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The association between self-reported sleep dissatisfaction after the Great East Japan Earthquake, and a deteriorated socioeconomic status in the evacuation area: the Fukushima Health Management Survey.

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Abstract

Background: Few studies have thoroughly investigated the socioeconomic factors related to sleep problems among evacuees following a disaster.

Objectives: To examine sleep problems in evacuees using data from a large-scale cohort survey of evacuees conducted after the 2011 Great East Japan Earthquake.

Methods: 73,433 residents in evacuation zones responded to The 2011 Fukushima Health Management Survey. We excluded 16,659 participants did not answer the question about sleep problems or younger than 20 years. Data for 56,774 participants (24,959 men and 31,815 women) were used for this analysis. Evacuees' self-reported sleep dissatisfaction was determined based on their response to the question 'Are you satisfied with the quality of your sleep? '. The response options 'Unsatisfied' and 'Very unsatisfied' were considered as the outcome for the present study. Prevalence ratios (PRs) and 95% confidence intervals (CIs) for the prevalence of self-reported sleep disturbance were estimated using modified Poisson regression models.

Results: Of the qualifying survey respondents, 20.3% of them (4,387 men and 7,128 women) reported sleep dissatisfaction. Compared with participants living in their own or a relative's home (PR=1), those living in temporary housing or rental accommodation had a higher prevalence of sleep dissatisfaction (1.47; 95% CI 1.44–1.50 and 2.16; 95% CI 2.07–2.26 in men; 1.39; 95% CI 1.36–1.41 and 1.92; 95% CI 1.86–1.99 in women). Higher educational attainment was also associated with a higher prevalence of sleep dissatisfaction in men, as were job loss and decreased income in both men and women.

Conclusion: Self-reported sleep dissatisfaction after the Great East Japan Earthquake was associated with a deteriorated socioeconomic status among evacuees. Future longitudinal studies are still warranted

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Introduction

On 11 March 2011, the Great East Japan Earthquake (GEJE) hit the northeastern coastal area of Japan. The subsequent tsunami caused approximately 18,500 people to die or go missing (1, 2) and damaged the Fukushima Daiichi Nuclear Power Plant, causing it to release radiation. Surviving residents had to evacuate the area and live as evacuees in poor conditions, coping with long-term worry about the radiation, which led to deteriorations in their health and caused psychological distress (3-8).

Sleep disturbance is a common health issue following traumatic events. Earthquake survivors have been reported to experience various types of sleep disorder, with a prevalence of 10.7–83.2% (9-12), and with respect to the GEJE specifically, a cross-sectional household survey reported a 15% prevalence of sleep difficulties among 4,176 respondents following the earthquake (13). Furthermore, other studies have found that a traumatic experience continues to affect sleep for 8 months to 15 years after the event (14-17).

The social factors on sleep problems in general populations is increasingly being investigated, and several epidemiologic studies suggest that lower income or economic strain (18, 19), lower education level (19), less social support (20, 21) and unemployment (18) predicted sleep problems. However, very few studies have thoroughly investigated the socioeconomic factors related to sleep problems among evacuees after disasters.

The present study, using data from the Fukushima Health Management Survey, was conducted to examine a comprehensive set of socioeconomic variables related to self-reported sleep satisfaction among people who were evacuated after the GEJE. The present study was also conducted in order to develop interventions or strategies that would help prevent people from sleep dissatisfaction in the future disasters.

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Methods

Participants

The details of the Fukushima Health Management Survey have been described previously (22). In brief, the target population consists of 210,189 officially registered residents who had been living for at least one year prior to the GEJE and in the following evacuation zones: Hirono Town, Naraha Town, Tomioka Town, Kawauchi Village, Futaba Town, Namie Town, Katsurao Village, Minamisoma City, Tamura City, Yamakiya District of Kawamata Town, and Iitate Village. In 2012, 180,604 questionnaires on mental health and various lifestyle habits were mailed to evacuees aged 15 years and older. 73,569 people returned the questionnaires with responses (the response rate was 40.7%). Of the responders, 136 were excluded due to blank or duplicated questionnaires and 14,656 because they did not answer the question about sleep disturbance. Since the information of drinking status and smoking status was not collected from the participants under than 20 years, 2003 teenagers were also excluded. The data for the remaining 56,774 Japanese adults (24,959 men and 31,815 women) were used for the analysis.

