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ORIGINAL ARTICLE

Overtime work is related to nonrestorative sleep independently of short sleep time among a Japanese occupational population

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Abstract

Objective The symptoms of insomnia are defined as difficulty falling asleep, difficulty staying asleep, and early awakening. Although also a symptom of insomnia, nonrestorative sleep (NRS) is clearly more associated with objective indices than other insomnia symptoms. However, the link between NRS and overtime work duration is poorly understood.

Methods The results of a single year's medical examinations were investigated for 26,144 Japanese office workers who were 30 to 59 years old. NRS status and lifestyle were collected through a computer-assisted medical interview. The subjects were asked about the presence or absence of NRS and their lifestyles in the most recent two to three months. The subjects were asked about their sleep times and average overtime durations per month (< 20 h/month, ≥ 20 but < 40 h/month, ≥ 40 but < 60 h/month, and ≥ 60 h/month). The relationships between NRS and overtime work duration adjusted for sleep time were also analyzed.

Results The proportion of subjects with NRS showed a stepwise increase as overtime work hours increased. A logistic regression analysis was performed using NRS as an objective variable. The multivariate analysis demonstrated that overtime work duration (OR, 1.13; 95% CI 1.10–1.17; $P < 0.001$; per one-category increase) was an independent determinant of NRS.

Conclusion For office workers, long hours of overtime work increased the NRS prevalence at any sleep duration.

Keywords Long working hours · Sleep restfulness · Sleep time · Medical checkup · Office worker

Introduction

The symptoms of insomnia are defined as difficulty falling asleep, difficulty staying asleep, and early awakening (American Academy of Sleep Medicine 2014). Although nonrestorative sleep (NRS) is also one of the symptoms of insomnia, it is clearly more associated with objective indices, such as sleep stage transitions, sleep stability, sleep efficiency, total sleep duration measured with polysomnography independent of other objective sleep parameters (Laffan et al. 2010; Kaplan et al. 2017a, b), and inflammatory responses (Zhang et al. 2013), than other insomnia symptoms. This unrefreshing sleep is considered to reflect the symptomatic physiological lack of rest following sleep.

NRS was reported to be associated with short sleep duration (Matsumoto et al. 2017). It is also known that there are higher proportions of subjects with NRS among short sleepers (Kaplan et al. 2017a, b; Sarsour 2010). Several papers have reported that sleep duration decreases as overtime work (long working hours) increases in workers (Watanabe et al. 2022; Ohtsu et al. 2013). However, it is not known whether the duration of overtime work in workers is associated with NRS.

Therefore, this study aimed to clarify whether overtime work duration is a risk factor for NRS independent of sleep time. This was a single-center, cross-sectional study.

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Materials and methods

Subjects

A medical checkup and medical interview were conducted for 31,295 company staff members of FUJITSU Limited or affiliated companies between April 1, 2021, and March 31, 2022, at the Health Examination Center, FUJITSU Ltd. Of these staff members, 21,526 Japanese men and 4618 Japanese women who were 30 to 59 years old, had no missing data in this study, were not receiving maintenance hemodialysis, and were free from mental illnesses were included as subjects in the analysis (Fig. 1). Approximately 98% of the final analysis subjects were non-shift office workers. There is a close relationship between mental illness and insomnia including NRS (Wakasugi et al. 2014; Wulff et al. 2010). In this study, 1577 subjects, who had a history of mental illness, were under treatment for a mental illness, or took hypnotic drugs were excluded from the analysis because the treatment of mental illnesses has a direct major impact on sleep and subjective symptoms of sleep (Manber et al. 2008) (Fig. 1).

Information regarding age, gender, height, weight, and body mass index (BMI) was collected at the medical checkup.

Questionnaires about sleep and lifestyle

Lifestyle habits, sleep duration, and duration of overtime work in the most recent two to three months were collected through a computer-assisted medical interview before the medical checkup.

The subjects were asked about the time they fall asleep and the time they wake up, and sleep duration was calculated to the closest hour. Subjects who responded with "No" to the following question were defined as having NRS in this study: "Have you been feeling sufficiently rested after sleeping in the most recent 2 to 3 months?".

