2 (16.9–33.6)		10.7 (4.7–16.6)	
9+	21 (0.8)	28.6 (9.2–47.9)		14.3 (−0.7–29.3)	
Sleep hours per day			< .001		< .001
< 6	1,028 (38.9)	36.8 (33.8–39.7)		16.0 (13.7–18.2)	
6 to < 8	1,491 (56.4)	27.0 (24.7–29.2)		9.9 (8.3–11.4)	
8+	124 (4.7)	25.8 (18.1–33.5)		11.3 (5.7–16.9)	
Subjective sleep sufficiency			< .001		< .001
Very sufficient	369 (14.0)	18.7 (14.7–22.7)		4.6 (2.5–6.7)	
Sufficient	1,026 (38.8)	24.9 (22.2–27.5)		9.8 (8.0–11.7)	
Insufficient	990 (37.5)	36.3 (33.3–39.3)		14.2 (12.1–16.4)	
Very insufficient	258 (9.8)	50.0 (43.9–56.1)		25.6 (20.3–30.9)	
Subjective sleep sufficiency			< .001		< .001
Very sufficient/sufficient	1,395 (52.8)	23.2 (21.0–25.4)		8.5 (7.0–9.9)	
Insufficient/very insuffcient	1,248 (47.2)	39.1 (36.4–41.8)		16.6 (14.5–18.7)	

Abbreviation: CES-D = Center for Epidemiologic Studies Depression Scale.

intercorrelation with work hours. The significance level for all statistical analyses was $P < .05$ (2-tailed test). Data were analyzed using IBM SPSS Statistics 17.0 software (SPSS Inc, Chicago, Illinois).

RESULTS

Descriptive statistics for participants stratified by the prevalence of depression are shown in Table 1. Roughly, 73% of participants were men, and 27% were women. Overall, the prevalence of a CES-D score ≥ 16 was 30.7%, and the prevalence of a CES-D score ≥ 25 was 12.3%. Although women had a slightly higher prevalence of depression than men, there were no statistically significant sex differences.

Ten of 18 covariates exhibited significant associations with depression (Table 1). Younger age, single or separated/divorced/widowed status, vocational/junior college education, difficulty in household financial situation, current smoking, occasional drinking, lower body mass index, managerial/clerical work, shift work, and high quantitative workload were associated with greater depression.

Prevalence of depression by work hours and sleep status is shown in Table 2. Long work hours and sleep status were significantly associated with depression, but the strength of association with depression seemed to be more pronounced for sleep status than for work hours. Among sleep variables, subjective insufficient sleep had a stronger association with depression than short sleep hours.

Associations of work hours and sleep status with depression as estimated by stepwise logistic regression analyses are shown in Table 3. Participants working > 10 hours per day had significantly higher odds of depression than those working 6–8 hours per day (reference category), while participants working > 8 to 10 hours per day did not have significantly increased odds of depression. On the other hand, participants sleeping < 5 hours per day or 5 to < 6 hours per day had significantly higher odds of depression compared to those sleeping 7 to < 8 hours per day (reference category); no significant difference was observed in participants sleeping 8 to < 9 hours per day or 9+ hours per day. When sleep hours were broken down into 3 groups (< 6, 6 to < 8, and 8+ hours per day), participants sleeping < 6 hours per day had significantly higher odds of depression than those sleeping 6 to < 8 hours per day. Subjective sleep sufficiency was strongly associated with depression. As subjective sleep sufficiency decreased, depression increased in a dose-dependent manner.

The combined effects of work hours and sleep status on depression are shown in Table 4 and Figure 1. As compared with a reference group with 6–8 hours per day of work and 6+ hours per day of sleep, participants with > 8 to 10 hours per day of work and < 6 hours per day of sleep and those with > 10 hours per day of work and < 6 hours per day of sleep had significantly higher odds of depression. No significant associations were seen for any other combinations of work hours with 6+ hours per day of sleep.