The present study was approved by the ethics review committee of the Fukushima Medical University (No. 1316). Participants who answered this self-administered questionnaire were considered to have consented to participate.

Data collection and measurement

The questionnaire was used to broadly investigate the health statuses and lifestyles of the evacuees. The measurement of sleep satisfaction was a part of the simplified Japanese version of Athens Insomnia Scale (AIS-SJ) which had been used previously (23, 24). All the participants were asked to answer the question 'Are you satisfied with the quality of your sleep?' and four response options were provided: 'extremely satisfied', 'slightly satisfied',

'unsatisfied', and 'very unsatisfied'. The latter two were treated as the outcome in this study. In addition, the following items appeared on the questionnaires.

1. Socioeconomic variables

The socioeconomic variables included in the study were educational attainment, living arrangements, change in employment, and change in income. Educational attainment comprised four options: 'elementary school or junior middle school', 'senior middle school', 'vocational college or junior college', and 'undergraduate and graduate education'. There were the following options for living arrangements: 'evacuation shelter', 'temporary

2. Other variables

The characteristics recorded were age group, gender, smoking and drinking status, and current physical exercise frequency. The options for smoking status were non-smoker, ex-smoker, and current smoker. The options for drinking status were 'once or more per month', 'ex-drinker', or 'less than once per month'. For the question about current physical exercise frequency there were four options: 'nearly daily', '2–4 times per week', 'once a week', or 'nearly none' (25).

Mental health status included PTSD symptoms, depression, and history of mental illness. PTSD symptoms were evaluated using the specific-trauma version of the PTSD Checklist for DSM-5 (PCL-S), the details of which have been described previously (3, 25). Mental health distress, i.e. depression, was measured using the Japanese version of the Kessler Psychological Distress Scale (K6), which has been validated (26) and described previously (22, 25). History of mental illness was evaluated based on 'yes' or 'no' answers to the relevant question.

The following information regarding the earthquake was also collected: experienced the tsunami (yes or no), experienced the nuclear power plant accident (defined as hearing the

explosion; yes or no), lost someone close because of the disaster (yes or no), house damage (no, less than half, half, more than half, total).

Statistical analysis

The prevalence of self-reported sleep disturbance was compared between individuals with different demographic, lifestyle-related, socioeconomic, and disaster-related characteristics using chi-square tests.

Similarly to previous studies (3, 27), a PCL-S score of 44 was used as the cutoff for a PTSD diagnosis. Participants with a PCL-S score ≥ 44 were assigned to the 'high-scoring group', and the remainder were assigned to the 'low-scoring group'. For the Japanese version of the K6 , which was used to measure mental health status, scores ≥ 13 were considered to signify poor mental health status (the range of the scores was 0–24), as in previous studies (4,22). Prevalence ratios (PRs) and 95% confidence intervals (CIs) on the prevalence of self-reported sleep disturbance were estimated using modified Poisson regression models. The adjustment variables were as follows: sex (male, female), age group (<20,20-<25,25-<30,30-<35,35-<40,40-<45,45-<50,50-<55,55-<60,60-<65,65-<70,70-<75,75-<80,80-<85,>=85 years), alcohol consumption (once or more per month, less than once per month, ex-drinker), smoking status (non-smoker, ex-smoker, current smoker), physical exercise frequency (nearly daily, 2–4 times per week, once per week, never), PTSD (yes or no), mental health distress (K6 < 13 or K6 ≥ 13), history of mental disorders (yes or no), educational attainment (elementary school or junior middle school, senior middle school, vocational college or junior college, and undergraduate and graduate education), living arrangements (evacuation shelter or temporary housing, rental housing or apartment, a relative's home or their own home), change in employment (yes or no), change in income

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(yes or no), tsunami experience (yes or no), radiation experience (yes or no), damage to house (no, less than half, half, more than a half, total), and loss of a family member (yes or no).

Analyses were conducted on the total sample and on samples stratified by sex, using SAS software version 9.4 (SAS Institute, Cary, NC, USA).

Before performing regression analyses, we employed multiple imputation under the missing at random (MAR) assumption to handle the missing values. We created 20 multiple imputed data sets and combined the estimated parameters using Rubin's combination methods (28). We also conducted a sub-analysis excluding all the participants with missing data (among 37,096 participants), showed the almost the similar results as the present one (Supplementary Table).

