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Which sleep hygiene factors are important? comprehensive assessment of lifestyle habits and job environment on sleep among office workers

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ABSTRACT

Background: Although several lifestyle habits are associated with sleep, it is unclear which factors are important. Among office workers, the effect of job environment should also be considered. The multivariate analyses on the effects of lifestyle habits and job environment on sleep among office workers was conducted.
Methods: A cross-sectional survey of 6,342 employees from 29 companies was conducted in 2017–2019. Complete responses and informed consent were provided by 5,640 participants. The survey examined demographic variables, sleep schedules, Pittsburgh Sleep Quality Index (PSQI), Brief Job Stress Questionnaire (BJSQ), and lifestyle habits.
Results: Mean values were as follows: age, 36.9 years (±10.2); PSQI, 6.52 (±2.83); and total sleep time, 6h06m (±1h40m) on work days and 7h39m (±1h58m) on free days. After adjusting for job environment and demographic variables, irregular meal time (1.45–2.86), not eating vegetables every day (1.35), nightcap (2.74–3.55), weight gain (1.20–1.42), lack of sunlight in the morning in the bedroom (1.48-1.60), waking up before dawn (2.18), electronic display use in bed (1.50), and daily caffeine intake (1.27) were significantly associated with sleep disturbance. Irregular meal time (1.51-2.37), lack of morning breakfast (1.74-2.95), having dinner within 2 hours before bed time (0.49-0.64), not eating vegetables every day (1.52), lack of sunlight exposure in the morning (1.43–2.01), and caffeine use every day (1.42) were also associated with eveningness ($p<.01$).
Conclusion: Each sleep hygiene factor had a different effect size. Sleep hygiene interventions to promote worker sleep health should prioritize factors in accordance with effect size.

Introduction

Sleep significantly affects mental health, physical health, social well-being, and productivity in workers. Regarding mental health, insomnia symptoms increase the risk of future depression or anxiety,[1–3] insufficient sleep increases the risk of depression symptoms,[4,5] and short sleep duration causes psychological distress in young adults.[6] In particular, short sleep duration can lead to a strong likelihood of suicidal ideation and suicide attempts among adults[7]. Late bedtime and poor sleep quality are also associated with depression symptoms and suicidal ideation.[8] Regarding physical health, sleep disturbance increases the risk of hypertension, obesity, cardiovascular disease, and diabetes.[9–19] Poor sleep quality and short sleep duration are risk factors for hypertension,[17,20] myocardial infarction, and stroke.[21] Short sleep duration is a risk factor for diabetes and its development in women.[22] In addition, insufficient sleep leads to loss of working hours and increases mortality, which result in economic damage.[23,24] Moreover, insomnia increases the number of accidents

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and errors in the workplace.[25] Chronotype is a circadian typology, typically described as morningness or eveningness, and is an important factor that affects sleep, physical and mental health,[26] and cognitive function and daytime performance.[27] Eveningness tends to be associated with depressive symptoms[28] and insomnia.[29]

Sleep hygiene is closely associated with sleep. In fact, caffeine intake reduces total sleep time, prolongs latency to sleep, and causes nocturnal awakening.[30,31] Moreover, poor sleep quality is associated with consumption of unhealthy foods, such as low intake of vegetables and high intake of confectionary, and with unhealthy eating habits, such as consumption of energy drinks or sugar-sweetened beverages, skipping breakfast, and eating irregularly in middle-aged female workers.[32] In middle-aged and older adults, moderate intensity exercise improves subjective sleep quality and reduces sleep latency and sleep medication use.[33] Regular exercise contributes to a feeling of having had sufficient sleep.[34] Use of electronic devices at night time is associated with poor sleep quality and long sleep latency and late wake-up time.[35–38] Consumption of alcohol at night reduces REM sleep, sleep time, and sleep continuity[39] and contentious alcohol intake leads to disruption of total sleep time, sleep efficiency, night time awakenings, and sleepiness in the day.[40,41] With regard to chronotype, since the circadian rhythm is entrained by light,[42] light conditions in the morning or evening affect chronotype.[43–45]

However, because few studies have examined the effect of multiple lifestyle habits on sleep at the same time, it is unclear which factors are important or not. Previous studies have focused on alcohol and caffeine use;[41] meal time and exercise;[34,46] meal pattern, exercise, and alcohol use;[47] alcohol consumption, caffeine intake, cell phone use, and snacking two hours before bedtime;[48] smoking, alcohol consumption and exercise;[49,50] caffeine intake and electronic media use at night;[51,52] electronic media use, stimulant use, and outdoor lights at night;[53] and multiple factors related to meal pattern.[32]

The effect of job environment should also be considered when examining sleep in workers. Previous studies have reported the association between job stress and sleep problems. The quality and/or quantity of sleep is to some extent affected by job demand and job control,[54] and overloading and the contents of the work.[55] Another study demonstrated that insomnia is associated with problems in human relationships at the worksite, the sense of satisfaction about one's work, and the social support received.[56]

There are few studies assessing the effect of multiple sleep hygiene on sleep disturbance or chronotype, moreover, for our knowledge, no studies assessing the effect of job environment and multiple sleep hygiene simultaneously. Although sleep hygiene interventions have been conducted as a clinical sleep treatment,[57] evidence on which sleep hygiene factors are important in workers is currently insufficient. Therefore, the aim of this study was to investigate the importance of lifestyle factors in sleep among general workers. We investigated and analyzed a wide range of lifestyle habits and job environment factors and conducted a comprehensive examination to calculate the effect size after adjusting for confounding factors.

Participants and methods

Participants

From April 2017 to April 2019, over a 25-month period, a survey was conducted among 6,342 employees of 29 companies in Japan. Of this total, 5,640 (88.9%) provided informed consent and responded to the questionnaire. The companies worked in the fields of information technology, finance, broadcasting, music, consulting, public office, chemical industry, health care, fashion, printing, movie industry, trading, restaurant, travel agency, patent agency, and temp agency. These companies ranged from 50 to 1,200 office workers and were located in Tokyo, Japan. The Greater Tokyo area is an urban conurbation with a population of 30 million, or one-quarter of the national total. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Tokyo Medical University, Tokyo, Japan (Approved code: #SH3652).