The analysis for the combination of work hours and subjective sleep sufficiency showed that all combinations of work hours with insufficient sleep were associated with significantly increased odds of depression, while none of the combinations with sufficient sleep showed statistically significant results (Table 4).

DISCUSSION

The focus of the present study was to clarify the independent association of work hours or sleep deprivation with depression and evaluate their combined effects on depression in a large number of employees of small- and medium-scale businesses. The results revealed the following: (1) long work

Table 3. Association of Work Hours, Sleep Hours, and Subjective Sleep Sufficiency With (A) CES-D Depression Scores ≥16 and (B) CES-D Depression Scores ≥25 (N=2,643)[a]

A. CES-D Score ≥16

Variable	Model 1,[a] OR (95% CI)	*P*	Model 2,[b] OR (95% CI)	*P*	Model 3,[c] OR (95% CI)	*P*	Model 4,[d] OR (95% CI)	*P*
Work hours per day								
6 to 8	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
>8 to 10	1.03 (0.86–1.24)	.719	1.04 (0.86–1.26)	.698	1.04 (0.85–1.26)	.726	1.03 (0.85–1.26)	.756
>10	1.41 (1.10–1.81)	.007	1.43 (1.09–1.87)	.010	1.36 (1.03–1.79)	.029	1.37 (1.02–1.83)	.034
Sleep hours per day								
<5	2.48 (1.77–3.47)	<.001	2.09 (1.48–2.99)	<.001	2.04 (1.43–2.90)	<.001	2.08 (1.45–2.98)	<.001
5 to <6	1.61 (1.24–2.09)	<.001	1.41 (1.07–1.84)	.013	1.38 (1.05–1.82)	.021	1.45 (1.10–1.91)	.009
6 to <7	1.19 (0.92–1.53)	.183	1.11 (0.86–1.44)	.431	1.12 (0.86–1.45)	.419	1.14 (0.88–1.49)	.325
7 to <8	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
8 to <9	1.04 (0.63–1.70)	.893	1.01 (0.61–1.67)	.974	1.01 (0.61–1.67)	.976	1.07 (0.64–1.78)	.808
9+	1.23 (0.46–3.24)	.681	1.11 (0.41–2.96)	.843	1.03 (0.38–2.83)	.952	0.99 (0.36–2.72)	.983
Sleep hours per day								
<6	1.58 (1.33–1.87)	<.001	1.43 (1.20–1.71)	<.001	1.39 (1.16–1.67)	<.001	1.43 (1.19–1.71)	<.001
6 to <8	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
8+	0.94 (0.62–1.43)	.780	0.95 (0.62–1.46)	.818	0.94 (0.61–1.44)	.768	0.96 (0.62–1.47)	.839
Subjective sleep sufficiency								
Very sufficient	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Sufficient	1.44 (1.07–1.94)	.017	1.37 (1.02–1.86)	.039	1.42 (1.05–1.93)	.024	1.42 (1.05–1.94)	.024
Insufficient	2.47 (1.85–3.31)	<.001	2.21 (1.64–2.99)	<.001	2.26 (1.66–3.06)	<.001	2.37 (1.74–3.23)	<.001
Very insufficient	4.35 (3.04–6.22)	<.001	3.57 (2.46–5.18)	<.001	3.52 (2.41–5.13)	<.001	3.64 (2.48–5.34)	<.001
Subjective sleep sufficiency								
Very sufficient/sufficient	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Insufficient/very insuffcient	2.12 (1.79–2.51)	<.001	1.91 (1.60–2.28)	<.001	1.88 (1.57–2.25)	<.001	1.97 (1.64–2.36)	<.001

