Health and socioeconomic factors associated with insomnia:

Secondary data use - 2013 health diary survey

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1. Abstract

Background	Insomnia is one of the important issues in public health because it has clinically and socioeconomically impacts to society. Regarding the factors affecting insomnia, although the effects of each clinical factor on insomnia have been studied individually, few research reports have simultaneously examined socio-economic factors, especially in Japan. In this study, we comprehensively examine various effects that affect insomnia. In particular, it examines factors that have not been noticed so far from a socio-economic viewpoint as well as a clinical viewpoint.
Methods	In this study, we used data from a questionnaire survey conducted in 2013 to explore clinical and socioeconomic factors that correlate with insomnia. This sample population is expected to represent people aged 18 years or older living in Japan. Athens Insomnia Scale (AIS) was used as an outcome index, and related factors were searched for in two groups, with/without "insomnia tendency," using AIS value 5.5 as a threshold. Because the PHQ-9 also includes questions about sleep, we also examined the collinearity of AIS and PHQ-9. In the sub-analysis, stratified analysis was performed by dividing into two layers, with/without "depression tendency."
Results	3546 subjects were analyzed, and 920 were classified as with "insomnia tendency," and the proportion in the study population was 25.9%. In the primary analysis, the factors that showed a statistically significant association with "insomnia tendency" were "age: 40-64 (OR 1.34 [1.03-1.74])," "age: 65- (OR 1.62 [1.16-2.26])," "with depression tendency (OR 10.59 [8.80-12.75])," "number of symptoms reported (OR 1.15 [1.09-1.22])," "currently working (OR 1.32 [1.05-1.65])," "Not-married (OR 0.67 [0.50-0.89])," and "living alone (OR 1.65 [1.10-2.48]).
Conclusion	It is suggested that not only clinical factors, but also socioeconomic factors play essential roles for early detection of people with insomnia.
Keywords	Insomnia, AIS, Health Literacy, Occupation, Health Diary, Japan, Self-reported

2. Background

2.1. Why insomnia is an important issue

Insomnia is one of the most common symptoms of sleep disorders, with a reported prevalence of 10% to 40% worldwide[1, 2]. Reported prevalence range from 50% to 60% depending on the target population. In Japan, one in five people is reported to suffer from insomnia, and its social importance is recognized in government-led initiatives such as

Healthy Japan 21. Although the prevalence figures vary widely in each study, they are considered a globally important public health challenge.

There is another reason why insomnia is considered an important issue, that it increases the risk of various diseases and leads to lower labor productivity.

The long-term effects of insomnia are to increase the risk of developing a variety of diseases, including mental illness[3], diabetes[4], cardiovascular diseases[5] and dementia[6]. For example, if insomnia continues for a long time, those people would suffer various upsets, malaise, decreased motivation, reduced concentration, depression, headache, dizziness, anorexia, and so on. Conversely, there are reports that comorbidities such as depression increase the risk of insomnia, so when analyzing the risk of insomnia, information such as co-morbidities and medical history should be taken into account.

Insomnia has also been reported to have a negative effect on daytime activities, resulting in lower labor productivity[7]. There is also a report that shift work is one of the risks of insomnia[8]. Considering these research results, a negative spiral such as "depression due to overwork" cause insomnia due to depression, and that leads to "reduced daytime productivity due to insomnia", and that also leads to "redundant working hours due to reduced productivity". Since a decline in productivity in the working generation can lead to a decline in productivity as a whole, it is considered important to improve coping and awareness of insomnia throughout society.

2.2. What is known about insomnia

It is widely known that the risk of sleep disorders such as falling asleep and premature awakening increases with "aging." [9] It is thought that the risk of sleep disorders increases with aging due to a decrease in melatonin secreted from the pineal gland of the brain. Melatonin is a crucial regulator of the sleep-wake cycle, and it has been suggested that the decline in

serum melatonin concentration with age at night is one of the causes of sleep disorders associated with aging.[10]

In addition to aging, "women" have also been found to be a significant factor in sleep disorders.[11] Despite the effects of reporting bias, the prevalence of insomnia was almost twice as high in women as in men.[12] However, it is not well understood why women have a higher risk of sleep disorders.