Questionnaires

Sleep was assessed based on participants' subjective sleep schedules on work days and free days, and participants' sleep disturbance was assessed using the Japanese version of the Pittsburgh Sleep Quality Index (PSQI).[58,59] The PSQI consists of 7 components from C1 to C7, each of which evaluates a different aspect associated with sleep disturbance: sleep quality (C1), sleep latency (C2), sleep duration (C3), habitual sleep efficiency (C4), frequency of sleep disturbance (C5), use of sleep medication (C6), and daytime dysfunction (C7). The PSQI global score, which is calculated by summing the component scores, indicates the seriousness of the sleep disturbance. The PSQI cutoff score is 6 points, with a score of 6 or higher indicating the existence of sleep disturbance and defined as "poor sleeper". To assess the sleep-wake cycle, the midpoint of sleep on free days, sleep-corrected (MSFsc), which is one of the indicators of chronotype, was calculated from the sleep schedule of work days and free days in accordance with the Munich Chronotype Questionnaire (MCTQ).[60,61]

To assess the job environment and stress factors, overwork time, commute time, and the 57-item Brief Job Stress Questionnaire (BJSQ),[62,63] which is currently authorized by the Japanese Ministry of Health, Labor and Welfare[63] and is considered a standard measure for the assessment of occupational stress, were examined. BJSQ examines the following four areas on a Likert scale:[64] job stressors (area A; score range: 17–68 points; quantitative job overload, qualitative job overload, physical demands, job control, skill utization, interpersonal conflict, poor physical environment, suitable jobs, and intrinsic rewards); stress reaction (area B; 29–116 points; lassitude, irritation, fatigue, anxiety, and depression); social support (area C; 9–36 points; supervisor support, coworker support, and support from family and friends); and job and life satisfaction (area D; 2–8 points). For each area, a higher score indicates worse circumstances. Details of the questionnaire are shown in Supplemental Material.

Sex, age, marital status, living status and lifestyle habits were also examined. For lifestyle habits, the following were asked about: (1) regularity of meal times, (2) frequency of morning breakfast intake, (3) time from dinner to bed time, (4) frequency of vegetable intake, (5) frequency of nightcap, (6) body weight change from 18 years old, (7) change in frequency of exercise from 18 years old, (8) sunlight exposure in the morning in the bedroom, (9) time spent using electronic visual displays at night, and (10) frequency of caffeine drink intake at night.

Data analysis

Comparison of the PSQI scores for each descriptive variable, including demographic variables, job environment factors, and lifestyle habits, was performed using one-way analysis of variance (ANOVA) followed by Tukey's HSD test as post hoc analysis. Regression analyses were performed to identify the factors associated with sleep disturbance and eveningness chronotype. To assess the chronotype, the late third of the distribution of MSFsc was defined as eveningness chronotype.[65] IBM SPSS, version 24 was used for analysis. The statistical significance level was set at $p < .01$ or the 99% confidence interval.

Results

Demographic data, job stress, and sleep-related variables

The respondents were 5,640 participants comprising 3,461 males (61.4%) and 2,171 females (38.5%). The remaining 8

Table 1
Demographic, job environment, and sleep-related variables and their correlations

Characteristic and lifestyle habit	N or mean (%)	SD	Correlation (r) or mean (SD)		
			PSQI global score	BJSQ area A (job stressors)	BJSQ area C (social support)
Total	5640 (100%)	-	6.52 (2.83)	39.78 (6.84)	20.02 (5.43)
Demographics					
Male	3461 (61.4%)	-	6.44 (2.73)	40.05 (6.77)	20.06 (5.48)
Female	2171 (38.5%)	-	6.64 (2.96)	39.34 (6.94)	19.93 (5.34)
Age	36.9	10.2	−0.029	0.048**	0.105**
Married	2343 (41.5%)	-	6.15 (2.71)	39.82 (6.59)	19.37 (5.19)
Live with family	3408 (60.4%)	-	6.34 (2.77)	39.76 (6.83)	19.58 (5.25)
Job environment					
Overtime work (hours/month)	26.0	28.7	.056**	.235**	−.032
Commute time (minutes/one way)	56.0	26.6	.082**	.061**	.061**
BJSQ Area A: job stressors	39.8	6.8	.309**	-	.369**
BJSQ Area C: social support	20.0	5.4	.278**	.369**	-
PSQI					
Global score	6.52	2.83	-	.309*	.278**
Global score ≥ 6	3397 (60.2%)	-	8.25 (2.22)	41.23 (6.79)	20.98 (5.29)
C1 sleep quality	1.47	0.77	.711**	.256**	.226**
C2 sleep latency	1.10	0.98	.677**	.118**	.159**
C3 sleep duration	1.57	0.82	.508**	.188**	.097**
C4 habitual sleep efficiency	0.20	0.58	.507**	.069**	.077**
C5 frequency of sleep disturbance	1.05	0.52	.492**	.184**	.179**
C6 use of sleep medication	0.12	0.54	.374**	.077**	.100**
C7 daytime dysfunction	1.01	0.79	.576**	.297**	.237**
Sleep schedule					
Time to bed on work days	0:42	2:28	.081**	.011	.035*
Time to fall asleep on work days	0:56	1:39	.312**	.045*	.059**
Wake up time on work days	7:02	1:25	.011	−.085**	.008
Total sleep time on work days	6h06m	1h40m	-.299**	−.117**	−.052**
Midpoint of sleep on work days	3:59	1:18	.205**	−.018	.042*
Time to bed on free days	0:57	1:53	.155**	−.016	.051**
Time to fall asleep on free days	1:18	1:55	.261**	.005	.064**
Wake up time on free days	8:58	2:08	.154**	−.011	.014
Total sleep time on free days	7h39m	1h58m	−.086**	−.017	−.046**
Midpoint of sleep on free days	5:08	1:47	.234**	−.004	.043*
Social jet lag	1h20m	1h13m	.176**	.026	.036*
MSFsc	4:31	1:40	.171**	−.046*	.040*

