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Original Article

Nationwide epidemiological study of insomnia in Japan

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ABSTRACT

Background: This study was a nationwide epidemiological study of insomnia in Japan. It was conducted because very few studies on this topic have previously been performed for the general Japanese population.
Methods: An interview survey on symptoms of insomnia (difficulty initiating sleep, difficulty maintaining sleep with difficulty resuming sleep, and early morning awakening with difficulty resuming sleep) and daytime dysfunction was conducted on the general nationwide population in the winter (February) and summer (August) of 2008. Data from 2614 participants who provided valid responses (age range 20–95 years, valid response rate 54.2%) were analyzed.
Results: The prevalence of difficulty initiating sleep, difficulty maintaining sleep with difficulty resuming sleep, and early morning awakening with difficulty resuming sleep was 8.3%, 5.8%, and 5.8%, respectively, in men, and 11.0%, 8.1%, and 7.4%, respectively, in women. The prevalence of insomnia was 12.2% in men and 14.6% in women, and the prevalence of insomnia with daytime dysfunction was 3.2% in men and 4.2% in women. The results of logistic regression analyses indicated that the factors aggravating insomnia for men were unemployment and having mental health issues, and for women they were being aged ≥70 years, completing fewer years of schooling, and having mental health issues. Seasonality and regionality in association with insomnia were also examined, but no significant associations were found.
Conclusion: In the present survey, insomnia was defined by using criteria that were closer to the clinical diagnostic criteria (eg, coexistence of both difficulty resuming sleep and daytime dysfunction was considered). Therefore, it is believed that the results of this study were representative of the clinical actuality of insomnia in Japan.

1. Introduction

Previous studies have found that insomnia is a common sleep disorder and an important risk factor for various physical and mental disorders [1]. High-quality epidemiological studies are extremely important for accurately understanding the actual status of insomnia and taking measures to improve this condition. As such, studies on the prevalence of, and factors associated with, insomnia have been actively conducted in many areas of the world [2].

In 1997, Doi et al. conducted a nationwide epidemiological study of insomnia in Japan; they used 2800 individuals aged ≥20 years who were randomly selected from the general population [3]. This self-administered questionnaire survey defined insomnia as the presence of any of the following three symptoms: difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), and early morning awakening (EMA). The results indicated that the prevalence of insomnia was 17.3% in men and 21.5% in women. Another nationwide study was conducted in 1997 by Kim et al. on 3030 individuals aged ≥20 years who were randomly selected from the general population [4]. The prevalence of insomnia determined from this interview survey was 20.5% in men and 22.3% in women. These are the only two nationwide-scale epidemiological studies of insomnia that have been performed in Japan.

Therefore, the present study was designed to address the shortcomings of the previous studies in order to clarify the actual status of insomnia in Japan. The first consideration was the definition of insomnia used to evaluate its prevalence. Differences in the definition of insomnia and the use of various criteria to define it have resulted in substantially large differences in the reported prevalence of insomnia in previous epidemiological studies worldwide [2].

In the two previous nationwide epidemiological studies of insomnia in Japan, insomnia was defined as merely having symptoms of insomnia [3,4]. In those studies, the questions regarding DMS and

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EMA were inadequate because they did not contain the element of difficulty resuming sleep (DRS). Therefore, the previous studies merely queried the presence of awakening from sleep. Several previous studies have indicated that mere nocturnal awakening is not always a pathological condition [5,6]. Ohayon et al. proposed that nighttime awakening must be assessed in terms of both the frequency and coexistence of DRS [5]. Based on the above findings, the present study considered the coexistence of DRS when investigating DMS and EMA as symptoms of insomnia.

Previous epidemiological studies of insomnia have reported that individuals who had daytime dysfunction (such as sleepiness, fatigue, mood disturbance, cognitive difficulties, social impairment, or occupational impairment) [7] in addition to insomnia required more full-scale health care, and were more likely to have mental disorders or organic diseases than those who had insomnia alone [2,8]. Therefore, in the present study, the presence/absence of daytime dysfunctions was also considered in the definition of insomnia. It was expected that considering the coexistence of daytime dysfunction would increase the clinical utility of any epidemiological study of insomnia.

Furthermore, while the two previous Japanese studies did not examine varying prevalences of insomnia based on differences in seasons or regions, the present study examined the seasonality and regionality of insomnia. To this end, the survey was conducted twice – in the summer and winter – and information was collected regarding the residence (place, size of the city, etc.) in each survey.

The present study had two objectives. First, it aimed to perform an epidemiological study of insomnia with high clinical utility by using new defining criteria such as the coexistence of DRS with symptoms of insomnia, and the coexistence of daytime dysfunction with insomnia. Second, it aimed to examine the seasonality or regionality of insomnia in Japan.

2. Materials and methods

2.1. Participants

The participants were sampled using the stratified three-stage random sampling method. The data were obtained by first performing stratification, in which: (1) the municipalities across the country were classified into 12 blocks using prefecture or city as a unit, and (2) each block was further divided into 19 large cities, other cities, and towns/villages according to their size. Based on a population aged ≥20 years, a total of 4000 samples were proportionally allocated in strata of the size of blocks and cities. In the three-stage extraction (to match the population distribution of Japan), predetermined criteria were used to determine the number of extractions for:

(1) Survey locations: the number of samples were proportionally allocated according to the estimated population of each stratum, and then adjusted so that the number of samples in one survey area became approximately 25 as a standard. Through this method, the number of survey areas (primary sampling units) was determined to be 157.
(2) Households: for selection of households (secondary sampling units), using a residential map database, every fourth house in the survey areas selected, as described in (1), was chosen as a subject household.
(3) Participants: upon contact with any member of a subject household, the researcher asked for the member of the subject household who would first reach his/her 20th birthday or older after the first of the survey month, and that person was selected as the subject. If the subject was not at home, the researcher was instructed to visit the house at least three times. If the researcher was unable to meet the subject, the interview with that subject was determined to be impossible. Other indices were extracted randomly. This tried to ensure an authentic representation of the general Japanese population.