There are reports that alcohol consumption[13] and smoking[14] increase the risk of insomnia and other sleep disorders. Regarding the mechanism of sleep disturbance caused by alcohol, there is a report that alcohol has the effect of shortening sleep onset time, but may also affect circadian rhythm and cause early arousal.[15] In a recent study of smoking and sleep disorders, there was no difference in self-assessment of 'sleep quality' between smokers and non-smokers. It has been stated that continuity was observed to have declined.

Exercise has been recommended as a non-drug method for improving sleep quality, and there are also research reports that shorten the time to sleep and reduce drug use.[16, 17]

A 2008 review article states, "No studies to date have looked at the relationships between sleep disorder outcomes and health literacy." It has also been proposed as one of the Research Agendas, "The prevalence of low health literacy in sleep disorder population."[18]

In recent years, there has been a study report on the relationship between eHealth Literacy and insomnia in patients with heart failure in Iran using an evaluation index called eHEALS.[19]

2.3.   What is unknown about insomnia

Few previous studies analyze factors that affect insomnia while considering both clinical and socioeconomic aspects simultaneously. For example, the effects of age, gender, exercise habits, smoking and drinking, co-morbidities, and health literacy on insomnia have been

studied or investigated individually. Still, few studies have analyzed these factors

simultaneously. In Japan, in particular, its verification has not been sufficiently conducted.

3.   Aim of this study

Comprehensively examine the various effects that affect insomnia. In particular, by

simultaneously analyzing the relationship between clinical and socioeconomic factors, we

will conduct verification from a different angle than previous studies.

4.   Methods

4.1.   Primary Database: Health Diary Survey

In this study, we used data collected at the 2013 Health Diary Survey. The outline of the

questionnaire is shown below.

- Survey period: Conducted in October, 2013

- Survey composition: Consisted of 2 questionnaires

    o   baseline questionnaire -> Socio-demographics data

    o   daily health diary questionnaire -> Record of daily health events and behaviors

- Recruitment: Participants were recruited via a Japanese commercial survey company.

4.2. Inclusion / Exclusion criteria

4,548 participants responded (response rate: 91.0%)

Exclusion flow

4548 participants responded	
↓	Include: 18 years old or older participants (N=3787)
3787	
↓	Exclude: ● AIS scores cannot be calculated (N=19) ● Not answered about the occupation (N=15) ● Not answered about education (N=81) ● Not answered about income (N=11) ● Not answered about marital status (N=52) ● Not answered about health literacy (N=22) ● Not answered about PHQ-9 (N=19) ● Not answered about height or weight [F3] (N=6) ● Not answered about family make-up [F18] (N=16)
3546	

- AIS: Athens Insomnia Scale
- PHQ: Patient Health Questionnaire

4.3. Outcome

Athens Insomnia Scale (AIS) was used as an outcome index in this study. AIS is an

evaluation index that has been validated based on the ICD-10 (International Classification of

Diseases 10th Revision) standard to measure sleep disorders[20]. The Japanese version of AIS

is developed and validated[21]. A study that conducted AIS validation based on ICD-10 was

published in June 2000, and a study on the development of a Japanese translation and

validation was published in September 2013.

The AIS consists of the following eight questions, and respondents can select from four

levels: "No problem," "Slightly," "Pretty," "Very" or "No" for each question. The eight

components of AIS are shown below.

1. Sleep induction

2. Awakenings during the night

3. Final awakening

4. Total sleep duration

5. Sleep quality

6. Sense of well-being during the day

7. Functioning during the day

8. Sleepiness during the day

4.4. Variables

Category	Variable	Definition
Basic Characteristics	Age	18 – 39 / 40 – 64 / 65 –
	Gender	Male / Female
	BMI	Actual value
Lifestyle	Alcohol use	Excessive / Not excessive
	Smoking	Currently smoking / Currently not-smoking
	Physical activity	Sufficient / Insufficient
Health Status	Depression tendency (PHQ-9)	With / Without
	Comorbidities	Number of self-reported comorbidities
	Known risk factor	With / Without
Health Literacy	CCHL scale	High / Low
Socioeconomic factors	Education	4 year college or more / Other
	Occupation	Working / Not working
	Household income	Under 300 mYen / Over 300 mYen
	Marital status	Married / Not-married / Other
	Living with someone	With someone / Alone

- BMI: Body Mass Index
- PHQ: Patient Health Questionnaire
- CCHL: Communicative and Critical Health Literacy

4.4.1. Basic Characteristics

  The considered basic characteristics of the participants were three factors: age, gender, and

BMI.