Social jet lag was calculated by the absolute value.
BJSQ = Brief Job Stress Questionnaire; higher scores indicate worse job environment or social support.
PSQI = Pittsburgh Sleep Quality Index; higher scores indicate poorer sleep.
MSFsc = Midpoint of Sleep on free days sleep-corrected; later MSFsc indicates greater eveningness preference.
* p<.01.
** p<.001 (Pearson's correlation).

participants (0.1%) answered "other" to the question on sex. The mean (±SD) age was 36.9 years (±10.2, range 18-79 years). The mean PSQI score was 6.52 (±2.83) and mean MSFsc was 4:31 (±1:40). Details of the scores and correlations between these variables are shown in Table 1 and the distributions of PSQI and MSFsc are shown in Figure 1. Details of each company are shown in Supplemental Table. Based on the respective criteria, a total of 3,397 (60.2%) participants exhibited a sleep disturbance using a cutoff PSQI score of 6 or greater.[58,59]

Group comparison of sleep-related variables with demographic characteristics and lifestyle habits

Table 2 shows the results of analyses of the relationships among demographic characteristics, lifestyle habits, and the sleep-related variables sleep disturbance (PSQI) and chronotype (MSFsc). ANOVA and post hoc analysis using Tukey's HSD test revealed that marriage status, living status, regularity of meal time, frequency of morning breakfast intake, time from dinner to bed time, frequency of vegetable intake, frequency of nightcap, body weight change from 18

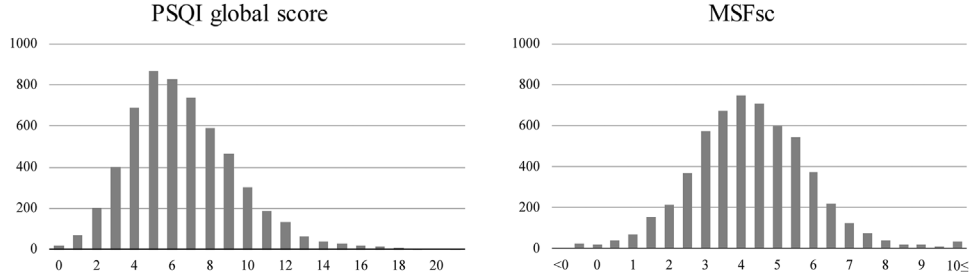

Figure 1. Distribution of PSQI and MSFsc. PSQI = Pittsburgh Sleep Quality Index; MSFsc = Midpoint of Sleep on free days sleep-corrected.

Table 2
Relationships among demographic characteristics, lifestyle habits, and sleep-related variables

Characteristic and lifestyle habit	n	%	Sleep disturbance (PSQI)				Chronotype (MSFsc) (hour)			
			Mean	SD	F-value	Post hoc	Mean	SD	F-value	Post hoc
Sex										
a)male	3461	61.4%	6.44	2.73	4.143*	n.s.	4.50	1.72	1.634 p=.195	
b)female	2171	38.5%	6.64	2.96	p=.001		4.56	1.56		
c)other	8	0.1%	9.13	5.89			3.93	2.18		
Age										
a)<30	1537	27.3%	6.60	2.79	0.706		5.07	1.57	159.715**	a vs b
b)≥30, <40	2098	37.2%	6.52	2.89	p=.548		4.68	1.60	p<.001	a vs c
c)≥40, <50	1665	29.5%	6.46	2.78			3.97	1.62		a vs d
d)≥50	340	6.0%	6.50	2.80			3.77	1.58		b vs c
										b vs d
Marriage										
a)single	3082	54.6%	6.77	2.86	33.993**	a vs b	4.95	1.61	260.688**	a vs b
b)married	2343	41.5%	6.15	2.71	p<.001	b vs c	3.96	1.56	p<.001	b vs c
c)other	129	2.3%	6.92	3.17			4.59	1.55		
Living status										
a)live alone	1884	33.4%	6.78	2.87	14.719**	a vs c	5.02	1.66	174.406**	a vs c
b)share a room	258	4.6%	6.65	2.94	p<.001		5.14	1.73	p<.001	b vs c
c)live with family	3408	60.4%	6.35	2.77			4.20	1.57		
Regularity of mealtime										
a)regular	779	13.8%	5.34	2.64	134.163**	a vs b	3.71	1.61	123.456**	a vs b
b)almost regular	2493	44.2%	6.21	2.69	p<.001	a vs c	4.39	1.53	p<.001	a vs c
c)tends to be irregular	1746	31.0%	6.99	2.75		a vs d	4.89	1.63		a vs d
d)quite irregular	622	11.0%	7.96	2.97		b vs c	5.03	1.84		b vs c
						b vs d				b vs d
						c vs d				
Frequency of morning breakfast intake										
a)every morning	2046	36.3%	5.95	2.64	46.516**	a vs b	3.91	1.56	189.007**	a vs b
b)almost every morning	1353	24.0%	6.71	2.85	p<.001	a vs c	4.56	1.54	p<.001	a vs c
c)rarely	1052	18.7%	6.86	2.83		a vs d	4.93	1.64		a vs d
d)never	1189	21.1%	6.99	2.95			5.17	1.62		b vs c
										b vs d
										c vs d
Time from dinner to bed time										
a)>2 hours	2914	51.7%	6.42	2.87	17.936**	a vs c	4.66	1.62	15.792**	a vs b
b)≤2 hours, >1 hour	1964	34.8%	6.42	2.68	p<.001	a vs d	4.40	1.71	p<.001	a vs c
c)≤1 hour	685	12.1%	7.10	2.85		b vs c	4.26	1.67		
d)do not eat dinner	77	1.4%	7.90	3.51		b vs d	4.62	1.36		
Frequency of vegetable intake										
a)every meal	1087	19.3%	5.71	2.63	91.566**	a vs b	4.02	1.51	114.865**	a vs b
b)every day	2377	42.1%	6.40	2.67	p<.001	a vs c	4.41	1.59	p<.001	a vs c
c)less than every day	2176	38.6%	7.07	2.97		b vs c	4.90	1.73		b vs c
Frequency of nightcap										
a)never	4901	86.9%	6.26	2.70	181.618**	a vs b	4.51	1.65	3.834	
b)rarely	309	5.5%	7.65	2.87	p<.001	a vs c	4.76	1.73	p=.022	
c)≥1 time a week	430	7.6%	8.68	3.12		b vs c	4.43	1.78		
Body weight change from 18 years old										
a)<-5kg	325	5.8%	6.59	3.04	17.335**	b vs c	4.27	1.51	3.331	
b)within ±5kg	2434	43.2%	6.27	2.76	p<.001	b vs d	4.57	1.66	p=.019	
c)>+5kg, <+15kg	2074	36.8%	6.60	2.81		c vs d	4.53	1.66		
d)≥+15kg	807	14.3%	7.07	2.91			4.48	1.73		
Change in frequency of exercise from 18 years old										
a)significantly decreased	3061	54.3%	6.72	2.87	11.368**	a vs b	4.56	1.68	1.919	
b)decreasd	1390	24.6%	6.33	2.74	p<.001	a vs c	4.46	1.66	p=.124	
c)unchanged	694	12.3%	6.21	2.84		a vs d	4.56	1.66		
d)increased	495	8.8%	6.28	2.72			4.42	1.59		
Sunlight exposure in the morning in the bedroom										
a)sunlight comes in directly	2058	36.5%	5.99	2.77	43.967**	a vs b	4.39	1.56	83.756**	a vs b
b)sunlight does not come in directly	667	11.8%	6.89	2.78	p<.001	a vs c	4.77	1.76	p<.001	a vs c
c)shaded and blacked out	2697	47.8%	6.76	2.80		a vs d	4.69	1.61		a vs d
d)wake up before dawn	218	3.9%	7.51	3.08		c vs d	2.99	1.91		b vs d
										c vs d
Time spent using electronic visual displays at night										
a) ≥1h before bed	603	10.7%	6.02	3.04	41.820**	a vs c	3.76	1.82	110.455**	a vs b
b) up to 0.5h before bed	771	13.7%	6.02	2.59	p<.001	a vs d	4.07	1.58	p<.001	a vs c
c) just before bed	2672	47.4%	6.42	2.71		b vs c	4.54	1.60		a vs d
d) use in bed	1594	28.3%	7.14	2.95		b vs d	4.99	1.58		b vs c
						c vs d				b vs d
										c vs d