The survey was conducted in February 2008 (winter survey) and August 2008 (summer survey). In the winter survey, the researchers were able to make contact with a member from 2449/4000 subject households; 1308 who agreed to participate in the survey were interviewed. Trained interviewers visited the selected households and interviewed persons aged ≥20 years. Verbal informed consent was obtained from the participants, and their privacy was protected in accordance with the Declaration of Helsinki. Stratified random sampling was similarly performed for the summer survey, and 1306/2371 selected subjects agreed to participate in the interview survey.

2.2. Interview method

The present survey employed a face-to-face interview method. Well-trained researchers visited the subject households and interviewed the subjects using a questionnaire that had been prepared beforehand. A structured interview method was employed, wherein a researcher read the questions exactly as they appeared on the questionnaire. Sheets indicating the answer options were presented to the subjects for their selection of a response.

2.3. Measures

The questionnaire inquired about the following four items, which are described in detail below: (1) basic attributes, (2) questions regarding the symptoms of insomnia, (3) questions regarding daytime dysfunction, and (4) mental health status.

(1) Basic attributes
  (a) Gender and age
  (b) Occupation: Agricultural, forestry, or fishery worker/commercial, industrial, or service business worker/clerk/laborer/freelancer or managerial staff/housewife without a job/student/others or unemployed.

State of occupation: For the statistical analyses, agricultural, forestry, or fishery workers, commercial, industrial, or service business workers, clerks, laborers, freelancers, and managerial staff were categorized as "with occupation." Housewives without a job were categorized as "housewives." Students, others, or the unemployed were categorized as "without occupation."

  (c) Regions: Hokkaido and Tohoku/Kanto, Keihin, and Koshinetsu/Hokuriku and Tokai/Kinki and Hanshin/Chugoku and Shikoku/Kyushu.
  (d) Size of the city of residence: 18 large cities; 17 government-decreed cities, and Tokyo Metropolis)/city/municipality.
  (e) Years of schooling completed: junior high school/senior high school/college or university.

(2) Questions regarding the symptoms of insomnia

The following three questions about symptoms of insomnia were asked:

  (a) Question related to DIS

Q: "Have you had difficulty initiating sleep over the past one month?"

A: Never/seldom/sometimes/often/always

  (b) Question related to DMS with DRS

Q: "Have you awoken at night and had difficulty falling asleep again over the past one month?"

A: Never/seldom/sometimes/often/always

  (c) Question related to EMA with DRS

Q: "Have you awoken early in the morning (at dawn) and had difficulty falling asleep again over the past one month?"

A: Never/seldom/sometimes/often/always

Participants who selected often or always for questions (a), (b), and (c) were defined as having DIS, DMS with DRS, and EMA with DRS, respectively. Analysis of these data was subsequently performed. In addition, participants who had at least one of DIS, DMS with DRS, or EMA with DRS, were defined as having insomnia, and analysis of these data was performed.

(3) Questions regarding daytime dysfunction

The following two questions about daytime dysfunction were asked:

(a) Q: "Have you been excessively sleepy during the daytime and unable to prevent yourself from falling asleep when you must not sleep over the past one month?"

A: Never/seldom/sometimes/often/always

(b) Q: "Have you felt physically or mentally disordered or had any trouble in your daily life as a result of lack of good sleep over the past one month?"

A: Never/seldom/sometimes/often/always

Participants who selected often or always for question (a) or (b) were defined as having daytime dysfunction, and analysis of this data was performed. In addition, participants who had both insomnia and daytime dysfunction were defined as having insomnia with daytime dysfunction, and analysis of this data was performed.

(4) Mental health status

The following two questions about mental health status were asked:

(a) Q: "Have you felt an unusual amount of unhappiness and depression over the past one month?"

A: Not at all/no more than usual/more than usual/much more than usual

(b) Q: "Have you been able to enjoy normal activities more than usual over the past one month?"

A: More so than usual/same as usual/less than usual/much less than usual

To evaluate the mental health statuses of the respondents, two independent factors (depression/anxiety and decrease in positive feeling) included in the 12-item General Health Questionnaire (GHQ-12) [9,10] were used, and one item from each factor was selected for the total score. One of the items from the depression/anxiety factor was evaluated. One of the items from the decrease in positive feeling factor was also evaluated. Each item described a symptom, and there were four possible answers: the two answers that indicated a lack of the symptom were assigned a rating of 0; the two answers that indicated a presence of the symptom were assigned a rating of 1. Thus, the overall score fell within the range of 0–2, and, accordingly, the higher the total score, the poorer the state of mental health. In the present study, participants who had total scores of ≥1 were considered to have poor mental health. Previous studies have shown that evaluation of mental health status using depression symptoms with the GHQ-12 and with this cut-off point has a sensitivity of 87.0% and a specificity of 85.1% [11]. These methods and cut-off were employed in other large-scale epidemiological studies [12–20].

2.4. Statistical analysis

First, the participants were stratified separately according to sex. The prevalence of DIS, DMS with DRS, EMA with DRS, insomnia, and insomnia with daytime dysfunction according to age class, state of occupation, region, size of the city of residence, years of schooling completed, season (February or August) of the survey, and mental health status were calculated. The Chi-squared test was used to determine statistical significance.

Second, multiple logistic regression analyses based on sex were performed by using DIS, DMS with DRS, EMA with DRS, insomnia, and insomnia with daytime dysfunction as the response variables. As the predictor variables, age class, state of occupation, region, size of the city of residence, years of schooling completed, season (February or August) of the survey, and mental health status were used. Significance was set at $p < 0.05$. All analyses were performed using IBM SPSS Statistics, version 22 J for Windows (IBM Corp., Somers, NY, USA).