  The age was used as a yearly value based on the answer in the baseline questionnaire. When

we looked at the age distribution of the target population, we treated "age" as a numerical

value (integer). When analyzing, we addressed "age" as a categorical variable, "18-39 years

old", "40-64 years old", and "65 years old or older".

  Gender was treated as two categorical variables, "male" or "female," based on the gender

described in the baseline questionnaire.

BMI (Body Mass Index) values were calculated based on height and weight information described in the baseline questionnaire.

4.4.2. Lifestyle

Based on the "moderate and moderate drinking" defined by the Ministry of Health, Labor, and Welfare in "Healthy Japan 21"[22], it was classified into two categories, "Excessive" and "Not-excessive."

In a Japanese with normal alcohol metabolism, moderate alcohol consumption is about 20 g per day on average pure alcohol.

- 20g of pure alcohol is equivalent to "1 bottle in beer", "1 sake", "1 bottle of Chu-Hi (7%) 350mL", "1 cup of whiskey double", etc.

Based on the smoking habit information described in the baseline questionnaire, it was classified into two categories, "Currently Smoking" and "Currently Not-smoking." "Currently Not-smoking" includes not only those who did not smoke / have never smoked, and those who smoked in the past but are not smoking now.

Physical activities are classified into two categories: "Sufficient" and "Not-sufficient." Based on answers to questions related to physical activity in the baseline questionnaire, follow the guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ)-Short Edition / Long Edition November 2005 Data processing was performed to classify the target population into three categories: "low physical activity (Low)," "moderate physical activity (Moderate)," and "high physical activity (High)." Thereafter, the population classified as Moderate and High was treated as "Sufficient," and the population classified as Low was treated as "Non-sufficient."

4.4.3. Health Status

Based on the results of the Patients Health Questionnaire (PHQ-9) included in the baseline questionnaire, subjects were classified into two categories: "With Depression Tendency" and "Without Depression Tendency." The PHQ-9 is the validated tool used for screening the patients with depression.[23] The Japanese version of PHQ-9 was developed and validated.[24, 25]

Based on the disease information described in the baseline questionnaire, the number of self-reported diseases was counted and treated as a numerical value (integer).

Diseases listed as risk factors for Insomnia in UpToDate were classified into two categories as "Yes" if they were included in the self-reported content, and "No" if they were not.

4.4.4. Health Literacy

Communicative and Critical Health Literacy (CCHL) scale was used as an indicator of health literacy. The questionnaire consists of the following five questions, which are used to measure the health literacy of workers and can be used not only by patients but also by citizens.[26]

4.4.5. Socioeconomic factors

Educational backgrounds are classified into two categories: "Four-year college or graduate/graduation" or "Other (two-year college, vocational school, high school, middle school, elementary school, etc.)."

The occupation was classified into two categories: "currently working" or "not currently working." Leave of absence (childcare leave, maternity leave, nursing care leave, etc.) is classified as "not currently working."

As a monetary component of SES, household income was used instead of personal income. Household income is classified into two categories: less than 3 million yen or more than 3 million yen.

Marriage status is classified into three categories: "married (including de facto couple),"
"unmarried," and "divorced or widowed."

The family structure was categorized into two categories: "living alone" and "other (with
family)."

4.5. Statistical Methods

Descriptive statistics for participants' sociodemographic, socioeconomic status, and health-
related characteristics were generated.

Comparing those participants identified as a risk for insomnia to those without, we
compared the data using t-test for continuous variables and Chi-squared test for categorical
variables.

We conducted two multivariate logistic regression analyses. The first one is the primary
analysis controlling for all relevant covariates, and the second one is to examine the
interactions between socioeconomic factors. We included all factors significant at the 0.1
significance value or less and clinically essential variables for the sub-analysis in order to
investigate the association between insomnia and clinical /socioeconomic factors stratified by
depression-tendency.

