

# Association between insomnia and personality traits among Japanese patients with type 2 diabetes mellitus

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## Keywords

Insomnia, Personality, Type 2 diabetes mellitus

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## ABSTRACT

**Aims/Introduction:** Insomnia is associated with type 2 diabetes mellitus, and results in a low quality of life. There are several known relationships between insomnia and personality. Thus, we clarified the association between some personality traits and insomnia among Japanese type 2 diabetes mellitus patients.

**Materials and Methods:** The participants were 504 type 2 diabetes mellitus patients (mean age 63.9 ± 12.5 years). Sleep disturbance and personality traits were evaluated using the Pittsburgh Sleep Quality Index-Japanese version and the Ten-Item Personality Inventory Japanese version, respectively. Lifestyle factors, glycosylated hemoglobin levels and depressive status of the patients were also included in the analyses.

**Results:** Among the 504 participants with type 2 diabetes mellitus, 154 (30.6%) showed probable insomnia. After adjustment for confounders, being female, living alone, high body mass index and “high neuroticism” were found to be significantly correlated with current insomnia. No other relationships between insomnia and glycosylated hemoglobin or lifestyle factors, such as smoking, drinking alcohol or exercise frequency, were found.

**Conclusions:** The prevalence of insomnia in individuals with type 2 diabetes mellitus was high, and the risk factors included some personality factors. Future prospective studies are required to confirm the therapeutic effects of behavioral interventions for insomnia in patients with type 2 diabetes mellitus.

## INTRODUCTION

Type 2 diabetes mellitus can result in serious damage to bodily systems, such as the eyes, kidneys and the heart, as well as to the vascular system<sup>1–3</sup>. Thus, the high prevalence of type 2 diabetes mellitus has become a further burden, as a lifestyle-related disease, and type 2 diabetes mellitus can increase the risk of severe physical and mental health issues. Type 2 diabetes mellitus negatively impacts the patient's quality of life in all aspects of their life.

Sleep disturbance, particularly insomnia (defined as trouble initiating or maintaining sleep), is one of the most frequently occurring mental disorders<sup>4,5</sup>, resulting in clinical dysfunctions in various areas of quality of life<sup>6</sup> and at high societal costs<sup>7</sup>.

The prevalence of insomnia in women is significantly higher than that of men<sup>8</sup>, and that is significantly correlated with age<sup>9</sup>. Individuals with insomnia have a higher risk of mental disorders, especially depression<sup>10,11</sup>. In addition, insomnia itself is associated with the risk of newly developing type 2 diabetes mellitus<sup>12–14</sup>. More than 40% of type 2 diabetes mellitus patients suffer from insomnia, and the prevalence of type 2 diabetes mellitus patients with insomnia is larger than that in the general population<sup>13,15–18</sup>.

Even though the relationship between insomnia and personality traits has been investigated extensively<sup>19–31</sup>, there is conflicting information regarding which personality traits are associated with sleep disturbance/insomnia in a general adult population. A five-factor model of personality<sup>28,32</sup> consistently showed that insomnia is related to a high score for

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neuroticism<sup>19,20,22,24,26,29,30</sup>. Several studies have reported that insomnia is associated with low conscientiousness<sup>18–20,22</sup>, but this association might be secondary to the inverse association between conscientiousness and neuroticism. To date, however, there is little information on which personality traits are associated with insomnia among type 2 diabetes mellitus patients.

Therefore, we examined an association between insomnia and personality traits using a five-factor model in type 2 diabetes mellitus patients.

## METHODS

### Participants

The present study was approved by the ethics committee at the Hirosaki University School of Medicine, and written informed

consent was obtained from each individual before participating in this study.

This study included 728 individuals with type 2 diabetes mellitus who received treatment for at least 1 year at the Department of Endocrinology and Metabolism at the Hirosaki University Hospital, Hirosaki, Japan. We asked 945 patients, and 728 patients agreed to participate in the survey. The remaining 217 patients were excluded because 41 declined to participate, 85 had moderate-to-severe dementia, 23 had blindness and 68 had moderate-to-severe psychiatric diseases (e.g., bipolar disorder and schizophrenia).