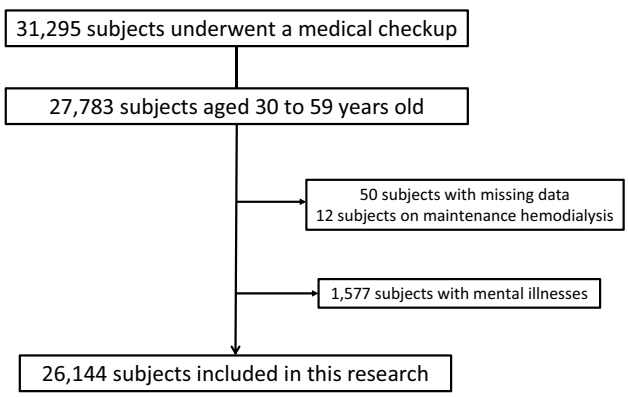

Fig. 1 Flowchart for the inclusion criteria

Smoking habit was defined as being a current smoker with a regular smoking habit (including heated cigarettes). The criterion for having a drinking habit was defined as alcohol consumption once a week or more, and the daily average alcohol consumption (g) was calculated. Overdrinking was defined as a daily average alcohol consumption of 20 g or more. Exercise habit was defined as regularly getting thirty minutes or more of exercise once or more a week. Improper eating habit was defined as habitually skipping breakfast three or more days a week and/or habitually eating within 2 h before bed 3 or more days a week.

All workers basically worked 8 h a day, 5 days a week. The monthly average self-reported duration of overtime work was recorded. Average overtime durations per month were divided into less than 20 h, 20 h or more but less than 40 h, 40 h or more but less than 60 h, and 60 h or more. In this study, we investigated lifestyle for 2 to 3 months.

Statistical analyses

The primary endpoint was long overtime work duration as a risk factor for NRS, independent of sleep duration, and was assessed by a logistic regression analysis.

The subjects were divided based on the duration of overtime work (<20 h/month, ≥ 20 but <40 h/month, ≥ 40 but <60 h/month, and ≥ 60 h/month) to obtain characteristics of the subjects' backgrounds according to the duration of overtime work. Potential risk factors for NRS (age, sex, BMI, sleep time, rates of smoking habit, overdrinking, exercise habit, and improper eating habit (Wakasugi et al. 2014; Matsumoto et al. 2017)) were compared among the four groups. Age, BMI, and sleep time were subjected to the Kolmogorov–Smirnov-Lilliefors test to evaluate the goodness of fit to a normal distribution. Age, BMI, and sleep time were tested with $P=0.010$, and the distribution was not normal. The Kruskal–Wallis test and Pearson's χ^2 test were used to compare parameters among the four groups. The data are expressed as mean ± standard deviation values. We performed a multiple regression analysis to evaluate the association of duration of overtime work with sleep time and factors related to sleep time, overtime work (per one-category increase), and/or NRS, age, gender, BMI, smoking habit, overdrinking, exercise habit, and improper eating habit. In addition, univariate and multiple logistic regression analyses were performed to determine the factors related to NRS. Statistical analyses were conducted using the JMP software for Windows (version 10.0; SAS Institute, Cary, NC, USA). Significant differences were defined at a P value for the risk ratio of <0.05.

Ethics

This research was conducted in accordance with the Helsinki Declaration. In conducting the research, we anonymized all information that could identify individuals and conducted the study under strict control with reference to the "Guidelines for Proper Handling of Personal Information by Medical Care/Nursing Care Service Providers" and "Things to Keep in Mind for Proper Handling of Personal Health Information on Employment Management" of the Ministry of Health, Labour and Welfare of Japan. The use of health information so that individuals cannot be identified was clearly stated in each patient's questionnaire, and posters were posted at the Health Examination Center, FUJITSU Ltd. The posters explained that questions about the handling of health information management would be answered and that opting out was allowed. The FUJITSU Clinic Ethics Committee reviewed this study, and we obtained the approval of the Committee before conducting the study (Ethical Committee Approval No. 31).