All statistical analysis was performed using IBM SPSS Statistics 24.

5.   Results

5.1.   Characteristics of participants

The response rate was 91% (n=4548) for the baseline questionnaire. Our analysis included

participants who were at least 18 years old and complete AIS, excluding those participants

with incomplete AIS data. Finally, 3546 participants were selected for the analysis.

Comparison of clinical characteristics and socioeconomic factor by AIS score

Category	Variables	All (n=3546)	Low AIS (5.5<) (n=2626)	High AIS (5.5>) (n=920)
Basic Characteristics	**Age** (mean [sd])	51.69 [18.42]	50.53 [18.49]	54.98 [17.82]
	Sex			
	0: Male	1668 (47.0%)	1276 (48.6%)	392 (42.6%)
	1: Female	1878 (53.0%)	1350 (51.4%)	528 (57.4%)
	BMI (mean [sd])	22.38 [3.55]	22.36 [3.45]	22.43 [3.80]
Lifestyle	**Alcohol**			
	0: Not excessive	3112 (87.8%)	2306 (87.8%)	806 (87.6%)
	1: Excessive	434 (12.2%)	320 (12.2%)	114 (12.4%)
	Smoking			
	0: Currently not-smoking	3078 (86.8%)	2271 (86.5%)	807 (87.6%)
	1: Currently smoking	468 (13.2%)	355 (13.5%)	113 (12.3%)
	Physical activity			
	0: Insufficient	1600 (45.1%)	1136 (43.3%)	464 (50.4%)
	1: Sufficient	1946 (54.9%)	1490 (56.7%)	456 (49.6%)
Health status	**Depression tendency (PHQ-9/)**			
	0: Non	2572 (72.5%)	2246 (85.5%)	326 (35.4%)
	1: Mild / Moderate / Severe	974 (27.5%)	380 (14.5%)	594 (64.6%)
	Comorbidities (mean [sd])	1.83 [1.85]	1.61 [1.64]	2.45 [2.22]
	Known risk factor			
	0: Without	2157 (60.8%)	1696 (64.6%)	461 (50.1%)
	1: With	1389 (39.2%)	930 (35.4%)	459 (49.9%)
Health literacy	**Health literacy**			
	0: High	2375 (67.0%)	1828 (69.6%)	547 (59.5%)
	1: Low	1171 (33.0%)	798 (30.4%)	373 (40.5%)
Socioeconomic factors	**Education**			
	0: 2-year college or less	2356 (66.4%)	1727 (65.8%)	629 (68.4%)
	1: 44year college or more	1190 (33.6%)	899 (34.2%)	291 (31.6%)
	Occupation			
	0: Not-working	1521 (42.9%)	1113 (42.4%)	408 (44.3%)
	1: Working	2025 (57.1%)	1513 (57.6%)	512 (55.7%)
	Household yearly income			
	0: >=300mY	3074 (86.7%)	2301 (87.8%)	769 (83.6%)
	1: <300mY	472 (13.3%)	321 (12.2%)	151 (16.4%)
	Marital status			
	0: Married	2373 (66.9%)	1740 (66.3%)	633 (68.8%)
	1: Not-married	830 (23.4%)	660 (25.1%)	170 (18.5%)
	2: Widowed / Divorced	343 (9.7%)	226 (8.6%)	117 (12.7%)
	Living with someone			
	0: With someone	3336 (94.1%)	2482 (94.5%)	854 (92.8%)
	1: Alone	210 (5.9%)	144 (5.5%)	66 (7.2%)