(continued on next page)

Table 2 *(continued)*

Characteristic and lifestyle habit	n	%	Sleep disturbance (PSQI)				Chronotype (MSFsc) (hour)			
			Mean	SD	F-value	Post hoc	Mean	SD	F-value	Post hoc
Frequency of caffeine drink intake at night										
a)never/rarely	1482	26.3%	6.17	2.74	19.142**	a vs b	4.18	1.61	48.951**	a vs b
b)often	1924	34.1%	6.53	2.78	p<.001	a vs c	4.56	1.60	p<.001	a vs c
c)everyday	2234	39.6%	6.75	2.90			4.72	1.71		b vs c

PSQI = Pittsburgh Sleep Quality Index; MSFsc = Midpoint of Sleep on free days sleep-corrected; ANOVA = one-way analysis of variance.
a/b/c/d: significantly higher or lower than group a)/b)/c)/d) on post-hoc analysis using Tukey's HSD test (p<.01).
* p < .01.
** p < .001.

years, change in frequency of exercise from 18 years, sunlight exposure in the morning, time spent using electronic visual displays at night, and frequency of caffeine drink intake at night are associated with sleep disturbance (PSQI). In addition, age, marriage status, living status, regularity of meal time, frequency of morning breakfast intake, time from dinner to bed time, frequency of vegetable intake, sunlight exposure in the morning, time spent using electronic visual displays at night, and frequency of caffeine drink intake at night are associated with the chronotype (MSFsc).

Factors associated with sleep disturbance and eveningness

Table 3 shows the results of the logistic regression analysis using the existence of sleep disturbance (PSQI global score ≥ 6)[58,59] as a dependent variable and demographic characteristics, job environment, and lifestyle habits as independent variables. Marriage status, living status, overtime work, commute time, job environment, social support, regularity of meal time, frequency of morning breakfast intake, time from dinner to bed time, frequency of vegetable intake, frequency of nightcap, body weight gain from 18 years, sunlight exposure, electronic visual display use at night, and caffeine intake were associated with sleep disturbance on univariate regression.

On multivariate logistic regression, female sex (adjusted odds ratio = 1.222 vs. male), married status (0.756 vs. single), commute time (1.545/hours one way), job stressors (1.066/point), social support (1.051/point), irregular meal times (1.449–2.858 vs. regular meal time), having dinner 1-2 hours before bed time (0.815 vs. more than 2 hours), eating vegetable less than every day (1.348 vs. eating every meal), having a nightcap (2.736-3.552 vs. never having nightcap), body weight gain from 18 years old (1.204–1.423 vs. within±5kg), lack of sunlight exposure (1.483–1.596 vs. sunlight comes in the bedroom directly), electronic visual display use in bed (1.497 vs. quit using display earlier than 1 hour before bed), and daily caffeine drink intake (1.267 vs. never or rare caffeine intake at night) were significantly associated with sleep disturbance (p<.01, 99% confidence interval). The Nagelkerke R^2 value was 0.231. The adjusted odds ratios are plotted in Figure 2.