B. CES-D Score ≥25

Variable	Model 1,[a] OR (95% CI)	*P*	Model 2,[b] OR (95% CI)	*P*	Model 3,[c] OR (95% CI)	*P*	Model 4,[d] OR (95% CI)	*P*
Work hours per day								
6 to 8	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
>8 to 10	1.10 (0.86–1.42)	.444	1.12 (0.87–1.47)	.405	1.10 (0.84–1.45)	.484	1.16 (0.88–1.54)	.302
>10	1.46 (1.04–2.05)	.029	1.56 (1.08–2.25)	.018	1.47 (1.01–2.14)	.046	1.73 (1.16–2.57)	.007
Sleep hours per day								
<5	3.08 (1.96–4.87)	<.001	2.66 (1.66–4.27)	<.001	2.56 (1.58–4.15)	<.001	2.68 (1.64–4.39)	<.001
5 to <6	1.81 (1.22–2.68)	.003	1.61 (1.08–2.41)	.020	1.51 (1.00–2.27)	.048	1.62 (1.07–2.46)	.023
6 to <7	1.29 (0.87–1.90)	.205	1.20 (0.81–1.78)	.369	1.14 (0.77–1.71)	.512	1.19 (0.79–1.78)	.407
7 to <8	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
8 to <9	1.31 (0.65–2.67)	.454	1.24 (0.60–2.54)	.562	1.24 (0.60–2.57)	.555	1.37 (0.66–2.85)	.401
9+	1.83 (0.52–6.50)	.351	1.68 (0.47–6.07)	.427	1.34 (0.36–4.95)	.666	1.17 (0.32–4.35)	.813
Sleep hours per day								
<6	1.74 (1.37–2.20)	<.001	1.60 (1.25–2.05)	<.001	1.56 (1.21–2.00)	.001	1.62 (1.25–2.10)	<.001
6 to <8	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
8+	1.16 (0.65–2.08)	.610	1.15 (0.64–2.07)	.645	1.15 (0.63–2.08)	.657	1.17 (0.64–2.14)	.614
Subjective sleep sufficiency								
Very sufficient	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Sufficient	2.26 (1.33–3.83)	.002	2.19 (1.29–3.74)	.004	2.28 (1.33–3.89)	.003	2.31 (1.34–3.96)	.002
Insufficient	3.44 (2.05–5.77)	<.001	3.15 (1.86–5.35)	<.001	3.17 (1.86–5.41)	<.001	3.29 (1.92–5.65)	<.001
Very insufficient	7.12 (4.06–12.5)	<.001	5.98 (3.34–10.7)	<.001	5.95 (3.30–10.7)	<.001	6.26 (3.45–11.4)	<.001
Subjective sleep sufficiency								
Very sufficient/sufficient	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Insufficient/very insuffcient	2.15 (1.69–2.74)	<.001	1.94 (1.50–2.49)	<.001	1.89 (1.46–2.44)	<.001	1.95 (1.50–2.53)	<.001

[a]Unadjusted (crude) OR.
[b]Adjusted for sex, age group, educational level, marital status, number of children in the household, and household financial situation.
[c]Adjusted for sex, age group, educational level, marital status, number of children in the household, household financial situation, smoking, drinking, caffeine intake, body mass index, number of physical/psychological symptoms, and use of medication (yes/no).
[d]Adjusted for sex, age group, educational level, marital status, number of children in the household, household financial situation, smoking, drinking, caffeine intake, body mass index, number of physical/psychological symptoms, use of medication (yes/no), job type, industry sector, work schedule, company size, and job control (high, medium, low).
Abbreviation: CES-D = Center for Epidemiologic Studies Depression Scale.

hours (>10 hours per day) were moderately associated with increased depression; (2) short sleep and insufficient sleep were both strongly related to depression, but subjective insufficient sleep exhibited a stronger association with depression than did short sleep; and (3) the combination of short sleep or insufficient sleep with long work hours had a synergistic effect on depression, but this effect was observed *only* when work hours were combined with short sleep or insufficient sleep. In light of these findings, to prevent workplace depression, it would seem to be of crucial importance to offer referrals for help with sleep management and treatment for employees who are working long hours and are sleep deprived and for those who are suffering from chronic sleep debt regardless of work hours.

