Relationship between Poor Sleep and Future Development of Depressive Symptoms in a 2-year Cohort Study of Male Japanese Workers

Naoko Nishitani*,[1] and Hisataka Sakakibara[2]

[1]*Sugiyama Jogakuen University Department of Nursing Nagoya, Japan*

[2]*Nagoya University School of Health Sciences Nagoya, Japan*

Abstract: We examined the relationship between poor sleep and the future incidence of depressive symptoms through a 2-year cohort study of male Japanese workers at a synthetic fiber manufacturing plant. A questionnaire survey addressing job stress, sleep conditions, and depressive symptoms was conducted in 2007 and 2009 using the Athens Insomnia Scale (AIS-5) and the Job Stress Questionnaire. Poor sleep was assessed using the AIS, a tool devised by the World Health Organization, based on criteria of the International Classification of Disease 10th Revision (ICD-10). Of the 158 respondents, 108 without depressive symptoms at baseline were analyzed. The incidence of new depressive symptoms was 10.2% over the 2 years. None of the subjects with AIS-5 scores of 0 in 2007 (baseline) suffered depressive symptoms in 2009, while 15.7% of the subjects with AIS-5 scores of 1 or more did so. Among those with AIS-5 scores of 3 or more in 2007, 20.0% experienced depressive symptoms in 2009. AIS scores at baseline were closely associated with the incidence of new depressive symptoms over the 2 years. Poor sleep can be a risk factor for developing depression or, at least, an important marker for the subsequent development of depression among male Japanese workers.

Keywords: Poor sleep, depressive symptoms, cohort study.

INTRODUCTION

The prevalence of insomnia among employees in Japan is reportedly 5-45% among day workers and 29-38% among shift workers [1]. Data from the US show comparable figures, with approximately 30% of day workers experiencing insomnia [2]. Earlier studies have reported that insomnia is associated with mental factors such as psychological stress and the inability to manage stress well [3]. Exhaustion and depression are also shown to be closely related to insomnia [4-8]. Among white-collar males, insomnia is reportedly shown to be connected with the work-related stress responses to depression and lower job satisfaction [4]. Persistent insomnia is considered to reduce quality of life [9] and to affect the person economically [10].

Moreover, insomnia is known to be closely linked to depression [4-6], and some studies have suggested that it can be a risk factor for depression [11, 12]. However, few studies have clearly demonstrated that insomnia might be a risk factor for developing depression in Japanese workers.

Our earlier study [13] indicated a strong relationship between insomnia and depression. However, since that study was cross-sectional, it could not show a causal association. For the present study, therefore, we conducted a 2-year follow-up survey to examine the relationship between poor sleep at baseline and the incidence of new depressive symptoms over the 2 years. The subjects were male Japanese workers without depressive symptoms at baseline. To assess sleep quality, our survey employed the Athens Insomnia Scale (AIS) [14, 15], a tool devised by the World Health Organization.

*Address correspondence to this author at the Sugiyama Jogakuen University Department of Nursing, 17-3, Hoshigaoka-motomachi, Chikusa-ku, Nagoya 464-8662, Japan; Tel / Fax: +81–(0)52–781–9268;
E-mail: n-nishitani@sugiyama-u.ac.jp

METHODS

Study Subjects

A self-administered questionnaire survey was conducted in April 2007 and April 2009 in conjunction with annual health checkups for male employees at a synthetic fiber manufacturing plant. That questionnaire included the same questions on the subjects' lifestyle, workplace stress and sleep conditions.

The questionnaires were distributed approximately 1 week prior to health checkups and were collected once the subjects received their checkups, with occupational health nurses checking for any unanswered questions. The questionnaires were collected together with signed consent forms from workers who agreed to participate in the study. The 2007 questionnaire was distributed to 212 subjects and collected from 210, for a response rate of 99.1%. The 2009 questionnaire was distributed in a similar manner to 213 subjects, with 199 respondents returning the form, for a response rate of 93.4%. Among them, 170 responded to both surveys in 2007 and 2009. Twelve of the respondents reported having a history of psychiatric illness and being under treatment for those 2 years. Fifty subjects also complained of depressive symptoms in 2007. After excluding those respondents, we analyzed the responses of 108 subjects over the 2-year period. This study was approved by the ethics committee of the Nagoya University Graduate School of Medicine.

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Contents of Questionnaire Survey

Participant Characteristics and Lifestyle

Participant characteristics and lifestyle were investigated, including age, work pattern (daytime work or shift work), whether alone or living with family, job type, mean overtime working hours (working days per week), mean sleeping hours (working days in the latest one month), regular exercise (days per week), smoking habits (yes, no, past, quantity per day), and alcohol consumption (days per week).