Results

Of the sample of 56,774 individuals, 11,515 (4,387 men and 7,128 women) reported sleep dissatisfaction.

Self-reported sleep dissatisfaction was more common in women than in men (22.4% vs 17.6%) in total .The baseline demographic characteristics of participants stratified by sex are summarized in Table 1. For men, Self-reported sleep dissatisfaction was more common in younger or middle age group while for women, the problem was more common in the middle or old age group. With respect to the lifestyle-related variables, ex-drinkers and current smokers reported more sleep dissatisfaction than other groups, and participants who had hardly any daily physical activity were also more likely to report sleep dissatisfaction in both sexes. Self-reported sleep dissatisfaction was significantly higher in individuals suffering from depression (K6 ≥ 13) and PTSD (PCL ≥ 44) and in those who had a history of a mental

disorder among men and women.

With respect to the socioeconomic variables, participants living in their own home or in a relative's home were less likely to experience sleep dissatisfaction: 10.7% of these participants reported sleep dissatisfaction, versus 21.8% of those living in rental accommodation and 19.5% of those in temporary housing among men. For women, the corresponding number was 15.0%, 25.1% and 26.2%. Participants with a lower educational attainment (elementary school and middle school) were less likely to report sleep dissatisfaction in men. Furthermore, participants who had not experienced unemployment or a decreased income were less likely to report sleep dissatisfaction in both sexes. With respect to disaster-related characteristics, sleep dissatisfaction was higher among participants who had experienced the tsunami, radiation, house damage (half of house or more), or loss of a family member due to the disaster in both sexes.

Table 2 summarizes the PRs and 95% CIs of each socioeconomic characteristic and mental-health variables for self-reported sleep dissatisfaction. The results did not change either in the crude model, age-adjusted model or in the multivariate adjusted model for most of the determinants. Compared with participants living in their own or a relative's home (PR = 1), those living in an evacuation shelter or temporary housing had a higher PR of sleep dissatisfaction (1.47; 95% CI 1.44–1.50 in men and 1.39; 95% CI 1.36–1.41 in women). The corresponding PR for the participants living in rental accommodation was even higher (2.16; 95% CI 2.07–2.26 in men and 1.92; 95% CI 1.86–1.99 in women). Compared with participants who had less than nine years' education (PR = 1), the PRs of sleep dissatisfaction for those who had completed senior middle school, vocational college, and undergraduate or graduate education were 1.39 (95% CI 1.34–1.45), 1.65 (95% CI 1.56–1.74) and 1.94 (95% CI 1.81–2.09), respectively. The corresponding PR for women

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were 1.08 (95% CI 1.05–1.11), 1.12 (95% CI 1.07–1.17) and 1.17 (95% CI 1.10–1.23). We also documented a higher PR (1.05; 95% CI 1.03–1.07 in men and 1.10; 95% CI 1.09–1.11 in women) of sleep dissatisfaction in participants who had experienced unemployment due to the disaster, compared with women who did not lose their jobs (PR = 1). Additionally, participants who had experienced a decreased income after the disaster had a higher PR of sleep dissatisfaction (1.15; 95% CI 1.13–1.17 in men and 1.09; 95% CI 1.08–1.11 in women).

Discussion

Sleep disturbance is a common health issue following traumatic events (9-12), and is often associated with the severity of PTSD and depression symptoms. A 1,573-participant study showed that 12 and 24 months after the 2008 Wenchuan Earthquake in China, 38.3% and 37.5% of participants, respectively, reported sleep difficulties, 22.5% and 14.0% reported PTSD symptoms, and 41.0% and 38.3% reported depressive symptoms. Sleep disturbance also predicted the persistence of PTSD (odds ratio [OR] = 2.35; 95% CI 1.43–3.85) and depressive symptoms (OR = 2.41; 95% CI 1.80–3.24) (29). Another study focused on 387 Wenchuan Earthquake survivors 17–24 months after the disaster, and showed that 83.2% of the participants suffered from sleep problems, 12.14% suffered from PTSD, 36.43% experienced depression, and 38.24% had anxiety; in particular, sleep disturbance was significantly related to anxiety (9) .A study on 143 Hanshin-Awaji earthquake survivors showed that 63% of them had sleep disturbance 3 weeks after the earthquake while 46% of them had sleep disturbance 8 weeks after the earthquake (30). Another study on 3078 suffers after the 2011 Northern Nagoya Prefecture Earthquake reported 25.1% of the participants had insomnia 2-5 weeks after the disaster (31). A recent systematic review of 45