- AIS: Athens Insomnia Scale

- PHQ: Patient Health Questionnaire

5.2. Univariate analysis

Category	Variables	Low AIS (5.5<) (n=2626)	High AIS (5.5>) (n=920)	P-value
Basic Characteristics	**Age**			
	18 – 39	865	214	
	40 – 64	1077	409	< 0.01*
	65 –	684	297	
	Sex			
	Male	1276	392	< 0.01*
	Female	1350	528	
	BMI (mean [sd])	22.35	22.43	0.577**
Lifestyle	**Alcohol**			
	0: Not excessive	2306	806	0.870*
	1: Excessive	320	114	
	Smoking			
	0: Currently not-smoking	2271	807	0.340*
	1: Currently smoking	355	113	
	Physical activity			
	0: Insufficient	1136	464	< 0.01*
	1: Sufficient	1490	456	
Health status	**Depression tendency (PHQ-9)**			
	0: Non	2246	326	< 0.01*
	1: Mild / Moderate / Severe	380	594	
	Comorbidities (mean [sd])	1.61	2.45	< 0.01**
	Known risk factor			
	0: Without	1696	461	< 0.01*
	1: With	930	459	
Health literacy	**Health literacy**			
	0: High	1828	547	< 0.01*
	1: Low	798	373	
Socioeconomic factors	**Education**			
	0: 2-year college or less	1727	629	0.150
	1: 4-year college or more	899	291	
	Occupation			
	0: Not-working	1113	408	0.300
	1: Working	1513	512	
	Household yearly income			
	0: >=300mY	2301	769	< 0.01*
	1: <300mY	321	151	
	Marital status			
	0: Married	1740	633	
	1: Not-married	660	170	< 0.01*
	2: Widowed / Divorced	226	117	
	Living with someone			
	0: With someone	2482	854	0.062
	1: Alone	144	66	

* Pearson's chi-square

** T-test

- AIS: Athens Insomnia Scale
- PHQ: Patient Health Questionnaire
- BMI: Body Mass Index

5.3. Multivariate Analysis – 1

Below are the results of multivariate analysis focusing on the factors of interest in this study.

- Age: There was a positive correlation between aging and insomnia tendencies. When the "18 to 39" group was used as a reference, the "40 to 64" group had an odds ratio of 1.34, and the "65 and older" group had an odds ratio of 1.62.

- PHQ-9 score: In the depression screening tool PHQ-9, those who are classified as "Mild, Moderate, or Severe" have an odds ratio of 10.59 for "prone to sleeplessness" compared to those who are classified as "None."

- The number of comorbidities: One more comorbidity (self-reported) resulted in an odds ratio of 1.15 for "prone to insomnia."

- Employment status: The odds ratio of "prone to sleeplessness" was 1.32 for workers compared to non-workers.

- Marital status: Unmarried people had an odds ratio of 0.67 for "prone to sleeplessness" compared to married people.

- Living alone: The odds ratio for "prone to sleep" was 1.65 when living alone, compared to living with someone.

	Odds Ratio	95% Confidential Interval			P-value
Age: 18-39	reference				0.017
Age: 40-64	1.34	1.03	-	1.74	0.032
Age: 65-	1.62	1.16	-	2.26	< 0.01
Female	1.13	0.92	-	1.40	0.239
BMI	1.00	0.97	-	1.02	0.684
Alcohol: Excessive use	1.10	0.83	-	1.46	0.522
Smoking: Currently Smoking	0.91	0.69	-	1.21	0.528
Exercise: Sufficient	0.87	0.73	-	1.04	0.116
PHQ-9 : Mild / Moderate / Severe	10.59	8.80	-	12.75	< 0.01
With known risk factor or insomnia	1.09	0.89	-	1.34	0.406
# of symptoms reported	1.15	1.09	-	1.22	< 0.01
Health literacy: Low	1.14	0.94	-	1.38	0.189
Occupation: Currently working	1.32	1.05	-	1.65	0.016
Education: 4 year college or more	1.15	0.94	-	1.42	0.178
Household income: <300mY	1.10	0.84	-	1.43	0.498
Marital status: Married	reference				0.019
Marital status: Not-married	0.67	0.50	-	0.89	< 0.01
Marital status: divorced / widowed	0.82	0.59	-	1.13	0.223
Living alone	1.65	1.10	-	2.48	0.016
Constant	0.08				< 0.01

- AIS: Athens Insomnia Scale
- BMI: Body Mass Index
- PHQ: Patient Health Questionnaire

5.4. Multivariate Analysis – 2

The similar multivariate analysis was performed by adding two variables to Analysis-1 to examine the following two interactions.

- Education x Occupation: "4-year college or more" x "unemployed or part-time job" -> 144

- Marital Status x Living with someone: "Not-married" x "Living alone" -> 123

The above two interactions were examined, but there was no strong correlation with insomnia tendency in the above group.