Table 4. Combined Effects of Work Hours and Sleep Hours or Subjective Sleep Sufficiency on (A) CES-D Depression Scores ≥16 and (B) CES-D Depression Scores ≥25 (N=2,643)[a]

A. CES-D Score ≥16

Variable	n (%)	Model 1,[a] OR (95% CI)	*P*	Model 2,[b] OR (95% CI)	*P*	Model 3,[c] OR (95% CI)	*P*	Model 4,[d] OR (95% CI)	*P*
Work hours and sleep hours									
Work 6 to 8 h/d with sleep 6+ h/d	806 (30.5)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Work 6 to 8 h/d with sleep <6 h/d	407 (15.4)	1.33 (1.03–1.72)	.031	1.20 (0.92–1.56)	.177	1.14 (0.88–1.49)	.325	1.15 (0.88–1.51)	.301
Work >8 to 10 h/d with sleep 6+ h/d	673 (25.5)	0.93 (0.74–1.17)	.540	0.94 (0.74–1.20)	.629	0.92 (0.72–1.18)	.523	0.92 (0.72–1.18)	.502
Work >8 to 10 h/d with sleep <6 h/d	406 (15.4)	1.55 (1.20–2.00)	.001	1.41 (1.08–1.84)	.013	1.37 (1.05–1.80)	.022	1.41 (1.07–1.86)	.016
Work >10 h/d with sleep 6+ h/d	136 (5.1)	1.03 (0.68–1.54)	.900	1.05 (0.69–1.59)	.829	0.96 (0.63–1.47)	.861	0.95 (0.62–1.47)	.822
Work >10 h/d with sleep <6 h/d	215 (8.1)	1.98 (1.45–2.70)	<.001	1.91 (1.37–2.66)	<.001	1.81 (1.29–2.54)	<.001	1.90 (1.33–2.71)	<.001
Work hours and subjective sleep sufficiency									
Work 6 to 8 h/d with sufficient sleep	721 (27.3)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Work 6 to 8 h/d with insufficient sleep	492 (18.6)	1.83 (1.43–2.35)	<.001	1.70 (1.32–2.20)	<.001	1.69 (1.30–2.19)	<.001	1.75 (1.34–2.27)	<.001
Work >8 to 10 h/d with sufficient sleep	561 (21.2)	0.87 (0.67–1.13)	.288	0.92 (0.70–1.21)	.544	0.92 (0.69–1.21)	.528	0.90 (0.68–1.19)	.464
Work >8 to 10 h/d with insufficient sleep	518 (19.6)	2.01 (1.57–2.57)	<.001	1.83 (1.41–2.37)	<.001	1.80 (1.38–2.35)	<.001	1.90 (1.45–2.49)	<.001
Work >10 h/d with sufficient sleep	113 (4.3)	0.98 (0.62–1.56)	.931	1.05 (0.65–1.69)	.856	1.01 (0.62–1.64)	.985	1.03 (0.63–1.70)	.894
Work >10 h/d with insufficient sleep	238 (9.0)	2.38 (1.75–3.24)	<.001	2.32 (1.67–3.23)	<.001	2.19 (1.57–3.05)	<.001	2.30 (1.62–3.26)	<.001