A total of 611 patients out of 728 returned the questionnaires, and 504 (69.2%) had completed their questionnaires. Blood samples from these patients were collected routinely for

**Table 1** | Characteristics of participants with and without current or clinical insomnia

	Current status		Significant ( <i>P</i> )	Clinical status		Significant ( <i>P</i> )
	Insomniacs ( <i>n</i> = 141)	Non-insomniacs ( <i>n</i> = 363)		Insomniacs ( <i>n</i> = 154)	Non-insomniacs ( <i>n</i> = 350)	
Sex						
Male, <i>n</i> (%)	68 (48)	225 (62)	<0.01	72 (47)	220 (63)	<0.01
Female, <i>n</i> (%)	73 (52)	138 (38)		83 (53)	130 (37)	
Age (years)	61.3 ± 13.6	64.9 ± 11.9	<0.01	62.3 ± 13.6	64.6 ± 12.0	NS
BMI	26.1 ± 4.7	24.7 ± 4.0	<0.01	26.0 ± 4.7	24.7 ± 3.9	<0.01
HbA1c (%)	7.1 ± 1.0	7.1 ± 0.8	NS	7.1 ± 1.0	7.1 ± 0.8	NS
Smoking habit						
Yes, <i>n</i> (%)	24 (17)	55 (15)	NS	25 (16)	54 (15)	NS
No, <i>n</i> (%)	117 (83)	308 (85)		129 (84)	296 (85)	
Habitual alcohol consumption						
Yes, <i>n</i> (%)	39 (28)	121 (33)	NS	41 (27)	119 (34)	NS
No, <i>n</i> (%)	102 (72)	242 (67)		113 (73)	231 (66)	
Exercise frequency						
No, <i>n</i> (%)	87 (62)	186 (51)	NS	81 (53)	183 (52)	NS
Once a week, <i>n</i> (%)	10 (7)	23 (6)		10 (6)	23 (7)	
2–3 times a week, <i>n</i> (%)	22 (16)	52 (14)		24 (16)	50 (14)	
4–5 times a week, <i>n</i> (%)	12 (9)	35 (10)		14 (9)	33 (9)	
Almost everyday, <i>n</i> (%)	19 (13)	67 (18)		25 (16)	61 (17)	
Single						
Yes, <i>n</i> (%)	51 (36)	99 (27)	NS	53 (34)	97 (28)	NS
No, <i>n</i> (%)	90 (64)	264 (73)		101 (66)	253 (72)	
Living alone						
Yes, <i>n</i> (%)	25 (18)	38 (10)	<0.05	25 (16)	38 (11)	NS
No, <i>n</i> (%)	116 (82)	325 (90)		129 (84)	312 (89)	
Depression (CES-D)	17.1 ± 8.7	11.6 ± 6.8	<0.001	16.9 ± 8.7	11.5 ± 6.7	<0.001
Personality traits						
Extraversion	4.1 ± 1.3	4.2 ± 1.2	NS	4.1 ± 1.3	4.3 ± 1.2	NS
Agreeableness	5.0 ± 1.0	5.3 ± 1.5	NS	5.0 ± 1.0	5.3 ± 1.5	NS
Conscientiousness	4.1 ± 1.2	4.4 ± 1.3	<0.05	4.1 ± 1.2	4.4 ± 1.3	NS
Neuroticism	3.5 ± 1.2	4.0 ± 1.2	<0.001	3.5 ± 1.2	4.0 ± 1.2	<0.001
Openness	3.9 ± 1.3	3.9 ± 1.1	NS	3.8 ± 1.3	3.9 ± 1.1	NS

Data are shown as mean ± standard deviation. Current insomnia is defined as ≥5.5 on the Japanese Pittsburg Sleep Quality Index. Clinical insomnia is defined by current use of hypnotics and ≥5.5 on the Japanese Pittsburg Sleep Quality Index. BMI, body mass index; CES-D, Center for Epidemiologic Studies Depression Scale; HbA1c, glycated hemoglobin; NS, not significant.

glycated hemoglobin (HbA1c) analysis at least four times per year. Among the participants, 409 patients were receiving an oral hypoglycemic agent and 235 were receiving insulin therapy. The patients' demographic data (age, sex, smoking, alcohol consumption, living alone, exercise habits) and medical histories were obtained from the questionnaires and medical records.