- Marital Status x Living with someone: "married x living alone" -> There were only seven persons, and they were not used as explanatory variables.

	Odds Ratio	95% Confidential Interval			P-value
Age: 18-39	reference				0.018
Age: 40-64	1.34	1.02	-	1.75	0.033
Age: 65-	1.62	1.16	-	2.27	< 0.01
Female	1.13	0.91	-	1.39	0.260
BMI	1.00	0.97	-	1.02	0.684
Alcohol: Excessive use	1.10	0.83	-	1.46	0.512
Smoking: Currently Smoking	0.91	0.69	-	1.21	0.525
Exercise: Sufficient	0.87	0.73	-	1.04	0.116
PHQ-9 : Mild / Moderate / Severe	10.59	8.80	-	12.7	< 0.01
With known risk factor or insomnia	1.09	0.89	-	1.34	0.412
# of symptoms reported	1.15	1.09	-	1.22	< 0.01
Health literacy: Low	1.14	0.94	-	1.38	0.191
Occupation: Currently working	1.31	1.05	-	1.65	0.017
Education: 4-year college or more	1.14	0.91	-	1.41	0.252
Household income: <300mY	1.09	0.84	-	1.43	0.519
Marital status: Married	reference				0.022
Marital status: Not-married	0.67	0.49	-	0.91	0.010
Marital status: divorced/widowed	0.82	0.58	-	1.15	0.247
Living alone	1.67	0.91	-	3.06	0.098
interaction02_kougakureki_mushokupart(1)	1.10	0.69	-	1.74	0.697
interaction03_mikon_livealone(1)	0.98	0.45	-	2.16	0.963
Constant	0.08				< 0.01

- AIS: Athens Insomnia Scale
- BMI: Body Mass Index
- PHQ: Patient Health Questionnaire

5.5. Examining correlations between variables

The collinearity of AIS and PHQ9 was studied. The correlation coefficient of AIS and

PHQ-9 was 0.6580.

Correlate y01_ais_score x08a_phq9_score (obs = 3,546)

	y01_ais_score	x08a_phq9_score
y01_ais_score	1.0000	
x08a_phq9_score	0.6580	1.0000

5.6. Sub-analysis

We stratified the population by "Depression tendency (PHQ-9)" and conduct sub-analysis.

5.6.1. Subgroup without depression tendency

- X08c_phq9_binary = 0

- N=2572

	Odds Ratio	95% Confidential Interval			P-value
Age: 18-39	reference				0.242
Age: 40-64	1.26	0.86	-	1.84	0.243
Age: 65-	1.48	0.94	-	2.33	0.092
Female	1.30	0.98	-	1.74	0.074
BMI	1.01	0.97	-	1.05	0.597
Alcohol: Excessive use	0.97	0.65	-	1.44	0.866
Smoking: Currently Smoking	0.80	0.53	-	1.22	0.304
Exercise: Sufficient	0.88	0.69	-	1.18	0.293
With known risk factor or insomnia	1.10	0.84	-	1.45	0.502
# of symptoms reported	1.13	1.05	-	1.21	< 0.01
Health literacy: Low	1.31	1.00	-	1.70	0.047
Occupation: Currently working	1.16	0.86	-	1.57	0.322
Education: 4-year college or more	1.27	0.96	-	1.68	0.095
Household income: <300mY	0.90	0.61	-	1.32	0.574
Marital status: Married	reference				0.078
Marital status: Not-married	0.60	0.39	-	0.94	0.024
Marital status: divorced/widowed	0.95	0.61	-	1.48	0.823
Living alone	1.82	1.07	-	3.11	0.027
Constant	0.06				< 0.01

When there was no depression tendency, the following factors were correlated with

insomnia tendency.