2.5. Ethical considerations

The following ethical considerations were taken into account: (1) participation was voluntary, but informed consent was required from the participant; (2) researchers who performed data collection were different from those who performed statistical analysis, to prevent access to the participants' personal data; (3) collected data were coded to protect personal information and maintain confidentiality; and (4) prior approval was obtained from the Ethics Committee for Epidemiological Study of Nihon University School of Medicine.

3. Results

From the total of 4820 subjects selected for the two surveys, 2614 (men 1189, women 1425) responded to the questions (response rate 54.2%). The ages of the participants ranged from 20 to 95 years. The mean age (±SD) of the participants in total was 52.4 years (±16.9); the mean ages for men and women were 52.2 years (±17.7) and 52.6 years (±16.5), respectively. The backgrounds of the participants based on sex are shown in Table 1.

Of the 2614 respondents, nine failed to complete data about insomnia symptoms. The prevalence of insomnia symptoms (DIS, DMS with DRS, and EMA with DRS) based on sex is shown in Table 2. The prevalence of each symptom was as follows: DIS, 8.3% in men and 11.0% in women; DMS with DRS, 5.8% in men and 11.0% in women; and EMA with DRS, 5.8% in men and 7.4% in women. The Chi-squared test indicated that DIS was significantly associated with mental health status ($p < 0.01$) for men and with age class ($p < 0.01$), state of occupation ($p = 0.02$), years of schooling completed ($p < 0.01$), and mental health status ($p < 0.01$) for women. DMS with DRS was significantly associated with state of occupation ($p = 0.01$) and mental health status ($p < 0.01$) for men and with age class ($p < 0.01$), state of occupation ($p < 0.01$), years of schooling completed ($p = 0.03$), and mental health status ($p < 0.01$) for women. EMA with DRS was significantly associated with state of occupation ($p < 0.01$) and mental health status ($p < 0.01$) for men and with age class ($p < 0.01$), state of occupation ($p = 0.02$), and mental health status ($p < 0.01$) for women. With regard to the season of the survey, region, and size of the city of residence, no significant associations with DIS, DMS with DRS, or EMA with DRS were found.

The prevalence of insomnia and insomnia with daytime dysfunction based on sex is shown in Table 3. The prevalence of insomnia was 12.2% in men and 14.6% in women, and the prevalence of insomnia with daytime dysfunction was 3.2% in men and 4.2% in women. The Chi-squared test indicated that insomnia was significantly associated with mental health status ($p < 0.01$) for men and with age class ($p < 0.01$), state of occupation ($p = 0.01$), years of schooling completed ($p < 0.01$), and mental health status ($p < 0.01$) for women. Insomnia with daytime dysfunction was significantly associated with size of the city ($p = 0.02$) and mental health status ($p < 0.01$) for men and with age class ($p < 0.01$), state of occupation ($p < 0.01$), years of schooling completed ($p = 0.05$), and mental health status ($p < 0.01$) for women. With regard to the season of the survey and region, no significant associations were found with either insomnia or insomnia with daytime dysfunction.

Table 1
Background of the survey subjects.

	Male		Female	
	N	%	N	%
Age class				
20–29 years	142	11.9	146	10.2
30–39 years	214	18.0	226	15.9
40–49 years	181	15.2	241	16.9
50–59 years	195	16.4	283	19.9
60–69 years	224	18.8	277	19.4
≥70 years	233	19.6	252	17.7
Occupation				
Agricultural, forestry, or fishery worker	27	2.3	26	1.8
Commercial, industrial, or service business worker	162	13.6	109	7.6
Clerk	269	22.6	201	14.1
Laborer	295	24.8	242	17.0
Freelancer or managerial staff	64	5.4	16	1.1
Housewife without a job	0	0.0	677	47.5
Student	31	2.6	19	1.3
Others or unemployed	341	28.7	135	9.5
Years of schooling completed				
Junior high school	149	12.6	215	15.2
Senior high school	599	50.5	782	55.1
College or university	439	37.0	421	29.7
Seasons of the survey				
Winter (February)	589	49.5	719	50.5
Summer (August)	600	50.5	706	49.5
Regions				
Hokkaido and Tohoku	155	13.0	174	12.2
Kanto, Keihin, and Koshinetsu	433	36.4	483	33.9
Hokuriku and Tokai	182	15.3	201	14.1
Kinki and Hanshin	166	14.0	248	17.4
Chugoku and Shikoku	112	9.4	153	10.7
Kyushu	141	11.9	166	11.6
Size of the city of residence				
18 large cities	284	23.9	357	25.1
City	783	65.9	910	63.9
Municipality	122	10.3	158	11.1
Mental health status				
Good	872	73.3	969	68.0
Poor	317	26.7	456	32.0

Subject with missing data was excluded from the analysis.

The results of multiple logistic regression analyses for separately stratified men and women by using DIS, DMS with DRS, or EMA with DRS as response variables are shown in Table 4. The adjusted odds ratios (AORs) for DIS, DMS with DRS, and EMA with DRS were significantly increased for mentally unhealthy subjects, both in men and women, when those in good mental health were used as the reference. In addition, for women, the AOR of DIS was significantly decreased for college or university graduates when junior or senior high school graduates were used as the reference.