B. CES-D Score ≥25

Variable	n (%)	Model 1,[a] OR (95% CI)	*P*	Model 2,[b] OR (95% CI)	*P*	Model 3,[c] OR (95% CI)	*P*	Model 4,[d] OR (95% CI)	*P*
Work hours and sleep hours									
Work 6 to 8 h/d with sleep 6+ h/d	806 (30.5)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Work 6 to 8 h/d with sleep <6 h/d	407 (15.4)	1.43 (0.99–2.05)	.055	1.31 (0.90–1.90)	.158	1.25 (0.86–1.82)	.244	1.28 (0.88–1.88)	.203
Work >8 to 10 h/d with sleep 6+ h/d	673 (25.5)	0.99 (0.70–1.39)	.952	1.01 (0.71–1.44)	.955	0.98 (0.69–1.40)	.914	1.05 (0.73–1.51)	.790
Work >8 to 10 h/d with sleep <6 h/d	406 (15.4)	1.74 (1.23–2.47)	.002	1.61 (1.12–2.33)	.011	1.56 (1.07–2.27)	.020	1.67 (1.14–2.46)	.009
Work >10 h/d with sleep 6+ h/d	136 (5.1)	0.95 (0.51–1.75)	.860	1.01 (0.53–1.90)	.981	0.94 (0.49–1.78)	.841	1.04 (0.54–2.00)	.915
Work >10 h/d with sleep <6 h/d	215 (8.1)	2.17 (1.45–3.27)	<.001	2.24 (1.45–3.47)	<.001	2.09 (1.33–3.26)	<.001	2.69 (1.67–4.33)	<.001
Work hours and subjective sleep sufficiency									
Work 6 to 8 h/d with sufficient sleep	721 (27.3)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Work 6 to 8 h/d with insufficient sleep	492 (18.6)	1.73 (1.21–2.47)	.003	1.60 (1.11–2.31)	.011	1.58 (1.10–2.29)	.015	1.62 (1.11–2.35)	.012
Work >8 to 10 h/d with sufficient sleep	561 (21.2)	0.86 (0.58–1.28)	.456	0.92 (0.61–1.39)	.690	0.92 (0.60–1.39)	.678	0.96 (0.63–1.46)	.846
Work >8 to 10 h/d with insufficient sleep	518 (19.6)	2.09 (1.49–2.95)	<.001	1.92 (1.33–2.77)	<.001	1.85 (1.28–2.68)	<.001	2.02 (1.38–2.95)	<.001
Work >10 h/d with sufficient sleep	113 (4.3)	0.87 (0.42–1.81)	.715	0.99 (0.47–2.09)	.979	0.93 (0.44–1.99)	.857	1.15 (0.54–2.49)	.715
Work >10 h/d with insufficient sleep	238 (9.0)	2.42 (1.60–3.65)	<.001	2.48 (1.60–3.85)	<.001	2.31 (1.48–3.62)	<.001	2.79 (1.73–4.48)	<.001