Subjective sleep difficulty was assessed using the validated Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J)<sup>33,34</sup>. The PSQI-J is a self-rated questionnaire that measures sleep difficulty for a 1-month period. Increased PSQI-J scores indicate greater sleep difficulty. The questionnaire measures seven subitems for sleep difficulty (C1: sleep quality; C2: sleep-onset latency; C3: sleep duration; C4: sleep efficiency; C5: sleep disturbance; C6: use of sleep medications; C7: daytime dysfunction).

We measured personality traits using the Japanese version of the Ten-Item Personality Inventory (TIPI-J). The TIPI-J is a measure of the Big-Five personality dimensions: extraversion, conscientiousness, neuroticism, agreeableness and openness to experience<sup>35</sup>. Each item was scored from 1 to 7 points, and the scores were summed. Oshio *et al.*<sup>36</sup> validated and tested the TIPI-J for reliability in Japan.

The Japanese version of the Center for Epidemiologic Studies Depression Scale (CES-D) was used for all patients to measure depressive symptoms<sup>37,38</sup>. The maximum score of CES-D is 60, and a CES-D score of  $\geq 16$  is defined as a depressive state<sup>38</sup>.

### Statistical analysis

In the present study, comparisons of several factors between insomnia and non-insomnia were carried out using *t*-tests and  $\chi^2$ -tests. The data are presented as the mean  $\pm$  standard deviation. A *P*-value of  $<0.05$  showed statistical significance. The factors associated with insomnia were examined using logistic regression analyses with the enter method including age, sex, body mass index (BMI), HbA1c, presence/absence of smoking, habitual alcohol consumption, living alone, exercise habits, CES-D score and each score on the five personality factors. In addition, regression analyses were adjusted for the confounding factors. Linear regression analyses with the enter method were carried out to examine the correlation between the severity of insomnia and several factors. Dummy variables were as follows: male = 1, female = 2, presence of spouse = 1, absence of spouse = 2, living with family = 0, living alone = 1, presence of smoking = 1, absence of smoking = 2, presence of alcohol consumption = 1, absence of alcohol consumption = 2, no exercise = 1, exercise once a week = 2, exercise 2–3 days per week = 3, exercise 4–5 days per week = 4 and exercise almost every day = 5. A *P*-value  $<0.05$  showed statistical significance. The SPSS Statistics software program for Windows, version 24.0 (IBM Japan. Ltd., Tokyo, Japan), was used for all analyses.

### RESULTS

A total of 141 (28.0%) of the 504 patients had current sleep disturbances/insomnia based on the PSQI-J cut-off value. A

total of 13 patients receiving hypnotics had PSQI-J scores lower than the cut-off score. We regarded those 13 patients as having clinical sleep disturbances/insomnia. Thus, 154 (30.6%) patients showed clinical sleep disturbances/insomnia.

There were significant differences in sex, age, BMI, living alone, depression, conscientiousness and neuroticism between patients with and without current insomnia, but not in HbA1c, lifestyle or marital status (Table 1). Among the patients receiving hypnotics, there were significant differences in sex, BMI, living alone, depression and neuroticism between patients with and without clinical insomnia, but not in age, HbA1c, lifestyle or marital status (Table 1).

Because strong collinearities existed between CES-D and personality traits, the CES-D was removed from the multiple variable regression. Table 2 shows the results of the logistic regression analysis that were used to determine the factors associated with sleep disturbances/insomnia, such as BMI, living alone and neuroticism. In addition, the logistic regression analysis that included patients receiving hypnotics for clinical insomnia showed associations with neuroticism and BMI. Multiple regression analysis showed the same results, indicating that high neuroticism, living alone, being female and low agreeableness were correlated with the severity of insomnia measured by the total PSQI-J score (Table 3).