The results of multiple logistic regression analyses for separately stratified men and women by using insomnia or insomnia with daytime dysfunction as a response variable are shown in Table 5. The AORs for insomnia and insomnia with daytime dysfunction were significantly increased for mentally unhealthy male and female subjects when those in good mental health were used as the reference. For men, the AORs for insomnia and insomnia with daytime dysfunction were significantly increased for those without occupation when those with occupation were used as the reference. In women, the AOR for insomnia was significantly increased for those aged ≥70 years when those aged 20–29 years were used as the reference. In addition, the AOR for college or university graduates was significantly decreased in women when junior or senior high school graduates were used as the reference. Moreover, in men, the AOR for insomnia with daytime dysfunction was significantly increased for those living in municipalities when those living in cities were used as the reference.

4. Discussion

4.1. Prevalence of insomnia symptoms or insomnia

The overall prevalence of insomnia in the present study was 13.5%, including DIS (9.8%), DMS with DRS (7.1%), and EMA with DRS (6.7%). The prevalence of insomnia, DMS, and EMA were substantially lower in the present study than in previous studies: insomnia 17.3–21.4% [3,4]; DIS 8.3–12.6% [3,4]; DMS 12.9–16.2% [3,4]; EMA 8.0% [4]. One reason for these differences may have been the stricter definition of insomnia, which was closer to the clinical definition (ie, considering the coexistence of DRS in DMS and EMA). In previous studies conducted in Japan, the prevalence of insomnia might have been overestimated because individuals who had DMS or EMA, but could not be defined as having insomnia, were defined as having insomnia. Therefore, the results of the present study may provide a more clinically accurate representation of insomnia in Japan.

In this study, the overall prevalence of insomnia with daytime dysfunction was 3.8%. This was the first study that considered the coexistence of daytime dysfunction, as this was not taken into account in previous epidemiological studies of insomnia in Japan. Ohayon classified previous epidemiological studies of insomnia into four categories according to the definitions employed, and reported the prevalence of insomnia in each category. The prevalence of insomnia ranged from 4 to 6% when the strictest definition of insomnia was used (ie, employing diagnostic criteria (such as those provided in the DSM-III-R [21] and DSM-IV [7] and the International Classification of Sleep Disorders [22]) [2]. In the present study, evaluation criteria that were similar to the clinical diagnostic criteria for insomnia were adopted. Specifically, the duration of insomnia symptoms was set to one month and the coexistence of daytime dysfunctions was considered in the survey questions. Therefore, the study results may be more clinically accurate.

The prevalence rates of the symptoms of insomnia, insomnia itself, and insomnia with daytime dysfunction were higher in women than in men. Lichstein et al. reviewed 33 previous studies that compared the prevalence of insomnia based on sex and reported that the prevalence of insomnia symptoms, and of insomnia itself, was higher in women than in men [23]. The results of the present study are consistent with this finding.

4.2. Associated factors of insomnia

The results of multivariate analyses indicated that the factors aggravating insomnia for men were being without occupation and having mental health issues, and for women they were being ≥70 years (compared with the 20–29 year age group), completing fewer years of schooling, and having mental health issues. In two previous epidemiological studies of insomnia in Japan [3,4], the factors associated with insomnia for men were never having been married, being widowed, or unemployed; for women they were older age, being unemployed, lack of habitual exercise, poor perceived health, psychological stress, and being unable to cope with stress.

Lichstein et al. reviewed 20 studies and reported that the prevalence and severity of insomnia were associated with age in 60% of those studies [23]. These authors found strong evidence for increased DMS with age, but modest evidence for increased DIS and EMA with age. Ohayon et al. performed a meta-analysis of sleep parameters reported in 65 studies of subjects ranging in age from five to 102 years [24]. They reported that sleep latency and the percentages of stage 1 and stage 2 sleep appeared to increase significantly with age, while the percentage of REM sleep decreased in adults. This indicates that, in the elderly, the mechanism for maintaining sleep is significantly impaired compared with the mechanism for initiating sleep. This result did not contradict the findings of the review by Lichstein et al. However, several other

Table 2
Prevalence of insomnia symptoms.