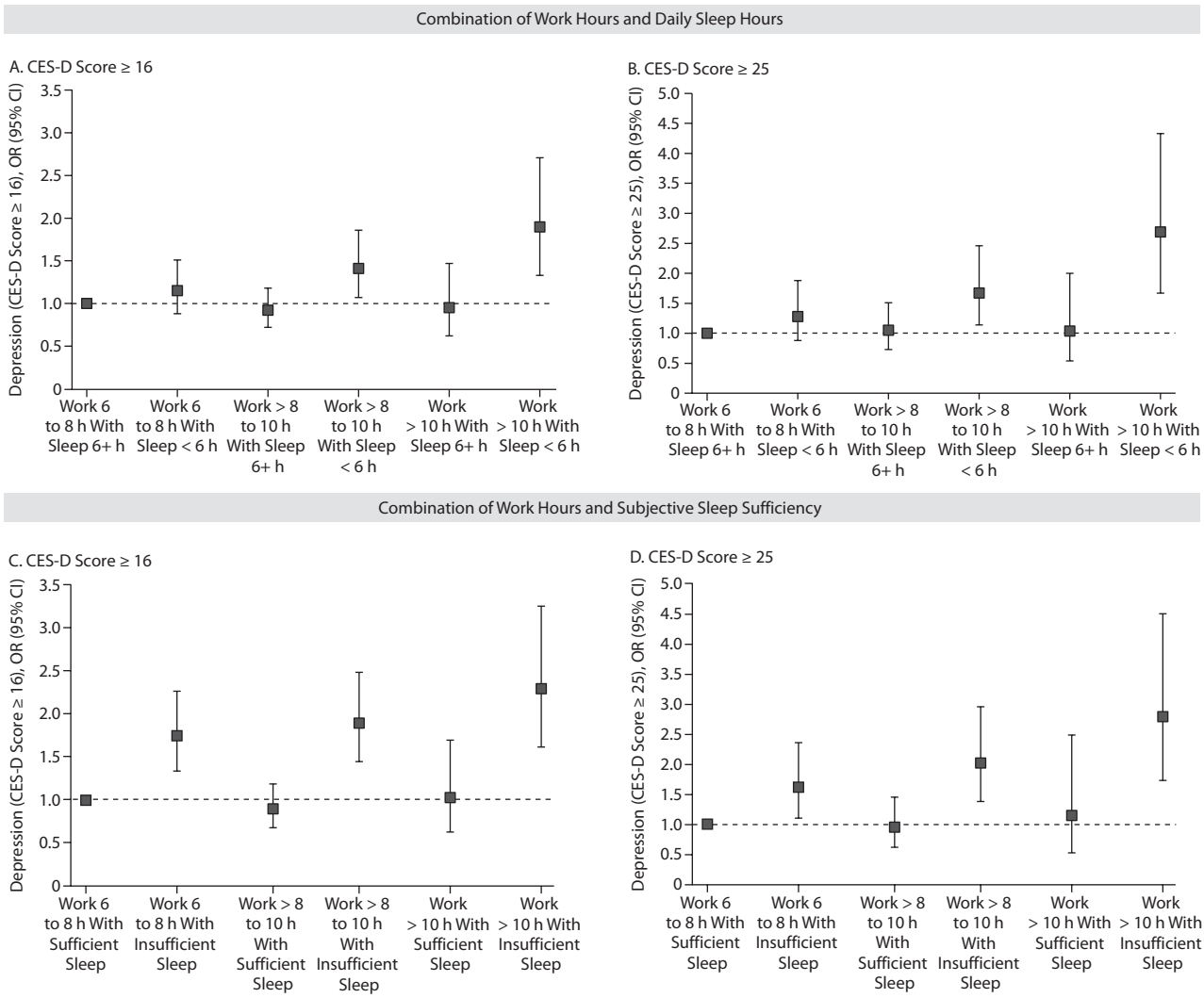
[a]Unadjusted (crude) OR.
[b]Adjusted for sex, age group, educational level, marital status, number of children in the household, and household financial situation.
[c]Adjusted for sex, age group, educational level, marital status, number of children in the household, household financial situation, smoking, drinking, caffeine intake, body mass index, number of physical/psychological symptoms, and use of medication (yes/no).
[d]Adjusted for sex, age group, educational level, marital status, number of children in the household, household financial situation, smoking, drinking, caffeine intake, body mass index, number of physical/psychological symptoms, use of medication (yes/no), job type, industry sector, work schedule, company size, and job control (high, medium, low).
Abbreviation: CES-D = Center for Epidemiologic Studies Depression Scale.

As stated in the Introduction, 17 studies have reported on the relationship between work hours and depression[4–20]; however, there was not always data agreement between the studies. This inconsistency may be explained by the fact that almost all previous studies did not consider the mediating role of sleep in the relationship between work hours and depression. In support of this assumption, the Whitehall II cohort study[25] reported that working more than 55 hours per week, compared with working 35 to 40 hours per week, was associated with 1.98 times higher odds for shortened sleep hours (<7 hours per 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. Similarly, in a 4-year prospective cohort study,[29] shortened sleep (<334 minutes per night) was associated with 3.18 times higher odds of depression as compared with sleeping 409 minutes per night. These findings, together with my results, support the notion that work hours influence depression through sleep.