Table 4 shows the results of logistic regression analysis using eveningness chronotype (the late third of the distribution of MSFsc) as the dependent variable. On multivariate logistic regression, female sex (0.782), age (0.969/year), married (0.526), commute time (0.629/hour), job stressors (0.967/point), social support (1.022/point), irregular meal time (1.513-2.369), lack of morning breakfast (1.735-2.946), having dinner within 2 hours before bed time (0.488-0.638), not eating vegetable every day (1.524), lack of sunlight exposure in the morning (1.433–2.008), and caffeine use every day (1.422) were significantly associated with an eveningness chronotype (p<.01, 99% confidence interval). The Nagelkerke R^2 was 0.300.

Table 5 shows the results of multivariate linear regression. The coefficients indicated the number of points of PSQI global score or MSFsc clock time (hours) increase/delay or decrease/advance with each characteristic and lifestyle habit. The maximum VIF value was 1.917. On analysis of PSQI, the F value was 100.544 (p<.001) and the adjusted R^2 value was 0.239. On analysis of MSFsc, the F value was 97.221 (p<.001) and the adjusted R^2 value was 0.243.

Discussion

To our knowledge, this is the first study to comprehensively and simultaneously assess the effect of various lifestyle habit and job environment factors on sleep, and demonstrate the risk ratios of multiple factors among office workers. Although various sleep hygiene factors have been examined to date, it remains unclear which lifestyle habits are most important. In the present study, we adjusted for confounding by multiple factors including job environment and revealed the level of impact of each factor. This information will be essential in the development of sleep hygiene interventions.

As reported in previous studies, univariate analyses indicated an association between sleep and job stressors, social support, and various other lifestyle habits. However, after adjusting for confounding, the significant effect of some factors was lost while others remained significant. For example, the effect of overtime work was no longer significant after adjusting for the effect of job stressors and lifestyle habits, whereas commute time remained significant and showed a strong effect. It is possible that overtime conducted in the evening might not be associated with sleep disturbance directly, unless it continues for an extremely late hour. A previous meta-analysis showed that there was a weak correlation between overtime work and depression.[66] On the other hand, longer commuting time usually forces workers to get up earlier and this could shorten sleep duration directly.

While the regularity of meal times is strongly associated with sleep disturbance, breakfast was not significant factors with sleep disturbance in the multivariate analysis. Given that regularity of food intake enhances the activity of clock genes,[67,68] irregularities in meal schedules may cause lower amplitude circadian rhythms and subsequent sleep disturbance. Although having breakfast in the morning also has a similar effect in entraining the peripheral circadian rhythm,[69] the effect of morning breakfast intake was not significant in multivariate analysis, suggesting that regularity may be more important than breakfast intake. Alternatively, maintaining a breakfast schedule may shorten sleep duration and cause subsequent sleep disturbance and daytime sleepiness due to a shortened total sleep time on workdays (6h06m), as observed in this survey. Dinner time one or two hours before bed had slightly associated the better sleep, whereas not eating dinner showed a tendency to be associated with sleep disturbance. A previous study also revealed

Table 3
Multivariate logistic regression analysis of factors associated with sleep disturbance

Characteristic and lifestyle habit	Sleep disturbance (PSQI≥6)	
	Univariate OR (99% CI)	Multivariate aOR (99% CI)
Sex		
Male	ref.	ref.
Female	1.078 (0.933-1.245)	1.222*(1.022-1.462)
Age (per years old)	0.994 (0.987-1.001)	0.997 (0.988-1.006)
Marriage		
Single	ref.	ref.
Married	0.670**(0.580-0.773)	0.756*(0.599-0.953)
Living status		
live alone	ref.	ref.
share a room	0.888 (0.625-1.264)	1.056 (0.701-1.591)
live with family	0.751**(0.644-0.874)	1.038 (0.821-1.314)
Overtime work (per 1-hour/month)	1.005**(1.002-1.007)	1.000 (0.997-1.003)
Commute time (per 1-hour/one way)	1.448**(1.230-1.703)	1.545**(1.266-1.884)
BJSQ Area A: job stressors (per pts.)	1.088**(1.076-1.101)	1.066**(1.051-1.081)
BJSQ Area C: social support (per pts.)	1.089**(1.075-1.104)	1.051**(1.034-1.068)
Regularity of meal time		
Regular	ref.	ref.
almost regular	1.783**(1.439-2.210)	1.449**(1.125-1.866)
tends to be irregular	3.086**(2.453-3.883)	2.067**(1.541-2.773)
quite irregular	5.673**(4.125-7.802)	2.858**(1.921-4.253)
Frequency of morning breakfast intake		
every morning	ref.	ref.
almost every morning	1.570**(1.306-1.889)	1.163 (0.936-1.446)
Rarely	1.742**(1.423-2.132)	1.042 (0.812-1.337)
Never	1.796**(1.478-2.182)	0.998 (0.782-1.273)
Time from dinner to bed time		
>2 hours	ref.	ref.
≤2 hours, >1 hour	1.062 (0.911-1.237)	0.815* (0.682-0.974)
≤1 hour	1.722**(1.360-2.181)	0.891 (0.673-1.180)
do not eat dinner	2.377*(1.180-4.789)	1.612 (0.713-3.683)
Frequency of vegetable intake		
every meal	ref.	ref.
every day	1.552**(1.284-1.876)	1.216 (0.976-1.515)
less than every day	2.324**(1.910-2.827)	1.348*(1.059-1.716)
Frequency of nightcap		
Never	ref.	ref.
Rarely	3.273**(2.400-4.464)	2.736**(1.946-3.846)
≥1 time a week	4.045**(2.593-6.309)	3.552**(2.183-5.779)
Body weight change from 18 years old		
<-5kg	1.284 (0.938-1.756)	1.261 (0.882-1.802)
within ±5kg	ref.	ref.
>+5kg, <+15kg	1.219*(1.042-1.425)	1.204*(1.002-1.448)
≥+15kg	1.651**(1.323-2.060)	1.423*(1.095-1.849)
Change in frequency of exercise from 18 years old		
significantly decreased	1.406**(1.129-1.750)	1.199 (0.931-1.543)
Decreasd	1.127 (0.886-1.435)	1.119 (0.851-1.472)
Unchanged	ref.	ref.
Increased	0.772 (0.472-1.265)	1.155 (0.814-1.638)
Sunlight exposure in the morning in the bedroom		
sunlight comes in directly	ref.	ref.
sunlight does not come in directly	1.970**(1.546-2.509)	1.596**(1.216-2.093)
shaded and blacked out	1.641**(1.407-1.913)	1.483**(1.248-1.762)
wake up before dawn	2.395**(1.598-3.591)	2.180**(1.378-3.447)
Time spent using electronic visual displays at night		
a) ≥1h before bed	ref.	ref.
b) up to 0.5h before bed	0.971 (0.734-1.286)	0.871 (0.630-1.202)
c) just before bed	1.307*(1.035-1.650)	1.026 (0.779-1.351)
d) use in bed	1.955**(1.520-2.515)	1.497** (1.103-2.030)
Frequency of caffeine drink intake at night		
never/rarely	ref.	reg.
Often	1.271*(1.061-1.522)	1.098 (0.894-1.348)
Everyday	1.456**(1.221-1.735)	1.267*(1,036-1.551)
Nagelkerke R^2		0.231