There were significant correlations between some subitem scores of the PSQI-J and personality (Table 4). Neuroticism was significantly correlated with C1 (sleep quality), C2 (sleep-onset latency), C3 (sleep duration), C4 (sleep efficiency), C5 (sleep disturbance) and C7 (daytime dysfunction). Contrary to

**Table 2** | Logistic regression results for factors associated with insomnia among type 2 diabetes mellitus patients

	Current insomnia		Clinical insomnia	
	Exp (B)	95% CI	Exp (B)	95% CI
Sex	1.53	0.95–2.47	1.55	0.99–2.44
Age	0.99	0.97–1.01	1.00	0.98–1.02
BMI	1.06*	1.00–1.11	1.06*	1.02–1.11
HbA1c	0.95	0.74–1.21	1.04	0.83–1.31
Smoking	0.87	0.48–1.59	0.89	0.50–1.58
Alcohol	1.37	0.83–2.27	1.35	0.84–2.19
Exercise frequency	0.94	0.82–2.27	1.00	0.87–1.14
Single	0.80	0.46–1.41	0.83	0.49–1.43
Living alone	2.84**	1.36–5.95	2.23*	1.17–4.80
Personality traits				
Extraversion	0.97	0.80–1.17	0.92	0.77–1.10
Agreeableness	0.85	0.70–1.04	0.84	0.69–1.01
Conscientiousness	0.99	0.82–1.20	1.04	0.87–1.23
Neuroticism	1.36**	1.13–1.65	1.23*	1.02–1.48
Openness	1.05	0.86–1.27	1.04	0.86–1.24

Current insomnia is defined as  $\geq 5.5$  on the Japanese Pittsburgh Sleep Quality Index. Clinical insomnia is defined by current use of hypnotics and  $\geq 5.5$  on the Japanese Pittsburgh Sleep Quality Index. \**P* < 0.05, \*\**P* < 0.01. BMI, body mass index; HbA1c, glycated hemoglobin.

neuroticism, extraversion was inversely correlated with C1 (sleep quality).

## DISCUSSION

The present study investigated the prevalence of probable insomnia measured by the PSQI-J, and assessed the relationship between insomnia and personality among individuals with type 2 diabetes mellitus using a cross-sectional study design. The proportion of individuals with insomnia was less than the proportion that was observed in several previous studies (37–50%)<sup>13,15–18</sup>, even with the inclusion of patients receiving hypnotics who had scores below the cut-off PSQI-J scores. Although we have no clear explanation for this finding, the average age of the participant was greater here than in previous studies<sup>13,15–17</sup>. Age was inversely correlated with sleep time ( $r = -0.082$ ,  $P < 0.05$ ), and the age of patients with insomnia

was significantly lower than that of patients without insomnia ( $P < 0.05$ ; Table 1). In addition, the prevalence of insomnia in Asian countries, such as China, Japan and Singapore, was 15.0–17.3%<sup>9,39</sup>, which was lower than in many Western countries<sup>40,41</sup>.

The present study is the first study to identify a significant association between insomnia and neuroticism in individuals with type 2 diabetes mellitus, and this finding was in accordance with most previous studies in the general population<sup>19,20,22,24,26,29,30</sup>, which show that neuroticism is directly associated with insomnia. It is known that neuroticism is also associated with other mental disorders<sup>42</sup>. Neuroticism is thought to be a risk factor for, diagnostic indicator of, and predictor of the onset, severity and outcome of most psychiatric disorders<sup>43</sup>. A network analysis showed insomnia was strongly and directly related to neuroticism and, secondarily, to openness and agreeableness, but not to extraversion or conscientiousness<sup>43</sup>. In the present study, however, a significant inverse correlation was found between insomnia and agreeableness, which was an opposite tendency from the previous study. Because a significant inverse correlation ( $r = -0.199$ ,  $P < 0.001$ ) between agreeableness and neuroticism was found in the present participants, insomnia might be inversely associated with agreeableness. These discrepancies between inverse associations in our study and positive associations in the previous study could be due to population differences between individuals with type 2 diabetes mellitus and the general population, and to the use of different personality measurement tools, such as the Neuroticism, Extraversion, Openness Personality Inventory, the five-factor model and TIPI-J, the correlations of which were significant, but not perfect<sup>36</sup>.