Sleep Quality

To assess poor sleep, the survey employed the AIS, a common global measure of insomnia. The AIS is based on criteria of the International Classification of Disease 10th Revision (ICD-10), and has been proven to be an effective and convenient scoring instrument [16]. Some researches in Japan have also used the AIS to survey the status of insomnia [16-18]. In this study the first 5 of 8 AIS questions were employed, since those 5 (AIS-5) were shown to be the most useful [14]. The AIS-5 questions were used to assess difficulty with sleep induction, awakenings during the night, early morning awakening (final awakening), total sleep time (total sleep duration) and overall quality of sleep (sleep quality) .

Based on the AIS-5 questions, subjects were asked if they had experienced difficulty sleeping more than three times a week in the last one month. The items were rated on a four-point scale: "not a problem" (0 points), "slight problem" (1 point), "considerable problem" (2 points), or "could not sleep at all" (3 points). In the full version of the AIS-8, a total score of less than 4 points is taken to indicate no problem, 4 or 5 to indicate that consultation with a physician may be necessary (some suspicion of insomnia), and 6 or more to indicate that a physician consultation would be necessary (suspected insomnia). Since the first 5 questions (AIS-5) were used in this study, subjects were divided into 3 groups with a total score of 0 considered to indicate no sleeping problems, a score of 1 or 2, and a score of 3 or more to indicate some difficulty that might be suggestive of poor sleep.

Job Stress

The Job Stress Questionnaire (JSQ), which was devised in a study commissioned by the Japanese Ministry of Health, Labor and Welfare, was used in the present study [19]. The questions were shown to have been validated [19], the Cronbach α coefficients were reported to be 0.74 for job stress factors, 0.84 for psychological stress response, 0.81 for physical stress response and 0.83 for support.

A total of 17 items was devised to measure job stress factors, including quantitative workload, qualitative workload, physical workload, job latitude, application of technology, interpersonal conflict, workplace environment, and suitability for the work. Answers were categorized using a four-step scale of "agree," "somewhat agree," "somewhat differ," and "differ." The burden from job stress factors was considered to be higher with lower scores for job latitude and compatibility, and with higher scores for all other items. Stress mitigating factors included 9 items concerning social support in the workplace and family. The answers were given on a four-step scale of "very little," "somewhat," "considerably," and "very much." For social support, lower scores indicated lower levels of support.

Depressive Symptoms

Among psychological stress responses of the JSQ, we used the following 6 items related to depressive symptoms to assess depression: "feel depressed," "everything is troublesome," "cannot concentrate on things," "feel gloomy," "cannot focus on work," and "feel sad." Each symptom in the preceding month was rated on a four-point scale of "almost never," "sometimes," "often," and "almost all the time." The responses can be evaluated and classified into two groups; those who replied "almost never" or "sometimes," and the group that responded "often" or "almost all the time [19]." Hence, the responses of "almost never" and "sometimes" were scored as 0 points, while those responding "often" and "almost all the time" were scored as 1 point. The 6 items of depressive symptoms were rated from 0 to 6 points. Subjects with a total score of 0 points for all 6 items were considered to be free of depression symptoms, while those scoring 1 point or more were considered to be somewhat depressed. In the present study, those with no depressive symptoms in the 2007 survey were analyzed to examine the relationship between symptoms of insomnia and a future incidence of depression over 2 years.

Statistical Analysis

The Wilcoxon and McNemar tests were used to analyze the changes in participant characteristics and lifestyle for the 2-year period. Subjects were divided into three groups by total AIS score in 2007 (at baseline): 0 point, 1-2 points, and 3 or more points. Participant characteristics and job stress factors in 2007 were then examined using the χ^2 test and analysis of variance (ANOVA). The Mann-Whitney U-test and χ^2 test were conducted to analyze the characteristics and lifestyle in 2007 in relation to the presence or absence of depressive symptoms in 2009. The presence or absence of such symptoms in 2009 was also examined using logistic regression analysis after adjusting for age and work pattern. All statistical analyses were conducted using SPSS 12.0J.

RESULTS

Changes in Participant Characteristics Over the 2-year Period

Participant characteristics for the 2-year period are shown in Table **1**. The mean age (standard deviation) of the 108 subjects was 38.2 (12.8) year (range: 20-63 years) at baseline in the 2007 survey. The subjects consisted of both day workers and shift workers, with the latter accounting for about 40%. Over the 2 years, there was a decrease in the number of smokers and workers engaged in overtime work ($p<0.001$). During that time, no significant differences were seen in body weight, BMI, work pattern, regular exercise, alcohol consumption, or overtime working hours. Mean sleeping hours or total AIS scores over the 2-year period were also not significantly different.