	DIS						DMS with DRS						EMA with DRS					
	Male			Female			Male			Female			Male			Female		
	%	95% CI	*p*	%	95% CI	*p*	%	95% CI	*p*	%	95% CI	*p*	%	95% CI	*p*	%	95% CI	*p*
Overall	8.3	6.7–9.9		11.0	9.4–12.6		5.8	4.5–7.1		8.1	6.7–9.5		5.8	4.5–7.1		7.4	6.0–8.8	
Age class			0.57			<0.01			0.14			<0.01			0.36			<0.01
20–29 years	9.2	4.4–14.0		8.2	3.7–12.7		4.9	1.3–8.5		5.5	1.8–9.2		4.9	1.3–8.5		3.4	0.5–6.3	
30–39 years	6.5	3.2–9.8		8.9	5.2–12.6		5.1	2.2–8.0		4.0	1.4–6.6		3.7	1.2–6.2		4.5	1.8–7.2	
40–49 years	7.7	3.8–11.6		6.6	3.5–9.7		3.3	0.7–5.9		5.4	2.5–8.3		4.4	1.4–7.4		5.0	2.2–7.8	
50–59 years	11.4	6.9–15.9		12.8	8.9–16.7		4.7	1.7–7.7		8.8	5.5–12.1		5.7	2.4–9.0		8.5	5.3–11.7	
60–69 years	8.5	4.8–12.2		10.5	6.9–14.1		9.4	5.6–13.2		10.1	6.6–13.6		7.6	4.1–11.1		8.3	5.0–11.6	
≥70 years	7.3	4.0–10.6		17.5	12.8–22.2		6.5	3.3–9.7		12.7	8.6–16.8		7.8	4.3–11.3		12.3	8.2–16.4	
State of occupation			0.36			0.02			0.01			<0.01			<0.01			0.02
With occupation	7.9	6.0–9.8		8.6	6.3–10.9		4.7	3.2–6.2		5.6	3.7–7.5		4.5	3.1–5.9		5.1	3.3–6.9	
Housewife	0.0	0.0–0.0		12.0	9.6–14.4		0.0	0.0–0.0		9.3	7.1–11.5		0.0	0.0–0.0		8.9	6.8–11.0	
Without occupation	9.4	6.4–12.4		16.2	10.4–22.0		8.4	5.6–11.2		12.3	7.1–17.5		8.6	5.7–11.5		9.7	5.0–14.4	
Years of schooling completed			0.25			<0.01			0.42			0.03			0.07			0.07
Junior or senior high school	9.0	6.9–11.1		12.9	10.8–15.0		6.2	4.5–7.9		9.1	7.3–10.9		6.7	4.9–8.5		8.2	6.5–9.9	
College or university	7.1	4.7–9.5		6.9	4.5–9.3		5.0	3.0–7.0		5.7	3.5–7.9		4.1	2.2–6.0		5.5	3.3–7.7	
Seasons of the survey			0.82			0.62			0.23			0.34			0.64			0.07
Winter (February)	8.2	6.0–10.4		11.5	9.2–13.8		6.6	4.6–8.6		7.4	5.5–9.3		6.1	4.2–8.0		6.1	4.3–7.9	
Summer (August)	8.5	6.3–10.7		10.6	8.3–12.9		5.0	3.3–6.7		8.8	6.7–10.9		5.5	3.7–7.3		8.6	6.5–10.7	
Regions			0.50			0.27			0.59			0.92			0.88			0.62
Hokkaido and Tohoku	7.7	3.5–11.9		13.8	8.7–18.9		5.8	2.1–9.5		9.8	5.4–14.2		5.2	1.7–8.7		6.9	3.1–10.7	
Kanto, Keihin, and Koshinetsu	7.4	4.9–9.9		9.7	7.1–12.3		6.7	4.3–9.1		7.5	5.2–9.8		6.3	4.0–8.6		6.6	4.4–8.8	
Hokuriku and Tokai	10.0	5.6–14.4		11.5	7.1–15.9		6.6	3.0–10.2		9.0	5.0–13.0		5.5	2.2–8.8		7.0	3.5–10.5	
Kinki and Hanshin	9.0	4.6–13.4		13.7	9.4–18.0		4.2	1.1–7.3		7.3	4.1–10.5		6.0	2.4–9.6		7.3	4.1–10.5	
Chugoku and Shikoku	5.4	1.2–9.6		11.2	6.2–16.2		2.7	−0.3–5.7		7.8	3.6–12.0		3.6	0.1–7.1		7.2	3.1–11.3	
Kyushu	11.4	6.1–16.7		7.3	3.3–11.3		6.4	2.3–10.5		8.5	4.2–12.8		7.1	2.8–11.4		10.9	6.1–15.7	
Size of the city of residence			0.10			0.34			0.62			0.46			0.28			0.69
18 large cities	5.6	2.9–8.3		11.2	7.9–14.5		6.4	3.5–9.3		7.8	5.0–10.6		5.7	3.0–8.4		7.6	4.8–10.4	
City	8.8	6.8–10.8		11.6	9.5–13.7		5.4	3.8–7.0		8.6	6.8–10.4		5.4	3.8–7.0		7.6	5.9–9.3	
Municipality	11.5	5.8–17.2		7.6	3.5–11.7		7.4	2.8–12.0		5.7	2.1–9.3		9.0	3.9–14.1		5.7	2.1–9.3	
Mental health status			<0.01			<0.01			<0.01			<0.01			<0.01			<0.01
Good	5.5	4.0–7.0		7.0	5.4–8.6		4.3	2.9–5.7		4.7	3.4–6.0		4.3	2.9–5.7		4.8	3.4–6.2	
Poor	16.2	12.1–20.3		19.9	13.6–26.2		10.2	6.9–13.5		15.5	12.2–18.8		10.2	6.9–13.5		13.0	9.9–16.1	

Subject with missing data was excluded from the analysis.
p was calculated by χ^2 test.
Abbreviations: DIS, difficulty initiating sleep; DMS, difficulty maintaining sleep; DRS, difficulty resuming sleep; EMA, early morning awakening; CI, confidential interval.

Table 3
Prevalence of insomnia.