Several studies reported no correlations between insomnia and HbA1c in patients with type 2 diabetes mellitus<sup>44,45</sup>, whereas increased HbA1c was significantly related to insomnia in a Japanese, male, subclinical population<sup>46</sup>. Thus, the association between HbA1c values and sleep disturbance is still inconclusive. In the present study, the HbA1c levels did not differ between the patients with and without insomnia. In addition, no multiple linear regression analysis showed a correlation between HbA1c level and insomnia severity. A previous study

**Table 3** | Simple and multiple regression results for factors associated with severity of insomnia among type 2 diabetes mellitus patients

	<i>r</i>	Significance	$\beta$	Significance
Sex	0.131	0.002*	0.108	0.030*
Age	-0.099	0.013*	-0.025	0.643
BMI	0.101	0.012*	0.072	0.142
HbA1c	0.024	0.295	0.017	0.707
Smoking	-0.045	0.155	-0.057	0.213
Alcohol	0.013	0.388	0.012	0.799
Exercise frequency	-0.028	0.266	0.012	0.793
Single	0.135	0.001*	0.005	0.929
Living alone	0.142	0.001*	0.160	0.003*
Personality traits				
Extraversion	-0.100	0.013*	-0.081	0.102
Agreeableness	-0.106	0.009*	-0.105	0.024*
Conscientiousness	-0.114	0.005*	0.016	0.747
Neuroticism	0.259	<0.000*	0.207	<0.000*
Openness	-0.036	0.212	0.018	0.710
Multiple correlation coefficients			0.322	<0.000*

\*Statistically significant. BMI, body mass index; HbA1c, glycated hemoglobin.

**Table 4** | Correlations between subitems of the Japanese Pittsburg Sleep Quality Index and personality in type 2 diabetes mellitus

	Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness
C1 (sleep quality)	-0.142**	-0.055	-0.097*	0.134**	-0.024
C2 (sleep-onset latency)	-0.064	-0.052	-0.017	0.121**	-0.004
C3 (sleep duration)	-0.029	-0.049	-0.079	0.164***	0.015
C4 (sleep efficiency)	-0.023	-0.127**	-0.014	0.155***	0.038
C5 (sleep disturbance)	-0.013	-0.051	-0.009	0.184***	0.013
C6 (medications)	-0.016	-0.020	-0.017	0.039	-0.029
C7 (daytime dysfunction)	-0.060	-0.079	-0.204***	0.232***	-0.088*

\* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ .

showed that the treatment of sleep problems in diabetes patients did not lead to a reduction in HbA1c<sup>44</sup>. Therefore, HbA1c might not be a predictive factor for insomnia in patients with type 2 diabetes mellitus.

Although there was no association with PSQI score, insomnia was significantly correlated with BMI in the present study. Several systematic reviews have found that short sleep duration is associated with greater risk of obesity<sup>47,48</sup>, whereas a recent meta-regression analysis showed that the association between sleep and obesity is still inconclusive<sup>49</sup>. The possibility that people with obesity have hypoventilation syndrome or obstructive sleep apnea, both of which are related to sleep disorders<sup>50</sup> and might be included among the present participants, was more likely.

Living alone was associated with insomnia. Several studies have suggested that living alone is correlated with long-term insomnia<sup>45</sup>. Thus, these results suggest that being single might be a cause of insomnia in type 2 diabetes mellitus patients. In addition, the results of the present study suggest that being female is a risk factor for insomnia. Several previous studies have shown that the prevalence of insomnia in women is higher than in men<sup>51–53</sup>, whereas a meta-analysis showed no sex difference in the prevalence of insomnia<sup>54</sup>. Therefore, the effect of sex on the prevalence of insomnia is still inconclusive.

The present study included several limitations. First, as this study was a cross-sectional study, it was difficult to identify a causal relationship between the presence and severity of insomnia and risk factors in our study design. Second, because of the lack of a control group, a reference neuroticism personality trait score could not be provided. Studies that include a control group are required. Third, all patients who had subjective insomnia in the present study were not clinically diagnosed. Finally, as the participants were recruited from a single institution, sampling bias might be hidden in the present study. Therefore, a large sample from multiple centers is required to confirm our findings.

In conclusion, the prevalence of insomnia in individuals with type 2 diabetes mellitus was 28–31%. The risk factors were being female, some personality traits (e.g., high neuroticism and low agreeableness) and living alone. Future prospective studies are required to confirm the therapeutic effects of behavioral interventions for insomnia in patients with type 2 diabetes mellitus.

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#### DISCLOSURE

Norio Yasui-Furukori has been a speaker for Dainippon-Sumitomo Pharmaceutical, Mochida Pharmaceutical and MSD. The other authors declare no conflict of interest.

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