Table 1. Participant Characteristics and Lifestyle for 2-year Period (Mean ± SD, n (%))

Item	2007	2009	*p*-value
Age (year)	38.2±12.8	40.5±12.8	
Weight (kg)	69.3±13.6	69.6±14.4	0.351 [a]
BMI (kg/m^2)	24.0±4.1	24.1±4.5	0.340 [a]
Shift worker	46 (42.6)	40 (37.0)	0.070 [b]
Smoker	72 (66.7)	60 (55.6)	<0.001 [b] **
No exercise	60 (55.6)	60 (55.6)	1.000 [b]
Alcohol drinking ≥ 5 days a week	31 (28.7)	35 (32.4)	0.289 [b]
Overtime work	68 (63.0)	30 (27.8)	<0.001 [b] **
Overtime (h/week)	2.2±3.2	3.7±3.2	0.900 [a]
Mean sleeping hours (h)	6.5±1.0	6.5±0.9	0.763 [a]
Total AIS score	1.7±2.1	1.9±2.2	0.438 [a]

a: Wilcoxon Test, b: McNemar Test
**p<0.01

Onset of Depressive Symptoms in 2009 based on the Severity of Poor Sleep at Baseline in 2007

Fig. (**1**) illustrates the onset of depressive symptoms in 2009 for each poor sleep condition in 2007. Seventy (64.8%) subjects occasionally complained of poor sleep with total AIS scores of 1 point or more in 2007. Among them, 45 (41.7%) had the AIS scores of 1-2 points, and 25 (23.1%) had scores of 3 points or more. No significant difference in poor sleep was found between workers on the different work patterns (14 (22.6%) of 62 daytime workers and 11 (23.9%) of 46 shift workers) with total AIS scores of 3 points or more.

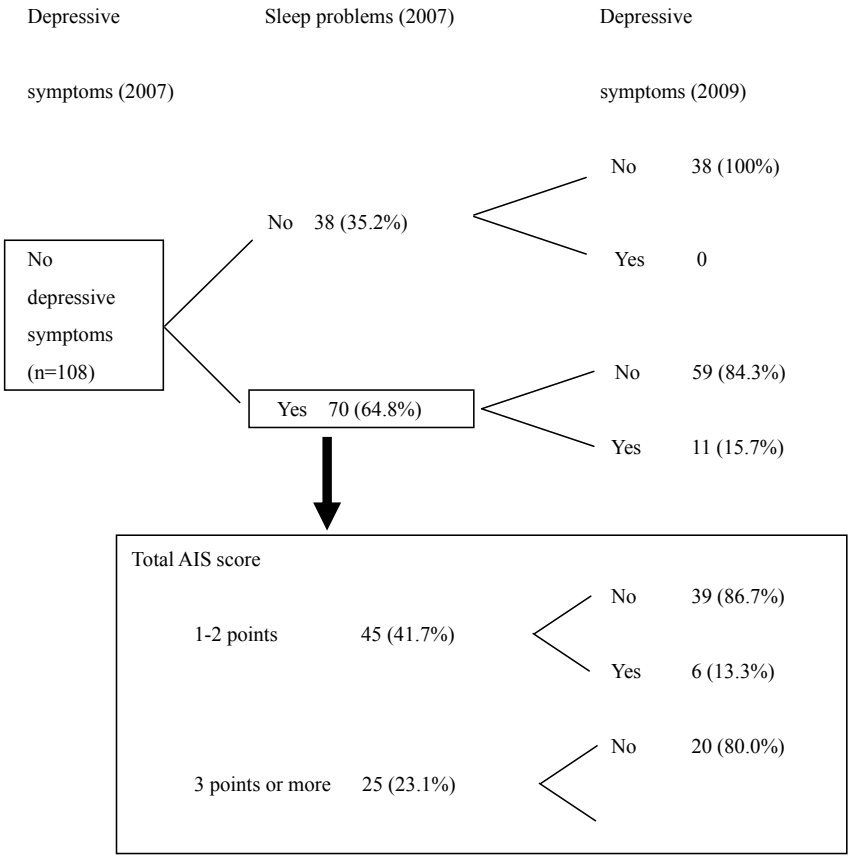

Fig. (1). Sleep problems (poor sleep) assessed by the AIS score in 2007 and subsequent onset of depressive symptoms in 2009.