	Insomnia						Insomnia with daytime dysfunction					
	Male			Female			Male			Female		
	%	95% CI	*p*	%	95% CI	*p*	%	95% CI	*p*	%	95% CI	*p*
Overall	12.2	10.3–14.1		14.6	12.8–16.4		3.2	2.2–4.2		4.2	3.2–5.2	
Age class			0.84			<0.01			0.90			<0.01
20–29 years	9.9	5.0–14.8		10.3	5.4–15.2		2.9	0.1–5.7		3.4	0.5–6.3	
30–39 years	11.7	7.4–16.0		10.3	6.3–14.3		2.8	0.6–5.0		1.8	0.1–3.5	
40–49 years	11.0	6.4–15.6		9.1	5.5–12.7		2.8	0.4–5.2		2.9	0.8–5.0	
50–59 years	14.5	9.5–19.5		16.0	11.7–20.3		4.7	1.7–7.7		3.2	1.1–5.3	
60–69 years	12.9	8.5–17.3		15.9	11.6–20.2		3.1	0.8–5.4		4.3	1.9–6.7	
≥70 years	12.1	7.9–16.3		23.4	18.2–28.6		3.1	0.9–5.3		9.1	5.5–12.7	
State of occupation			0.05			0.01			0.06			<0.01
With occupation	10.9	8.8–13.0		11.5	8.9–14.1		2.6	1.5–3.7		2.5	1.2–3.8	
Housewife	0.0	0.0–0.0		16.4	13.6–19.2		0.0	0.0–0.0		4.9	3.3–6.5	
Without occupation	14.9	11.3–18.5		18.8	12.6–25.0		4.6	2.5–6.7		7.8	3.6–12.0	
Years of schooling completed			0.15			<0.01			0.11			0.05
Junior or senior high school	13.2	10.8–15.6		16.7	14.4–19.0		3.8	2.4–5.2		4.9	3.6–6.2	
College or university	10.3	7.5–13.1		10.0	7.1–12.9		2.1	0.8–3.4		2.6	1.1–4.1	
Seasons of the survey			0.82			0.32			0.95			0.83
Winter (February)	11.9	9.3–14.5		13.7	11.2–16.2		3.3	1.9–4.7		4.3	2.8–5.8	
Summer (August)	12.4	9.8–15.0		15.6	12.9–18.3		3.2	1.8–4.6		4.1	2.6–5.6	
Regions			0.14			0.78			0.58			0.47
Hokkaido and Tohoku	10.4	5.6–15.2		17.8	12.1–23.5		2.6	0.1–5.1		4.6	1.5–7.7	
Kanto, Keihin, and Koshinetsu	11.3	8.3–14.3		14.1	11.0–17.2		3.5	1.8–5.2		3.7	2.0–5.4	
Hokuriku and Tokai	15.0	9.8–20.2		14.6	9.7–19.5		5.1	1.9–8.3		3.5	0.9–6.1	
Kinki and Hanshin	13.3	8.1–18.5		15.7	11.2–20.2		3.0	0.4–5.6		4.4	1.8–7.0	
Chugoku and Shikoku	6.3	1.8–10.8		13.2	7.8–18.6		2.7	−0.3–5.7		7.2	3.1–11.3	
Kyushu	16.4	10.3–22.5		12.7	7.6–17.8		1.4	−0.5–3.3		3.0	0.4–5.6	
Size of the city of residence			0.12			0.74			0.02			0.25
18 large cities	9.9	6.4–13.4		15.2	11.5–18.9		2.5	0.7–4.3		4.3	2.2–6.4	
City	12.2	9.9–14.5		14.8	12.5–17.1		2.8	1.6–4.0		3.2	2.1–4.3	
Municipality	17.2	10.5–23.9		12.7	7.5–17.9		7.4	2.8–12.0		5.1	1.7–8.5	
Mental health status			<0.01			<0.01			<0.01			<0.01
Good	8.6	6.7–10.5		10.1	8.2–12.0		1.6	0.8–2.4		1.7	0.9–2.5	
Poor	22.3	17.7–26.9		24.6	20.6–28.6		7.7	4.7–10.7		9.7	7.0–12.4	

Subject with missing data was excluded from the analysis.
p was calculated by χ^2 test.
Abbreviations: CI, confidential interval.

epidemiological studies of insomnia have refuted any significant associations between age and insomnia after adjustment for other important comorbidities [25–27]. No definitive epidemiological conclusion regarding the association between age and insomnia has yet been drawn. In the present study, a significant association was only observed between insomnia and specific age classes (20–29 years and ≥70 years old) in women. However, no significant associations were observed between age and the symptoms of insomnia in men and women.

Some previous studies have reported associations between insomnia and education as well as socioeconomic status (income and employment). An epidemiological study of 3684 public servants working for local authorities in Japan reported a significant association between employment grade and the Pittsburgh Sleep Quality Index (PSQI) score (an index of insomnia) in men, but not in women [28]. A study of 94 women aged 61–90 years reported a significant association between PSQI score and socioeconomic status defined according to education and income [29]. In addition, Mezick et al. investigated the associations between socioeconomic status and subjective sleep quality defined by the PSQI score, and concluded that lower socioeconomic status was associated with lower subjective sleep quality [30].

Previous studies have reported associations between psychological disorders and insomnia. In particular, insomnia was the strongest risk factor for depression. According to the results of a systematic review of longitudinal epidemiological studies on associations between insomnia and onset of depression by Baglioni et al., in which 21 studies published between 1980 and 2010 were included in a meta-analysis, the overall OR for the prediction of depression in insomnia cases was 2.60 (95% CI 1.98–3.42) [31]. In addition, aggravation of sleep before onset of MDD was indicated [32]. Furthermore, chronic insomnia was shown to be a risk factor for reducing the effects of therapy for depression [33,34].

The present study observed sex-based differences in the prevalence of insomnia and factors associated with insomnia. Zhang et al. performed a meta-analysis of 29 papers and reported that the risk ratio (95% CI) for insomnia in women was significantly higher [1.41 (1.28–1.55)] than that in men [35]. They also performed a meta-analysis based on the subtypes of insomnia (DIS, DMS, EMA, and non-restorative sleep), and reported that all subtypes of insomnia had a significant female preponderance, with the exception of non-restorative sleep [35]. These findings are consistent with the results of the present study. The difference in the rise and fall of sleep-related hormone levels between men and women provides a physiological explanation for sex-based differences in insomnia [36].

4.3. Seasonality and regionality of insomnia in Japan

The present study also investigated the seasonality and regionality of insomnia in Japan. With regard to the seasonality of insomnia, the main focus has been on associations between the midnight sun in Polar Regions and sleep, and previous epidemiological studies have mainly been conducted in Northern Europe. These studies indicated that symptoms of insomnia are more common in summer and winter than in spring and autumn [37]. When summer and

Table 4
Factors associated with insomnia symptoms.