Results

Background characteristics of the subjects

The average age of the subjects (n = 26,144) was 47.9 ± 7.3 years old, and the proportion of males was 82% (n = 21,526). The average BMI of the subjects was 23.9 ± 3.9 kg/m^2, and the average sleep time was 6.0 ± 1.0 h. The proportion of subjects with NRS among all subjects was 26% (25% in male subjects and 33% in female subjects). The numbers of subjects with overtime work hours of < 20 h/month, ≥ 20 h but < 40 h/month, ≥ 40 h but < 60 h/month, and ≥ 60 h/month were 9878 (38%), 9884 (38%), 4056 (16%), and 2326 (9%). As for lifestyle habits, the rates of smoking habit, overdrinking, exercise habit, and improper eating habit in the subjects were 19%, 22%, 59%, and 60% (Table 1). For overtime work hours, the proportions of subjects with NRS showed a stepwise increase as the overtime work hours increased. There were significant differences in age, sex, BMI, sleep time, and the rates of smoking habit, exercise habit, and improper eating habit among the groups classified by overtime work status (Table 1).

Relationships between overtime work duration and sleep time

In the multiple regression analysis, age ($\beta = -0.14$; $P < 0.001$), sex ($\beta = 0.17$; $P < 0.001$), BMI ($\beta = -0.06$; $P < 0.001$), sleep time ($\beta = -0.20$; $P < 0.001$), smoking habit ($\beta = -0.01$; $P = 0.034$), exercise habit ($\beta = 0.02$; $P < 0.001$), and improper eating habit ($\beta = 0.11$; $P < 0.001$) were independently associated with overtime work duration (Table 2).

Table 2 Multivariate regression analysis to determine factors associated with overtime work

Variables	β	*P*-value
Age (1 years)	− 0.14	< 0.001
Male gender (0 = no; 1 = yes)	0.17	< 0.001
BMI (kg/m^2)	− 0.06	< 0.001
Sleep time (1 h)	− 0.20	< 0.001
Smoking habit (0 = no; 1 = yes)	− 0.01	0.034
Overdrinking (0 = no; 1 = yes)	0.00	0.496
Exercise habit (0 = no; 1 = yes)	0.02	< 0.001
Improper eating habit (0 = no; 1 = yes)	0.11	< 0.001

Table 1 Backgrounds of the subjects according to duration of overtime work

Overtime work, h/month	All subjects	< 20	≥ 20 but < 40	≥ 40 but < 60	≥ 60	*P*-value
Subjects, no. (%)	26,144	9878	9884	4,056	2,326	/
Age, years	47.9 ± 7.3	49.0 ± 7.5	47.6 ± 7.3	46.7 ± 6.9	46.4 ± 6.1	< 0.001[a]
Male, no. (%)	21,526 (82)	7320 (74)	8396 (85)	3677 (91)	2133 (92)	< 0.001[b]
BMI, kg/m^2	23.9 ± 3.9	24.0 ± 4.1	24.0 ± 3.9	24.0 ± 3.8	23.7 ± 3.5	0.079[a]
Sleep time (h)	6.0 ± 1.0	6.2 ± 1.0	6.1 ± 0.9	5.8 ± 0.9	5.6 ± 0.9	< 0.001[b]
NRS, no. (%)	6921 (26)	2356 (24)	2435 (25)	1209 (30)	921 (40)	< 0.001[b]
Lifestyle, no. (%)						
Smoking habit	4882 (19)	1701 (17)	1930 (20)	791 (20)	460 (20)	< 0.001[b]
Overdrinking	5711 (22)	2095(21)	2178 (22)	911 (22)	527 (23)	0.226[b]
Exercise habit	15,501 (59)	5737 (58)	5954 (60)	2430 (60)	1380 (59)	0.016[b]
Improper eating habit	15,606 (60)	5137 (52)	6012 (61)	2791 (69)	1666 (72)	< 0.001[b]