None of the 38 subjects without sleeping problems in 2007 suffered depressive symptoms in 2009 (Fig. **1**). On the other hand, of the 70 subjects reporting some sleeping problems in 2007, 11 (15.7%) exhibited depressive symptoms in 2009. Among them, 6 (13.3%) experienced the above symptoms from the 45 subjects with total AIS scores of 1-2, while 5 (20.0%) suffered them from the 25 subjects with total AIS scores of 3 or more.

Cox proportional hazards regression analysis was then conducted to investigate a relation between poor sleep (total AIS score) in 2007 (at baseline) and depressive symptoms in 2009 (2 year later), adjusting for age and work pattern. As shown in Fig. (**2**), all subjects with a total AIS score of 1 point or above in 2007 were more likely to experience a 2-year later onset of depressive symptoms (OR 1.30; 95% CI 1.06-1.58, p<0.05) than those with a total AIS score of 0 point. In addition, the subgroup with an AIS score of 3 points or more in 2007 showed a closer relationship with depressive symptoms in 2009 (OR 1.40; 95% CI 1.08-1.89, p<0.05) compared with those with AIS score of 0.

Participant Characteristics and Job Stress Factors in Relation to AIS Score in 2007

Participant characteristics and job stress factors in 2007 were further analyzed according to three groups divided by their total AIS scores (i.e. 0, 1-2 and 3 or more).

As shown in Table **2**, no significant differences were seen in body weight, BMI, work pattern, regular exercise, alcohol consumption, etc. As for subjective stress factors (Table **3**), with higher AIS scores the mean score of "suitability to the work" decreased (trend p=0.004), while the score of "qualitative workload" increased (trend p=0.047).

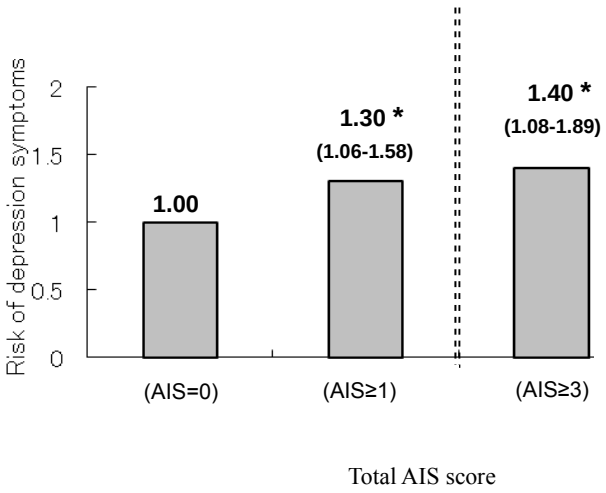

Fig. (2). Risk of depressive symptoms in 2009 according to total AIS-5 score in 2007.
* $p<0.05$
The risks were expressed as Cox proportional hazards regression analysis (95% confidential interval) after adjusting for age and work pattern.

DISCUSSION

In the present 2-year follow-up study, the incidence of new depressive symptoms was 10.2% over the 2 years. None of the subjects free from poor sleep in 2007 suffered depressive symptoms in 2009, while 15.7% of those with poor sleep did so. Moreover, poor sleep with total AIS scores of 3 or more showed a closer association with depressive symptoms. The present findings suggest that poor sleep can be a risk factor for developing depression or, at least, an important marker for the subsequent development of depression.

Table 2. Participant Characteristics by Total AIS Score (2007) (Mean ± SD, n (%))

Item (range)	Total AIS Score			
	0 (n=38)	1–2 (n=45)	≥3 (n=25)	*P* for trend
Age (year) (20.0-63.0)	40.0±13.2	36.6±12.4	38.4±13.1	0.526
Weight (kg) (44.1-144.0)	69.5±14.0	70.1±15.3	67.6±9.7	0.644
BMI (kg/m^2) (16.9-48.6)	24.1±4.0	24.2±4.9	23.3±2.7	0.527
Shift worker	16 (42.1)	19 (42.2)	11 (44.0)	0.987 [a]
Smoker	24 (63.2)	33 (73.3)	15 (60.0)	0.447 [a]
No exercise	20 (52.6)	25 (55.6)	15 (60.0)	0.847 [a]
Drink alcohol ≥5 days week	11 (28.9)	13 (28.9)	7 (28.0)	0.996 [a]
Overtime work	23 (60.5)	28 (62.2)	17 (68.0)	0.827 [a]
Overtime (h/week) (0-20.0)	2.3±3.8	1.8±2.5	2.7±3.4	0.660
Mean sleeping hours (h) (4.0-10.0)	6.6±1.0	6.5±0.9	6.4±1.1	0.331

a: χ^2 test

Table 3. Mean Job Stress Factor Score by Total AIS Score (2007) (mean ± SD)