	DIS						DMS with DRS						EMA with DRS					
	Male			Female			Male			Female			Male			Female		
	AOR	95% CI	*p*	AOR	95% CI	*p*	AOR	95% CI	*p*	AOR	95% CI	*p*	AOR	95% CI	*p*	AOR	95% CI	*p*
Age class			0.69			0.08			0.37			0.17			0.98			0.11
20–29 years	1.00			1.00			1.00			1.00			1.00			1.00		
30–39 years	0.77	0.34–1.76		1.35	0.62–2.93		1.29	0.47–3.52		0.84	0.31–2.27		0.88	0.30–2.56		1.44	0.47–4.37	
40–49 years	0.91	0.40–2.09		0.89	0.40–2.00		0.77	0.25–2.44		1.09	0.43–2.78		1.01	0.34–2.97		1.55	0.52–4.56	
50–59 years	1.24	0.58–2.67		1.77	0.86–3.65		0.97	0.33–2.82		1.80	0.76–4.27		1.13	0.41–3.15		2.68	0.97–7.36	
60–69 years	0.84	0.38–1.87		1.16	0.55–2.47		2.02	0.79–5.19		1.72	0.73–4.10		1.34	0.51–3.53		2.17	0.77–6.08	
≥70 years	0.65	0.27–1.56		2.02	0.97–4.20		1.21	0.43–3.38		2.07	0.87–4.91		1.19	0.43–3.29		3.20	1.16–8.86	
State of occupation			0.20			0.11			0.17			0.09			0.11			0.14
With occupation	1.00			1.00			1.00			1.00			1.00			1.00		
Housewife				1.35	0.90–2.02					1.59	0.99–2.57					1.65	1.01–2.72	
Without occupation	1.49	0.81–2.75		1.62	0.88–2.97		1.61	0.82–3.16		1.96	0.98–3.92		1.78	0.89–3.56		1.62	0.76–3.41	
Years of schooling completed			0.31			<0.01			0.71			0.16			0.15			0.29
Junior or senior high school	1.00			1.00			1.00			1.00			1.00			1.00		
College or university	0.78	0.48–1.26		0.49	0.31–0.77		0.90	0.51–1.58		0.69	0.42–1.15		0.65	0.36–1.17		0.76	0.45–1.27	
Seasons of the survey			0.59			0.38			0.36			0.53			0.75			0.15
Winter (February)	1.00			1.00			1.00			1.00			1.00			1.00		
Summer (August)	0.89	0.58–1.36		1.16	0.82–1.65		1.27	0.77–2.10		1.14	0.76–1.69		1.09	0.66–1.79		0.74	0.49–1.12	
Regions			0.48			0.26			0.70			0.85			0.85			0.58
Hokkaido and Tohoku	1.00			1.00			1.00			1.00			1.00			1.00		
Kanto, Keihin, and Koshinetsu	1.11	0.54–2.29		0.65	0.37–1.12		1.24	0.54–2.80		0.72	0.38–1.36		1.42	0.60–3.34		0.92	0.45–1.89	
Hokuriku and Tokai	1.42	0.65–3.13		0.84	0.44–1.60		1.26	0.50–3.17		0.91	0.44–1.89		1.23	0.46–3.30		1.04	0.45–2.37	
Kinki and Hanshin	1.54	0.67–3.50		0.98	0.54–1.78		0.79	0.28–2.26		0.70	0.34–1.44		1.47	0.54–3.99		1.03	0.47–2.25	
Chugoku and Shikoku	0.72	0.25–2.03		0.71	0.35–1.43		0.52	0.14–2.03		0.66	0.29–1.48		0.81	0.23–2.84		0.93	0.39–2.24	
Kyushu	1.67	0.74–3.75		0.48	0.23–1.03		1.25	0.47–3.32		0.84	0.39–1.84		1.60	0.60–4.29		1.67	0.76–3.68	
Size of the city of residence			0.18			0.35			0.68			0.48			0.33			0.63
18 large cities	0.63	0.35–1.13		1.02	0.68–1.54		1.18	0.64–2.15		0.95	0.59–1.54		1.07	0.58–2.00		1.10	0.67–1.78	
City	1.00			1.00			1.00			1.00			1.00			1.00		
Municipality	1.28	0.68–2.44		0.62	0.33–1.20		1.37	0.62–3.01		0.63	0.30–1.33		1.74	0.84–3.62		0.74	0.35–1.55	
Mental health status			<0.01			<0.01			<0.01			<0.01			<0.01			<0.01
Good	1.00			1.00			1.00			1.00			1.00			1.00		
Poor	3.39	2.21–5.21		3.81	2.68–5.41		2.66	1.60–4.42		4.12	2.75–6.15		2.70	1.63–4.48		3.25	2.15–4.91	

Subject with missing data was excluded from the analysis.
p was calculated by the multiple logistic regression analysis.
Abbreviations: DIS, difficulty initiating sleep; DMS, difficulty maintaining sleep; DRS, difficulty resuming sleep; EMA, early morning awakening; AOR, adjusted odds ratio; CI, confidential interval.

Table 5
Factors associated with insomnia.