aOR = adjusted odds ratio; PSQI = Pittsburgh Sleep Quality Index.
* p<.01.
** p<.001.

that there was a non-significant relationship between a shorter time from dinner to bed time and hyperglycemia.[70] Therefore, the advice "do not eat before bed for sleep and health" may be incorrect. However, this study could not examine the amount of dinner. The possibility remains that eating too much at the evening meal before bed is inappropriate for sleep. The mechanism

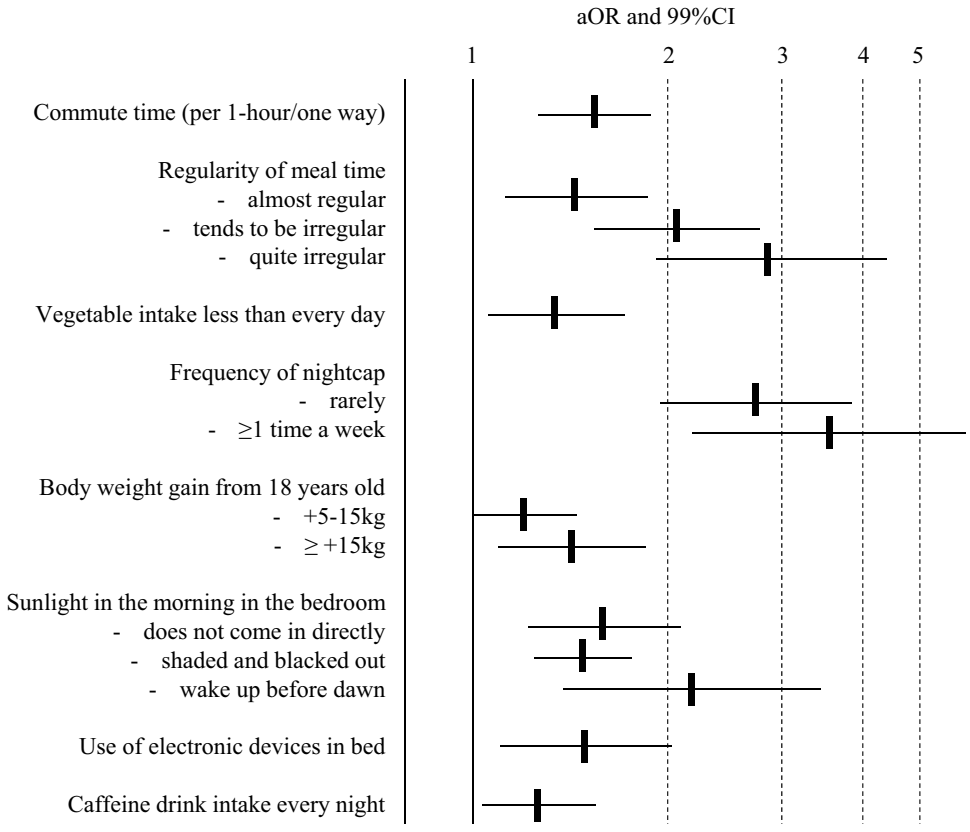

Figure 2. Plot of adjusted aORs and 99% CIs of the effect of each lifestyle habit on sleep disturbance. aOR = adjusted odds ratio; 99% CI = 99% confidence interval.

by which dietary pattern affects sleep remains unclear, a pattern that is also associated with mental health such as suicide.[71] However, we found that a lack of vegetable intake tended to associated with sleep disturbance, similar to previous findings,[32] suggesting that vegetables likely play an important role. Recent nutritional psychiatry research has reported a close association between meals and psychosomatic symptoms.[72] Depression and anxiety are associated with vegetable intake[73,74] and consumption of them could improve symptoms.[75,76] A deficiency in folic acid, which is found in some vegetables, causes depression, and continuous intake of folic acid is associated with a lower risk of depression.[77,78] The intestinal environment affects the HPA axis[79] and probiotics could improve stress reactions with HPA axis regulation.[80] Further, vegetable consumption prevents hyperglycemia,[81] which may be associated with sleep.[82] Alternatively, the effect of vegetables may be related to an economic bias. Low income status is associated with sleep disturbance[83] and vegetables are usually more expensive than staple foods or fast food.

Nightcaps were a strong sleep deteriorating factor. Although there is a possibility of a reverse causal relationship in that participants may have taken nightcaps because of insomnia symptoms, previous studies have shown that alcohol causes sleep problems,[39–41] suggesting that nightcaps should be avoided.