[a]Kruskal-Wallis test

[b]Pearson's χ^2

Relationships between nonrestorative sleep and overtime work

Logistic regression analyses were performed using NRS as an objective variable (Table 3). The results of univariate analyses indicated significant relationships between the occurrence of NRS and all factors. The multivariate analysis demonstrated that male gender [odds ratio (OR), 0.59; 95% confidence interval (CI) 0.55–0.64; $P < 0.001$], sleep time (OR, 0.50; 95% CI 0.49–0.52; $P < 0.001$), overtime work duration (OR, 1.13; 95% CI 1.10–1.17; $P < 0.001$; per one-category increase), smoking habit (OR, 0.79; 95% CI 0.73–0.85; $P < 0.001$), exercise habit (OR, 0.68; 95% CI 0.64–0.72; $P < 0.001$), and improper eating habit (OR, 1.18; 95% CI 1.11–1.26; $P < 0.001$) were independent determinants of NRS (Table 3).

Discussion

This study was the first cross-sectional study to investigate the relationship between NRS and overtime work hours in office workers. The findings of this study of 30- to 59-year-old office workers with an average age of 47.9 years old and without mental illnesses can be summarized as follows: (i) The proportion of subjects with NRS showed a stepwise decrease as sleep time increased and a stepwise increase as overtime work hours increased. (ii) NRS risk increased as overtime work increased. Long overtime work hours were a contributing factor for NRS independently of sleep time.

The strengths of this investigation were the performance of the medical checkups under the same conditions, as they were conducted at a single facility, and the large number of subjects. NRS is often noticed at a younger age than the main insomnia symptoms of difficulty falling asleep, difficulty staying asleep, and early awakening (American Academy of Sleep Medicine 2014; Zhang et al. 2013). Therefore, investigating the relationships between NRS and overtime work hours in an occupational population is significant for the prevention of health disorders (Wakasugi et al. 2014; Wulff et al. 2010; Ohayon and Roth 2001; Vernon et al. 2010). In this study, since the proportion of subjects with NRS among all subjects was not low (26%), we had to pay attention to the fact that the OR of NSR in the results of this study would appear to be larger than an assessment using the risk ratio.

Nonrestorative sleep

The definition of subjects with NRS has yet to be standardized, making it difficult to draw comparisons between studies (Vernon et al. 2010; Wilkinson and Shapiro 2012). The definition of NRS also varies depending on the study, with some studies evaluating it based on only the presence or absence of NRS (Matsumoto et al. 2017; Takahashi et al. 2022; Nisenbaum et al. 2004), like this study; NRS frequency (Zhang et al. 2013; Ohayon 2005); severity of feeling that sleep is restless (Laffan et al. 2010); and the NRS scale (Wilkinson and Shapiro 2013). In this study, the subjects were only asked about the presence or absence of NRS in the most recent two to three months with a single item. A single question regarding the presence of NRS is appealing, as it minimizes the administrative burden in such a large observational study. In studies using a yes–no questionnaire to determine the presence of NRS, the prevalence of NRS was relatively higher compared with studies using other methods. The prevalence of NRS was reported to be 19.2 to 31.0% in men and 26.3 to 42.1% in women (Wakasugi et al. 2014; Matsumoto et al. 2017; Phillips and Mannino 2005). The frequency of NRS in this study was similar. However, the subjects of the abovementioned studies were community residents in their 30 s to early 70 s (Wakasugi et al. 2014; Matsumoto et al. 2017; Phillips and Mannino 2005). Therefore, when examining NRS, it was necessary to pay attention to the methodology used for the assessment of NRS and the background of the subjects (Matsumoto and Chin 2019).

Table 3 Logistic regression analyses to determine factors associated with nonrestorative sleep

Variables	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Age (1 years)	1.00 (1.00–1.01)	0.046	1.00 (0.99–1.01)	0.093
Male gender (0 = no; 1 = yes)	0.67 (0.63–0.72)	< 0.001	0.59 (0.55–0.64)	< 0.001
BMI (kg/m^2)	1.01 (1.00–1.01)	0.032	1.00 (0.99–1.01)	0.565
Sleep time (1 h)	0.49 (0.47–0.50)	< 0.001	0.50 (0.49–0.52)	< 0.001
Overtime work (< 20; ≥ 20 but < 40; ≥ 40 but < 60; ≥ 60 h/month)	1.24 (1.21–1.28)	< 0.001	1.13 (1.10–1.17)	< 0.001
Smoking habit (0 = no; 1 = yes)	0.82 (0.76–0.88)	< 0.001	0.79 (0.73–0.85)	< 0.001
Overdrinking (0 = no; 1 = yes)	0.87 (0.81–0.93)	< 0.001	1.00 (0.93–1.08)	0.975
Exercise habit (0 = no; 1 = yes)	0.63 (0.59–0.66)	< 0.001	0.68 (0.64–0.72)	< 0.001
Improper eating habit (0 = no; 1 = yes)	1.27 (1.20–1.35)	< 0.001	1.18 (1.11–1.26)	< 0.001