studies on the psychological impact of the GEJE reported that 10-20% of refugees suffered from mental problems for anywhere from several days up to three years after the earthquake in most of the studies (5). A Greece study reported 55% of the survivors developed sleep problems 1 year after the 1999 Athens earthquake (12). In the present study, 19.9% of participants reported sleep dissatisfaction, 13.6% reported depression, and 13.8% reported PTSD symptoms; thus the prevalence of sleep and mental health problems was lower than in most of the prior studies.This could be related to the following factors: Firstly, most of the previous studies employed an objective instrument such as the Pittsburgh Sleep Quality Index to assess sleep problems, whereas the present study was based on subjective self-assessment; Secondly, the relatively low prevalence of sleep dissatisfaction in the present may due to variations in the interval between the disaster and the period of the survey. Our survey was conducted 9-12 months after the disaster, which might, to some extent, provide time for survivors to overcome sleep difficulties. Additionally, selection bias or reporting bias might not be excluded either.

Very few studies discuss the impact of living conditions on sleep problems in people evacuated following natural disasters. The present study showed that comparing with the participants living in home-condition, the ones living in rental or temporary accommodation were reported a higher prevalence of sleep dissatisfaction. The results were not unexpected, and may be explained by the following points. First, rental or temporary accommodation, rather than own-home or relatives' home, was usually associated with more limited living space, thinner wall or worse soundproofing conditions, suboptimal thermal environment and worse sanitary conditions (32). All of above-mentioned factors would contribute to sleep problems among evacuees, especially among Japanese old participants.

Second, studies have shown that after the GEJE, poorer living conditions (living in rental accommodation, an evacuation shelter, or temporary housing) predicted an lower frequency of consumption of fruits and vegetables, meat, soybean products, and dairy products (33) or unbalanced diet (34), or increased consumption of fast food or processed food, which may lead to more likelihood of poor sleep quality .Previous studies have shown that diet with richness of fruits, vegetables, dairy or fishes may exert neuroprotection and reduce oxidative damage and cerebral ischemia (35,36) .At a consequence, unbalanced diet may increase rate of oxidative processes in heart, liver and brain and increase neuro-inflammation, which may contribute to poor sleep quality (37,38) .

Third, living in rental or temporary accommodation was associated with relatively weak social networks in the neighborhood or less of social support, which may lead to increased psychological distress. A study suggested that after the GEJE, fewer changes of address were significantly associated with a higher frequency of laughter (39), whereas one on survivors of the Niigata-Chuetsu Earthquake in Japan reported that poor contact or loss of contact with people in the community was associated with psychological distress (40). After the GEJE, a cross-sectional study of 4,176 survivors suggested that a lack of pleasure in life and a reduction in the amount of interaction with and visiting of neighbors were significantly associated with self-reported sleep difficulties (13). Another two studies also suggest that the GEJE survivors who moved into temporary housing by individual way, rather than by group relocation, were not only less likely to report receiving social support from their neighborhood but also associated with less social participant (41,42) .The present study showed the similar results. Among the refugees living in non-home conditions, the ones living in rental apartment had the higher PR of sleep satisfaction than the evacuation or temporary housing dwellers due to the experience of much more social

isolation than other groups. Stronger relationships generated by neighbors or sharing information and feelings, as well as deriving a sense of belonging or security, through social networks in local communities might alleviate anxiety, stress, and sorrow in evacuees and reduce the likelihood to have sleep satisfaction, especially immediately following the disaster (13). However, a previous reported an inconsistent result that living environment was not associated with depression among GEJE evacuees (43). The result may due to the interval between the disaster and the period of the study (2.5 years afterward).

Previous studies showed lower economic levels were associated with a higher prevalence of sleep problems (18, 19, 44) among general populations, presumably since a low income was associated with increased psychological distress (45). For the studies on disaster-affected participants, the results were inconsistent. A cross-sectional study of GEJE survivors showed relative to evacuees earning a salary, those living on a pension or public livelihood assistance were more likely to report sleep difficulties (13). However, a prolonged study on the same participants 14-21 months after GEJE showed no significant association between change in income and sleep difficulties (46). The result may due to the time interval between the disaster and the survey or the selection bias. In the present study, participants who experienced unemployment and a decreased income had a higher PR of sleep dissatisfaction. Similarly, A recent study of 1,573 Chinese adolescents suggests that sleep problems 12 months after the Wenchuan Earthquake were significantly associated with PTSD (OR = 2.35; 95% CI 1.43–3.85) and depression onset (OR = 2.41; 95% CI 1.80–3.24) two years after the earthquake (29). Several other studies also reported unemployment or low income due to disasters was associated with depression or deteriorated mental status among evacuees (45, 47).