Body weight gain was associated with sleep disturbance. Obstructive sleep apnea is closely associated with body weight gain[84]. Therefore, the association between body weight gain and sleep in the present study may be related to the incidence of breathing disorders.

Light conditions in the morning and night were significantly associated with sleep disturbance and chronotype. Light exposure in the morning entrains the circadian rhythm,[85] interruptions to which may cause sleep disturbance. In contrast, light exposure at night disrupts[85] and delays[86] the circadian rhythm. In particular, the blue light from electronic visual displays specifically affects the circadian rhythm.[87–92] Light exposure advances the circadian rhythm in the morning and delays it in the evening.[86] The results of the present study support it, whereas there is a possibility of an opposite interaction that eveningness behavior may lead night-time light exposure.

Various sleep hygiene are commonly advocated to improve sleep, but priority among them is unclear. The findings of this study suggest the important idea that these various life-habits might differ in importance. For instance, a nightcap is a risk factor of sleep disturbance which appears to have a stronger impact than caffeine use or light conditions. Dinner time might appear less important, whereas the regularity of meal times is more important. In this study, nightcap, too early wake up before dawn, and irregular meal time were suggested as remarkable sleep hygiene which raises sleep disturbance with more than two times of adjusted odds ratio. Our present results will aid persons with sleep disturbance arising from multiple problems of sleep hygiene to prioritize which specific sleep hygiene factors should be preferentially improved.

The present study has limitations. First, the causal relationships of the associations are unclear because this study was cross-sectional in design and all parameters were evaluated only once. A prospective study or randomized control trial is required to examine whether sleep problems are improved by sleep hygiene interventions based on the results of the present study. Second, we examined self-reported subjective data obtained from questionnaires, which may not be accurate.

Table 4
Multivariate logistic regression analysis of factors associated with eveningness chronotype

Characteristic and lifestyle habit	Eveningness chronotype	
	Univariate OR (99% CI)	Multivariate aOR (99% CI)
Sex		
Male	ref.	ref.
Female	0.832 (0.126-5.480)	0.782**(0.646-0.946)
Age (per years old)		
Marriage	0.942**(0.934-0.950)	0.969**(0.958-0.98)
Single	ref.	ref.
Married	0.442**(0.385-0.508)	0.526**(0.410-0.674)
Living status		
live alone	ref.	ref.
share a room	1.050 (0.746-1.479)	1.097 (0.734-1.640)
live with family	0.523*(0.289-0.947)	0.799 (0.630-1.013)
Overtime work (per 1-hour/month)	1.002 (1.000-1.005)	1.001 (0.998-1.004)
Commute time (per 1-hour/one way)	0.509**(0.426-0.607)	0.692**(0.559-0.856)
BJSQ Area A: job stressors (per pts.)	0.985*(0.977-0.996)	0.967**(0.953-0.981)
BJSQ Area C: social support (per pts.)	1.015*(1.002-1.029)	1.022*(1.004-1.040)
Regularity of meal time		
Regular	ref.	ref.
almost regular	2.170**(1.643-2.866)	1.513*(1.086-2.106)
tends to be irregular	4.103**(3.092-5.444)	2.185**(1.526-3.128)
quite irregular	4.921**(3.547-6.828)	2.369**(1.541-3.642)
Frequency of morning breakfast intake		
every morning	ref.	ref.
almost every morning	2.523**(2.041-3.120)	1.735**(1.361-2.212)
Rarely	4.043**(3.243-5.041)	2.355**(1.813-3.059)
Never	5.247**(4.239-6.494)	2.946**(2.282-3.804)
Time from dinner to bed time		
>2 hours	ref.	ref.
≤2 hours, >1 hour	0.761**(0.648-0.893)	0.638**(0.526-0.774)
≤1 hour	0.677**(0.533-0.861)	0.503**(0.375-0.675)
do not eat dinner	0.932 (0.500-1.738)	0.488 (0.235-1.011)
Frequency of vegetable intake		
every meal	ref.	ref.
every day	1.734**(1.381-2.178)	1.241 (0.950-1.620)
less than every day	3.263**(2.604-4.089)	1.524**(1.155-2.010)
Frequency of nightcap		
Never	ref.	ref.
Rarely	1.453**(1.130-1.868)	1.269 (0.938-1.717)
≥1 time a week	0.925 (0.649-1.318)	1.113 (0.728-1.701)
Body weight change from 18 years old		
<-5kg	0.705*(0.502-0.990)	0.725 (0.490-1.072)
within ±5kg	ref.	ref.
>+5kg, <+15kg	0.926 (0.786-1.090)	1.048 (0.859-1.279)
≥+15kg	1.019 (0.818-1.270)	1.188 (0.902-1.566)
Change in frequency of exercise from 18 years old		
significantly decreased	1.087 (0.863-1.368)	1.150 (0.874-1.513)
Decreasd	0.998 (0.773-1.288)	1.165 (0.864-1.572)
Unchanged	ref.	ref.
Increased	0.903 (0.651-1.252)	1.161 (0.795-1.696)
Sunlight exposure in the morning in the bedroom		
sunlight comes in directly	ref.	ref.
sunlight does not come in directly	1.623**(1.278-2.062)	1.344*(1.020-1.771)
shaded and blacked out	1.458**(1.240-1.714)	1.448**(1.200-1.747)
wake up before dawn	0.247 (0.133-0.458)	0.298**(0.141-0.630)
Time spent using electronic visual displays at night		
a) ≥1h before bed	ref.	ref.
b) up to 0.5h before bed	1.146 (0.803-1.636)	0.980 (0.650-1.478)
c) just before bed	2.179**(1.627-2.916)	1.433*(1.018-2.017)
d) use in bed	3.973**(2.941-5.367)	2.008**(1.403-2.874)
Frequency of caffeine drink intake at night		
never/rarely	ref.	ref.
Often	1.409**(1.157-1.715)	1.069 (0.849-1.345)
Everyday	1.797**(1.488-2.172)	1.422**(1.138-1.777)
Nagelkerke R^2		0.300

Eveningness chronotype was classified according to the tertile distribution.
aOR = adjusted odds ratio; MSFsc = Midpoint of Sleep on free days sleep-corrected.
* p<.01.
** p<.001.