In a study using NRS defined solely by a "yes–no" question about having NRS with no time limit, misperceptions regarding sleep duration were responsible for the perception of NRS (Takahashi et al. 2022). NRS assessed by this simple "yes–no" question was also associated with not only sleep parameters but also depressive mood, mental fatigue, gastroesophageal reflux symptoms, metabolic syndrome, hypertension, diabetes mellitus, and a lack of habitual exercise (Matsumoto et al. 2017; Otsuka et al. 2023). Even with NRS assessed by this simple "yes–no" question, it was possible to stratify the risk of health problems. In the future, it may be necessary to unify and develop consistent question methods for NRS evaluation.

Overtime work and sleep duration

Several papers have reported that sleep duration decreases as overtime work (long working hours) increases in workers (Watanabe et al. 2022; Ohtsu et al. 2013), and the results of this study are similar. Overtime work is generally a time commitment we do not desire. Short sleep durations and short amounts of free time other than for rest are known to cause poor mental and physical health (Ohtsu et al. 2012). There was a reciprocal relationship between overtime work and sleep duration, such that short sleep or sleep deprivation could result in productivity problems at work (Orzeł-Gryglewska 2010) that, in turn, increase the overtime work duration.

In addition, the average sleep time of our subjects was 6.0 ± 1.0 h. In a study of normal volunteers, after a recovery period of 8 h of sleep for 3 days, 9 h of sleep for 7 days did not impair daytime work performance, but 7 h of sleep did reduce work performance (Belenky et al. 2003). The workers in this study might have needed more sleep than we thought to relieve the fatigue that accumulates in their daily lives.

Overtime work and nonrestorative sleep

To our knowledge, no reports have shown an association between overtime work hours and NRS. The results of this study also revealed that subjects who had long hours of overtime work were frequently aware of the presence of NRS independently of sleep time. Job stress is known to cause NRS (Knudsen et al 2007). Knudsen et al. reported that work overload and job autonomy were significantly associated with NRS. Not only did overtime work reduce sleep time and cause NRS but also the job stress resulting from overtime work could also cause NRS. Further investigation is needed to evaluate changes in NRS through interventions for overtime work durations and prospective observations of overtime work durations.

Clinical implications of the results of this study

For 30- to 59-year-old office workers, long hours of overtime work increased the NRS prevalence at any sleep duration.

Limitations

Whether or not the results of the present study can be applied to general workers is unclear. This study was also unable to distinguish between cause and effect. The backgrounds of the subjects and answers regarding both exposure (sleep durations and overtime work durations) and outcome (NRS) were based on information they provided, so they might have been inaccurate. The nature of questionnaires limits the reliability and validity of the obtained data, making this study prone to self-report bias, recall bias, and spurious correlations (Watanabe et al. 2022).

Commuting time (Hafner et al. 2017), housework, and childcare time (Watanabe et al. 2022), which are factors that shorten sleep duration, could not be evaluated. NRS symptoms often overlap the main symptoms of insomnia of difficulties in initiating and maintaining sleep and early morning awakening (Ohayon and Roth 2001). We were not able to compare these symptoms with NRS in this study. In addition, an evaluation of the comorbidity of sleep-disordered breathing was not performed.

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Author contributions HS conceived the presented idea and collected the data for this study. HS verified the analytical methods. HM encouraged HS to investigate and supervised the interpretation of findings for the whole work. All authors discussed the results and contributed to the final manuscript.

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Data availability The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare no conflict of interest.

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