Some studies have found that a lower educational attainment predicted more sleep

complaints (18, 48). A recent meta-analysis also provided evidence that lower educational level predicted worse post-disaster mental health status among adults (49). However, in the present study the reverse was true, especially for men. These results may be reasonable for our particular participants. The disaster-affected area, parts of Fukushima Prefecture, was countryside along the Pacific coastline of eastern Japan. Most residents in this areas were locally born and brought up, doing fishing or farming work with relatively median or low educational levels. The participants with high educational level in the area might be under the situation that transferring here on an assignment by himself, which was common in Japanese companies. At a consequence, the participants with high educational levels in the present study were more likely to live alone, receive fewer emotional support from social networks and feel isolation, which may lead to sleep dissatisfaction. Further study is needed to make the issue clear. Besides, People with high educational background were more likely to have sleep-related problems because they often had opportunity to do office work, especially visual display terminal (VDT) operation (50).

The strengths of the present study were its large scale and the fact that it was based on a reliable assessment conducted under post-disaster conditions. It is the first study to identify a comprehensive set of social determinants related to the sleep problems experienced by evacuees after a disaster. Meanwhile, it is also the first study to investigate the social-economical risk factors of sleep dissatisfaction among evacuees of multiple disasters, including earthquake, tsunami and nuclear disaster. However, several limitations should be considered. First, the overall response rate to the questionnaire was low (40.7%), and there may have been selection biases in the study. Second, the one-index of self-reported sleep satisfaction was used in the present study which may be associated with some biases. However, in the present study, among a large scale and old population, the simple index

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helped us earn relatively high response rate in a short time. We also conducted the same analysis in the present study using AIS-SJ (the simplified Japanese version of Athens Insomnia Scale) and showed the similar results as the present study. Third, as mentioned above, due to its cross-sectional design, we could not identify the causal relationship between sleep dissatisfaction and some social determinants. Third, our survey was conducted 9-12 months after the disaster, the findings might not be applicable to other periods after a disaster. Forth, since all the questionnaires were collected over a brief period (January–March 2012), the present study did not capture seasonal influences.

In conclusion, the present study was the first to investigate a set of comprehensive variables related to sleep problems in people evacuated after a disaster, and it suggests that self-reported sleep dissatisfaction after the Great East Japan Earthquake was associated with a deteriorated socioeconomic status. Future longitudinal studies are still warranted to identify what factors would be beneficial for the sleep satisfaction of evacuees, which would be helpful in promoting health level among the evacuees.

Nuclear Incident.

Declaration of interests

We declare that we have no competing interests.