Precise results for variables such as sleep-wake schedule or meal schedule, amount of vegetable consumption and caffeine use, strength of exercise, exact frequency of exercise, and strength of light in the morning or evening are unknown. In addition, the presence of sleep disturbance was evaluated using a questionnaire rather than being clinically diagnosed. Third, some

Table 5
Multivariate linear regression analysis of factors associated with sleep disturbance

Characteristic and lifestyle habit	PSQI (points)			MSFsc (hours)			
	Coefficient	(99% CI)	β	Coefficient	(99% CI)	B	VIF
Sex: female	0.395**	(0.205 - 0.585)	0.069	−0.148*	(−0.260 - −0.035)	−0.043	1.167
Age (per years old)	−0.002	(−0.012 - 0.008)	−0.007	−0.028**	(−0.034 - −0.022)	−0.169	1.439
Marriage: married	−0.338**	(−0.578 - −0.098)	−0.060	−0.461**	(−0.603 - −0.319)	−0.137	1.917
Living status: live alone	−0.057	(−0.296 - 0.181)	−0.010	0.096	(−0.045 - 0.237)	0.027	1.734
Overtime work (per 1-hour/month)	−0.002	(−0.005 - 0.002)	−0.016	0.000	(−0.002 - 0.002)	−0.004	1.209
Commute time (per 1-hour/one way)	0.501**	(0.293 - 0.709)	0.078	−0.004***	(−0.006 - −0.002)	−0.070	1.128
BJSQ Area A: job stressors (per pts.)	0.079**	(0.065 - 0.093)	0.193	−0.022**	(−0.031 - −0.014)	−0.092	1.306
BJSQ Area C: social support (per pts.)	0.076**	(0.058 - 0.093)	0.146	0.016**	(0.005 - 0.026)	0.052	1.258
Regularity of meal time (per pts.)	0.476**	(0.351 - 0.600)	0.145	0.253**	(0.180 - 0.327)	0.131	1.541
Frequency of morning breakfast intake (per pts.)	0.029	(−0.056 - 0.114)	0.012	0.221**	(0.170 - 0.271)	0.153	1.316
Time from dinner to bed time: >2 hours	0.320**	(0.138 - 0.503)	0.057	0.378**	(0.270 - 0.486)	0.113	1.127
Frequency of vegetable intake (per pts.)	0.187**	(0.070 - 0.304)	0.055	0.071*	(0.002 - 0.141)	0.035	1.262
Frequency of nightcap (per pts.)	0.991**	(0.832 - 1.150)	0.195	−0.001	(−0.095 - 0.093)	0.000	1.043
Body weight change from 18 years old: within ±5kg	−0.352**	(−0.535 - −0.169)	−0.062	−0.045	(−0.153 - 0.063)	−0.013	1.111
Change in frequency of exercise from 18 years old (per pts.)	−0.057	(−0.142 - 0.028)	−0.021	−0.030	(−0.080 - 0.020)	−0.019	1.057
Sunlight comes in the bedroom directly in the morning	−0.540**	(−0.720 - −0.359)	−0.093	−0.154**	(−0.261 - −0.047)	−0.045	1.023
Time spent using electronic visual displays at night (per pts.)	0.196**	(0.106 - 0.287)	0.072	0.153**	(0.100 - 0.206)	0.094	1.164
Frequency of caffeine drink intake at night (per pts.)	0.083**	(0.018 - 0.148)	0.040	0.086**	(0.048 - 0.125)	0.070	1.048
F value	100.544**			97.221**			
Adjusted R^2	0.239			0.243			

Dependent variable: PSQI (Pittsburgh Sleep Quality Index) and MSFsc (Midpoint of Sleep on free days sleep-corrected) as a contenious variable.
* p<.01.
** p<.001.

lifestyle habits were assessed in accordance with frequency only, and not quantity. The amount of vegetable, nightcap, or caffeine intake is likely important. Objective measurements are needed to examine the exact effect size of each lifestyle habit. Fourth, we did not examine some important associated factors, such as income, social status, physical and psychological comorbidities, objective data of BMI, or the other sleep hygiene such as smoking. Moreover, sleep may also be affected by work-life balance and interaction or conflict between work and private environmental factors such as the family, local community, or private activities. Possible confounding by these was not adjusted for and further study is needed.

Conclusions

Among office workers, job stressors, social support, commute time, and various lifestyle habits such as regularity of dinner time, nightcap, frequency of vegetable intake, sunlight exposure in the morning in the bedroom, electronic visual display use at night, and frequent caffeine intake at night were independently associated with sleep disturbance. Each factor had a different effect size, indicating that sleep hygiene interventions to promote workers' sleep health should prioritize factors in accordance with effect size.

Disclosure

A.S. has received fees from Meiji Seika Pharma, Yoshitomi Yakuhin, Tanabe Mitsubishi Pharma, and Eisai outside the submitted work and is a stockholder of Children and Future Co., Ltd. T.I. has received personal fees from Mochida Pharmaceutical, Takeda Pharmaceutical, Eli Lilly, Janssen Pharmaceutical, MSD, and Taisho Toyama Pharmaceutical, Yoshitomiyakuhin, and Daiichi Sankyo; received grants from Shionogi, Astellas, Tsumura, and Eisai; and received grants and personal fees from Otsuka Pharmaceutical, Dainippon Sumitomo Pharma, Mitsubishi Tanabe Pharma, Kyowa Pharmaceutical Industry, Pfizer, Novartis Pharma, and Meiji Seika Pharma; and is a member of the advisory boards of Pfizer, Novartis Pharma, and Mitsubishi Tanabe Pharma outside the submitted work. The other authors declare that there are no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleh.2020.02.001.

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