	Insomnia						Insomnia with daytime dysfunction					
	Male			Female			Male			Female		
	AOR	95% CI	*p*	AOR	95% CI	*p*	AOR	95% CI	*p*	AOR	95% CI	*p*
Age class			0.69			0.01			0.54			0.10
20–29 years	1.00			1.00			1.00			1.00		
30–39 years	1.47	0.71–3.05		1.11	0.55–2.25		1.34	0.34–5.31		0.66	0.17–2.57	
40–49 years	1.36	0.64–2.92		0.93	0.46–1.90		1.32	0.31–5.66		0.99	0.29–3.30	
50–59 years	1.67	0.81–3.44		1.70	0.89–3.26		1.56	0.42–5.77		1.06	0.33–3.39	
60–69 years	1.20	0.58–2.50		1.49	0.77–2.89		0.59	0.15–2.36		1.16	0.37–3.62	
≥70 years	0.96	0.44–2.08		2.37	1.23–4.58		0.43	0.10–1.83		2.65	0.89–7.85	
State of occupation			0.02			0.31			<0.01			0.38
With occupation	1.00			1.00			1.00			1.00		
Housewife				1.32	0.92–1.89					1.56	0.79–3.07	
Without occupation	1.85	1.08–3.15		1.28	0.74–2.22		4.00	1.50–10.70		1.76	0.70–4.40	
Years of schooling completed			0.20			0.01			0.13			0.11
Junior or senior high school	1.00			1.00			1.00			1.00		
College or university	0.77	0.51–1.15		0.61	0.41–0.90		0.52	0.23–1.21		0.56	0.27–1.15	
Seasons of the survey			0.61			0.55			0.74			0.56
Winter (February)	1.00			1.00			1.00			1.00		
Summer (August)	0.91	0.63–1.31		1.10	0.81–1.50		0.89	0.45–1.76		0.85	0.49–1.47	
Regions			0.12			0.71			0.33			0.65
Hokkaido and Tohoku	1.00			1.00			1.00			1.00		
Kanto, Keihin, and Koshinetsu	1.30	0.69–2.45		0.75	0.46–1.23		2.01	0.60–6.74		0.76	0.31–1.87	
Hokuriku and Tokai	1.74	0.88–3.45		0.81	0.45–1.46		3.01	0.85–10.67		0.81	0.28–2.41	
Kinki and Hanshin	1.67	0.82–3.41		0.87	0.50–1.49		2.08	0.51–8.53		0.91	0.34–2.41	
Chugoku and Shikoku	0.65	0.25–1.68		0.63	0.33–1.20		1.47	0.30–7.26		1.50	0.55–4.08	
Kyushu	1.92	0.95–3.90		0.67	0.36–1.25		0.55	0.09–3.28		0.65	0.20–2.15	
Size of the city of residence			0.21			0.70			0.01			0.33
18 large cities	0.81	0.51–1.29		1.09	0.76–1.57		1.02	0.41–2.54		1.36	0.73–2.53	
City	1.00			1.00			1.00			1.00		
Municipality	1.46	0.84–2.52		0.85	0.50–1.44		3.66	1.52–8.81		0.39	0.11–1.33	
Mental health status			<0.01			<0.01			<0.01			<0.01
Good	1.00			1.00			1.00			1.00		
Poor	3.17	2.20–4.58		3.27	2.40–4.45		5.26	2.59–10.68		7.23	3.97–13.16	

Subject with missing data was excluded from the analysis.
p was calculated by the multiple logistic regression analysis.
Abbreviations: AOR, adjusted odds ratio; CI, confidential interval.

winter were compared, some studies reported a deterioration of sleep in summer [38], whereas others reported such an effect in winter [39]. No previous studies have investigated the seasonality of insomnia in Japan. Japan has clear seasonal changes in weather, with hot summers and cold winters, and it was hypothesized that insomnia would increase in the hot and humid summer. However, no significant associations were found between the symptoms of insomnia and seasonality, or between insomnia and seasonality. It is known that, in Japan, the number of patients with seasonal affective disorder increases in the winter [40]. As insomnia is often a symptom of depression, temperature and humidity alone may not be enough to explain the seasonality of insomnia. The present study was the first to investigate the seasonality of insomnia in Japan, and further studies of this topic will be required.

With regard to the regionality of insomnia in Japan, Kageyama et al. conducted a study of 3600 women living in eight cities in Japan to investigate associations between nighttime road traffic volume and insomnia. They concluded that a level–response relationship exists between the nighttime traffic volume on main roads and the risk of insomnia in subjects living in zones 0–20 m from those roads [41]. In a nationwide epidemiological study on seasonal affective disorders, Imai et al. reported that there was a significant difference in the prevalence of these disorders between the southern and northern regions [42]. The present study found no significant associations between the size of the city of residence and insomnia. Thus, the size of a city alone may not have an impact on insomnia. Future investigations will focus more on the environment surrounding the area of residence and the size of the city of residence.

4.4. Interview method

The present survey adopted an interview method to avoid the limitations of a self-administered questionnaire survey. The advantage of an interview-based method is that it has better reliability in that questions are less restricted, more complex questions can be used, and researchers can confirm the responses on the spot. As the questions in the present study were not simple (particularly those regarding DMS and EMA, because the coexistence of DRS was considered), they had to be conveyed accurately so that the participants would respond appropriately. This is why the interview method was adopted. A limitation of the interview survey was that interviewer technique might create variations in the validity and reliability of the interview. To address this shortcoming as much as possible, a structured interview method was employed in the present study.

4.5. Limitations

The present study had some limitations. First, the data on insomnia were based on self-reporting, which could have biased findings. However, several studies have indicated that self-reported data on sleep status show at least a moderate agreement with data from laboratory studies [43,44]. Second, this study was a cross-sectional investigation and, as such, could not demonstrate causal directions. As the main purpose of this study was to clarify the prevalence of insomnia and associated factors among the general population in Japan, and not to discuss a causal relationship between

them, the goal was achieved. Third, as the present study used a questionnaire and the length of the questionnaire was limited, the questions for diagnosing insomnia could not include entire clinical diagnostic criteria for insomnia from the ICSD-III [45] and DSM-V [46]. As a result, diagnosis of insomnia in the present study may have been different from that based on strict clinical diagnostic criteria. In addition, many other factors, such as the psychiatric diagnosis (lifetime and current), physical comorbidities, socioeconomic status such as monthly income, other lifestyle factors, and use of sedatives were not assessed. In future studies, the above-mentioned factors must be considered. Fourth, the response rate of 54.2% in the present study may suggest an existence of non-response bias.

5. Conclusion

This was an epidemiological study of the general nationwide population in Japan regarding insomnia. It is believed that the results convey a more clinically accurate picture of insomnia conditions than data obtained in previous epidemiological studies because of the fact that the definition of insomnia was closer to the clinical diagnostic criteria (eg, it considered DRS and daytime dysfunction).

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2016.05.013.

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