Job Stress Factor (range)	Total AIS Score			
	0 (n=38)	1–2 (n=45)	≥3 (n=25)	*P* for trend
Quantitative workload (5.0-12.0)	8.2±1.7	8.3±1.7	8.6±1.6	0.424
Qualitative workload (4.0-12.0)	7.9±1.6	8.2±1.7	8.8±1.4	0.047
Physical workload (1.0-4.0)	2.6±1.0	3.0±1.0	2.9±0.7	0.224
Job latitude (4.0-12.0)	8.8±1.1	8.8±1.5	8.9±1.8	0.837
Application of technology (1.0-4.0)	2.3±0.8	2.2±0.7	2.2±0.8	0.525
Interpersonal conflict (3.0-10.0)	6.0±1.5	5.6±1.3	6.8±1.5	0.102
Workplace environment (1.0-4.0)	2.6±1.0	2.5±0.9	2.7±1.0	0.715
Suitability for the work (2.0-8.0)	6.0±1.1	5.9±1.2	5.0±1.2	0.004
Social support (17.0-36.0)	26.9±4.2	27.9±4.8	25.7±4.1	0.379

A close relationship has been shown between insomnia and depression [4-6]. It is thought that insomnia can be both a risk factor for depression and/or a consequence of depression [12]. In our study, the subjects for analysis were limited to those without depressive symptoms at baseline. The present 2-year follow-up study then showed that the development of depressive symptoms was associated with the subjective poor sleep assessed by the AIS at baseline. In addition, higher AIS points were shown to be more closely related with the onset of depressive symptoms. Some studies have also suggested that insomnia may entail a risk of subsequent depression [11, 12]. A recent study showed during 4-year follow-up that 4.7% of participants with insomnia developed depression, and that insomnia symptoms increased depression risk 3.2-fold [20]. Another meta-analysis indicated that subjects with insomnia run a twofold risk of developing depression, compared to people without sleep problems [21]. In the present study, the increased risk of the onset of depressive symptoms was 1.6-fold among workers with AIS points of 3 or more. Among such studies, there are some differences in measuring methods for insomnia and depression symptoms. However, studies including the present one have suggested that insomnia symptoms can be a risk factor for developing depression.

Insomnia among workers is reported to be connected with workload [17, 18, 22]. In the present study, workers who sleep poorly were more likely to feel the impact from job stress factors such as diminished suitability for the work and increased qualitative workload. Our earlier study also showed that sleep quality was associated with psychological job stress factors of qualitative workload and suitability for the work [13]. Some studies have indicated that low job control exacerbates sleep disorders [22, 23]. Higher levels of interpersonal conflict and lower levels of social support were also evident in subjects experiencing insomnia [4, 24-26]. The present study showed that those with AIS scores of 3 or more (severely poor sleep) tended to experience higher job stress. Such stress may contribute to sleep disturbances in workers, which could lead to developing depression.

A relationship between anxiety and insomnia has also been reported [27]. In the present study, the category of anxiety symptoms of psychological stress responses was correlated with insomnia (Speaman's correlation coefficient; r=0.28), while the category of depressive symptoms was also correlated with insomnia (r=0.38). Anxiety symptoms may be associated with insomnia, though its relation might be weaker than that in depressive symptoms.

There are some limitations in the present study. First, all subjects were male employees at a single workplace, and the number of subjects surveyed was low. In future it will be necessary, therefore, to conduct a study with a greater number of subjects including workers in other industries and female employees. Second, using the AIS and the Job Stress Questionnaire, we analyzed the results obtained from self-reported questionnaire surveys on sleep and depressive symptoms. In that regard, since we did not utilize a questionnaire designed specifically for depression, our study may describe depressive symptoms much milder than those of clinical depression. Moreover, we used only the first 5 of 8 questions of the AIS to assess insomnia. Third, we did not inquire about family antecedents of either sleep or psychiatric disease, caffeine intake, or other xanthine beverages, which might affect sleep. With regard to medication, respondents with psychiatric disorders under treatment were excluded in the present analyses. Finally, since the follow-up period of this study was limited to 2 years, longer-term studies on insomnia and depression will be required.

CONCLUSION

The present study showed that poor sleep was associated with a subsequent onset of depressive symptoms, and that insomnia symptoms were also correlated with job stress factors. Untroubled sleep might reduce the risk for onset of depression and other mental disorders [12].

ACKNOWLEDGEMENTS

None declared.

DECLARATION OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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