The current study has further implications for strategies to reduce workplace depression. As indicated in the results (Table 4), no excess risk of depression was found in employees who were exposed to long work hours with sufficient sleep or 6+ hours daily sleep, in contrast with employees who did not work long hours but experienced insufficient sleep and had a significantly higher prevalence of depression. In cases of the latter type, referral for help with sleep management and treatment may be a key to reducing depression. In contrast, those who were exposed to long work hours and suffered from sleep deprivation had had a greater chance of developing depression with increasing work hours. In cases such as these, reducing long work hours to decrease sleep debt may reduce depression.

The present study suggests that subjective sleep insufficiency is a better predictor of depression than is short sleep, which is consistent with a study by Kaneita et al.[30] This finding is plausible since some people are satisfied with short sleep while others are dissatisfied even with a long

Figure 1. Combined Effects of Work Hours and Daily Sleep Hours (A and B) or Work Hours and Subjective Sleep Sufficiency (C and D) on Depression



Abbreviation: CES-D = Center for Epidemiologic Studies Depression Scale.

duration of natural sleep. Since sufficiency of sleep is determined by an individual's physiologic desire rather than simple duration of sleep, it seems important to identify how to obtain sufficient sleep in relation to work hours.

I did not find a significant association between long sleep duration (9+ hours per day) and a high prevalence of depression in this study, although the relationship between sleep hours and depression indicated a weak U-shaped curve. Several large-scale studies have reported significant increases in depression incidence among people sleeping longer hours. In a Japanese general population survey[30] (N = 24,686), subjects sleeping 8 to < 9 hours per day, 9 to < 10 hours per day, and 10+ hours per day had a respective increase in depression of 36%, 98%, and 304%, as compared with those sleeping 6 to < 7 hours per day. In a cross-sectional analysis[42] of the Nurse Health Study II (N = 65,666), 12.2% of nurses sleeping 9+ hours per day had current depressive symptoms versus 6.1% for those sleeping 7 to 8 hours per day. Because the number of participants sleeping 8+ hours per day in the present survey was very small (4.7%), it is likely that the statistical power prevented the detection of statistical significance. The small percentage of employees sleeping long hours in this population may be attributable to the fact that all participants were full-time employees and many could be working long hours and, therefore, have reduced sleep time on working days.

A principal strength of this study is that it not only explored the independent association of work hours and sleep with depression but also evaluated the combined effects of work hours and sleep status on depression in a fairly large number of full-time employees of small- and medium-scale businesses representing various industry sectors and occupations. Furthermore, participants who reported MDD or who worked < 6 hours per day or > 20 hours per day were excluded to minimize selection bias leading to underestimation.

The limitations of this study are as follows: First, since this study is of cross-sectional data, the association could be

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in either direction, ie, subjective poor quality of sleep may increase the risk of depression—or undiagnosed depression or depressive personality traits may be the cause for subjective poor sleep quality.[32] Second, work hours, sleep status, and depression were assessed by self-report rather than through the use of objective measures. Third, response bias may have occurred if nonrespondents differed from respondents; in particular, those who worked extremely long hours may have had less time available to respond to the questionnaire. Fourth, although the study included a fairly large number of confounders, information on menopausal status, personality traits, or unknown common factors for both depression and poor subjective sleep quality were not included in the analyses.

In conclusion, this study found independent associations of work hours, sleep duration, and subjective sleep sufficiency with depression. However, when the combined effects of work hours and sleep on depression were tested, short sleep or insufficient sleep turned out to be the main factor related to depression. Furthermore, combination of long work hours with short sleep or insufficient sleep exerted a reciprocal effect on depression, but combination of long work hours with 6+ hours of sleep or sufficient sleep did not show such an effect. Prospective research is warranted to determine the causal mechanisms underlying the present findings.

Disclosure of off-label usage: The author has determined that, to the best of his knowledge, no investigational information about pharmaceutical agents that is outside US Food and Drug Administration–approved labeling has been presented in this article.
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