- 65 years or older

- Be a woman

- Low health literacy

- Number of comorbidities

- University degree or higher

- Married

- Living alone)

5.6.2. Subgroup with depression tendency

- X08c_phq9_binary = 1

- N=974

	Odds Ratio	95% Confidential Interval			P-value
Age: 18-39	reference				0.035
Age: 40-64	1.48	1.01	-	2.15	0.042
Age: 65-	1.90	1.14	-	3.17	0.015
Female	0.94	0.69	-	1.28	0.687
BMI	0.98	0.95	-	1.02	0.256
Alcohol: Excessive use	1.27	0.82	-	1.97	0.288
Smoking: Currently Smoking	1.02	0.67	-	1.55	0.914
Exercise: Sufficient	0.82	0.62	-	1.08	0.154
With known risk factor or insomnia	1.10	0.80	-	1.51	0.572
# of symptoms reported	1.18	1.08	-	1.28	< 0.01
Health literacy: Low	1.00	0.75	-	1.33	0.997
Occupation: Currently working	1.53	1.09	-	2.16	0.014
Education: 4-year college or more	1.04	0.76	-	1.42	0.820
Household income: <300mY	1.30	0.88	-	1.92	0.186
Marital status: Married	reference				0.183
Marital status: Not-married	0.77	0.52	-	1.15	0.201
Marital status: divorced/widowed	0.70	0.44	-	1.13	0.145
Living alone	1.30	0.67	-	2.54	0.434
Constant	1.09				0.858

In the subgroup with depression tendency, the following factors were correlated with insomnia.

- "Age 40-64" or "Age 65 or older"

- Number of symptoms reported

- Currently working

6.   Discussion

This study examined the association between insomnia and socioeconomic factors among Japanese population using Athens Insomnia Scale as an outcome. In this study, the prevalence of insomnia, defined as AIS > 5.5, is 25.9% and consistent with the previous studies.

6.1.   Consideration of each factor

6.1.1.   New factor found in this study

The correlation between "living alone" and insomnia tendency was newly found through this study. Even if the expression "living alone" can be described as a single word, various "living alone" are assumed, and the age, marital status, presence/absence of dependents living remotely, and employment status vary. In this study, only a correlation was found, and causality could not be discussed, and it was not known whether living with someone would reduce the risk of insomnia. However, if the presence of a family member is related not only to insomnia but also to various public health issues, it may be possible to consider this in addition to the medical approach.

6.1.2.   Factors showing a similar tendency to previous studies

In the primary analysis, the odds ratio was 1.34 for the group aged 40 to 64 and 1.62 for the group aged 65 and older, based on the age group of ages 18 to 39. In the sub-analysis, the results showed that the odds ratio increased as the age group increased, confirming the same tendency as in the existing research.

Univariate analysis showed a significant difference, but the primary analysis (multivariate analysis) showed no correlation between moderate exercise and insomnia. In previous studies, moderate exercise reduced the risk of insomnia. In this study, the odds of insomnia tended to be as low as 0.87, but there was no significant difference. In the sub-analysis, there was no significant difference, but the odds ratio was 0.88 and 0.82, both lower than 1,

indicating that the risk of insomnia tended to be small. It's difficult to clarify why no significant difference was observed in the primary analysis, but it is suggested that the association between physical activity and insomnia might be diluted by the effect of age. With aging, it seems natural to assume that the amount of physical activity decrease because of the changes in social roles, in addition to the physiological changes. In fact, it is reported the ratio who answered "actively go out myself" decreases with aging.[27]

In the primary analysis, the odds ratio of "with insomnia" was a tremendous value of 10.59 in the group with "depressive tendency" based on "without depressive tendency." The reason why the considerable odds ratio was found is that the question related to sleep was included in the question item of PHQ-9 used in determining whether or not there was a tendency to depression. In this study, we examined correlations between PHQ-9 and AIS scores, and Pearson's correlation coefficient was 0.658, confirming a positive correlation between the two variables.

"The number of comorbidities" is an index newly created in this study. This indicator is considered to indicate "how much the health condition is impaired" indirectly. In the primary analysis, the odds ratio with insomnia was 1.15 each time the number of comorbidities increased by one. It should be noted that the seriousness of the comorbidity and the specificity of the comorbidity cannot be taken into account. It is presumed that this has a particular significance.

We cannot observe statistically significant association between health literacy and insomnia, though there's a tendency the low health literacy is associated with insomnia. One of the reason is that the study population and evaluation scale are different from previous study, in which the population is heart failure patient and the scale was eHEALS (eHealth Literacy Scale). The eHEALS focusing on the literacy to handle the health related information on the internet, otherwise the CCHL (Communicative and Critical Health

Literacy) is to evaluate more general health literacy. In the sub-analysis of this study, there was a correlation between low health literacy and insomnia in the "no depression" group. These results indicate that the effect of health literacy is limited in a group with a tendency of depression, even if health literacy is high. On the other hand, health literacy plays a vital role in reducing the risk of insomnia in a group without a tendency of depression.

In the primary analysis, the odds ratio of "having insomnia" was 1.31 in the "working" group based on the "not working" group. Previous studies have reported similar trends in the relationship between work and insomnia, and there is a Norwegian study that "work-related mental fatigue is a strong risk factor for insomnia." In the sub-analysis, the result was 1.16 (no significant difference) in the group with no tendency to depression, and 1.53 (with a significant difference) in the group with depression. The results of sub-analysis suggest the insomnia risk due to "working" varies depending on if there is a depression tendency.

6.1.3. Factors that did not show the same tendency as previously reported studies

There was no correlation between smoking and insomnia in the study population. No difference was found in either univariate analysis or multivariate analysis. This result seems to be different from previous studies that smoking is a risk of insomnia. However, a recent study of smoking and sleep disorders showed no difference in self-assessment of 'sleep quality' between smokers and non-smokers, but objective sleep data was also taken at the same time. It is alleged that reduced sleep continuity was observed. The odds ratio of 0.91 (no significant difference) in the primary analysis of the present study may be due in part to the smoker's lack of awareness of impaired sleep.

There was no correlation between excessive drinking and insomnia in the study population. No difference was found in either univariate analysis or multivariate analysis. Previous studies have shown that drinking alcohol makes it easier to fall asleep temporarily, but impairs circadian rhythm and impairs sleep quality. However, there is a possibility that the

person himself/herself may not be aware that sleep is impaired in drinking as well as smoking, and subjective outcome evaluation such as in this study does not reveal any objective sleep disorder there is a possibility.

Regarding the relationship between marital status and insomnia, some studies have shown that marriage reduces the risk of insomnia, while others have reported a higher prevalence of insomnia among married people. Besides, it is difficult to state the marital status alone, and a Korean study that states that bad relationships between partners increase the risk of sleep disorders.

6.2. Limitation

There are several limitations to this study.

Firstly, this study is a cross-sectional study and does not discuss causality. Through this study, we believe that we have gained useful information to discuss the relationship between insomnia and each factor.

Secondly, AIS and PHQ-9 are both self-reported. PHQ-9 is a self-reported and validated tool that is used for screening purposes, not for diagnostic purposes. As for insomnia, it is considered that there is no problem with subjective evaluation indexes such as AIS in this study because the problem is that the person does not sleep even if he/she wants to sleep. The effects of "sleep disorders" may be impaired in sleep quality in areas where the person is unaware, so it would be difficult to evaluate them sufficiently using only subjective evaluation indices as in this study. Besides, most of the bias caused by self-reporting is considered to be non-differential classification, and it is thought to work in the direction of reducing each correlation estimated in this study. We also consider that the financial incentive provided as an incentive to participate in this survey also contributes to the non-differential classification.

Thirdly, the question about sleep is included in the question item of PHQ-9. Also, the correlation coefficient between AIS and PHQ-9 was 0.658 in the population analyzed in this study. Besides, in the analysis performed in this study using PHQ-9 as an explanatory variable, the results showed that the coefficient of PHQ-9 was one order of magnitude larger than other covariates. In Analysis2, sub-analysis was performed in two groups according to the PHQ-9 value, and the correlation between each variable and AIS was different between the PHQ-9 high-value group and the PHQ-9 low-value group.

6.3.   Future Tasks

In this study, only the information of the baseline questionnaire is used. As the next step, it is essential to use the information from the Daily health diary questionnaire to verify that "higher AIS scores often cause some harmful events." Besides, socio-economic factors such as information on residential areas and the presence or absence of family doctors cannot be considered in this study, so we will consider including them in future analyses.

7.   Conclusion

Through this study, it is suggested that not only clinical factors such as a history of depression and co-morbidities, but also socioeconomic factors such as family structure, employment status, and health literacy play essential roles for early detection of people with insomnia. It is vital to address the socioeconomic aspects by improving the environment.

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