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Table

Table 1. Baseline characteristics of participants

		Subjects not reporting sleep dissatisfaction	Subjects reporting sleep dissatisfaction	P
Men				
Age	20-<25	707 (87.2%)	104 (12.8%)	<0.001
	25-<30	904 (80.6%)	218 (19.4%)	
	30-<35	1,199 (78.6%)	327 (21.4%)	
	35-<40	1,451 (79.5%)	375 (20.5%)	
	40-<45	1,171 (76.8%)	354 (23.2%)	
	45-<50	1,193 (77.2%)	352 (22.8%)	
	50-<55	1,618 (79.8%)	409 (20.2%)	
	55-<60	2,115 (82.9%)	435 (17.1%)	
	60-<65	3,084 (84.9%)	548 (15.1%)	
	65-<70	2,033 (84.3%)	379 (15.7%)	
	70-<75	1,962 (85.1%)	345 (15.0%)	
	75-<80	1,598 (84.8%)	287 (15.2%)	
	80-<85	992 (85.9%)	163 (14.1%)	
	≥ 85	545 (85.7%)	91 (14.3%)	
Living arrangements	Own home & Relatives' home	7,657 (89.3%)	914 (10.7%)	<0.001
	Rental house/apartment	6,289 (78.2%)	1,754 (21.8%)	
	Evacuation shelter/temporary housing	2,166 (80.5%)	526 (19.5%)	
	Missing or unclear	4,460 (78.9%)	1,193 (21.1%)	
Mental health status	K6 < 13	19,227 (86.9%)	2,888 (13.1%)	<0.001
	K6 ≥ 13	1,345 (47.3%)	1,499 (52.7%)	
Posttraumatic stress disorder	No	19,155 (87.0%)	2,875 (13.1%)	<0.001
	yes	1,417 (48.4%)	1,512 (5%)	
History of mental disorder	No	19,379 (83.9%)	3,722 (16.1%)	<0.001
	Yes	654 (58.3%)	490 (42.8%)	
	Missing	539 (75.5%)	175 (24.5%)	
Alcohol consumption	≥ Once per month	13,907 (82.8%)	2,886 (17.2%)	0.257
	Ex-drinker	1,074 (78.5%)	294 (21.5%)	
	< Once per month	5,505 (82.3%)	1,187 (17.7%)	
	Missing	86 (81.1%)	20 (18.9%)	
Smoking status	Current smoker	7,105 (81.3%)	1,640 (18.8%)	<0.001
	Never-smoker	8,157 (83.2%)	1,653 (16.9%)	
	Ex-smoker	5,172 (83.1%)	1,054 (16.9%)	
	Missing	138 (77.5%)	40 (22.5%)	
Physical exercise frequency	Nearly daily	3,581 (87.4%)	515 (12.6%)	<0.001
	2–4 times per week	3,940 (83.0%)	805 (17.0%)	

	Weekly	3,091 (84.8%)	555 (15.2%)	
	Never	9,651 (80.0%)	2,448 (20.2%)	
	Missing	309 (82.8%)	64 (17.2%)	
Tsunami experience	No	15,837 (83.6%)	3,115 (16.4%)	<0.001
	Yes	4,735 (78.8%)	1,272 (21.2%)	
Radiation experience	No	9,629 (86.4%)	1,510 (13.6%)	<0.001
	Yes	10,943 (79.2%)	2,877 (20.8%)	
Damage to house	None	5,363 (85.4%)	919 (14.6%)	
	Less than half	11,223 (83.5%)	2,216 (16.5%)	
	Half	1,358 (76.1%)	426 (23.9%)	
	More than half	482 (74.0%)	169 (26.0%)	<0.001
	Total	1,015 (78.3%)	282 (21.7%)	
	Missing	1,131 (75.1%)	375 (24.9%)	
Loss of family member	No	16,571 (83.8%)	3,212 (16.2%)	
	Yes	3,517 (76.5%)	1,078 (23.5%)	<0.001
	Missing	484 (83.3%)	97 (16.7%)	
Education status	Elementary school and middle school	5,276 (85.6%)	887 (14.4%)	
	Senior middle school	9,944 (81.6%)	2,239 (18.4%)	
	Vocational college	2,151 (80.2%)	532 (19.8%)	<0.001
	Undergraduate and graduate education	2,542 (81.5%)	579 (18.6%)	
	Missing	659 (81.5%)	150 (18.5%)	
Loss of job	No	17,106 (83.6%)	3,356 (16.4%)	<0.001
	Yes	3,466 (77.1%)	1,031 (22.9%)	
Decreased income	No	16,063 (83.7%)	3,124 (16.3%)	<0.001
	Yes	4,509 (78.1%)	1,263 (21.9%)	

Women

Age	20-<25	1,011 (85.2%)	175 (14.8%)	
	25-<30	1,437 (82.9%)	296 (17.1%)	
	30-<35	1,788 (79.8%)	453 (20.2%)	
	35-<40	2,010 (79.6%)	514 (20.4%)	
	40-<45	1,643 (75.3%)	539 (24.7%)	
	45-<50	1,585 (76.7%)	481 (23.3%)	<0.001
	50-<55	1,875 (76.7%)	656 (26.1%)	
	55-<60	2,341 (75.9%)	744 (24.1%)	
	60-<65	2,879 (74.6%)	979 (25.4%)	
	65-<70	1,938 (76.7%)	590 (23.3%)	
	70-<75	2,076 (77.6%)	600 (22.4%)	

	75-<80	1,832 (79.0%)	488 (22.4%)	
	80-<85	1,289 (80.1%)	320 (19.0%)	
	≥ 85	1,001 (77.4%)	293 (22.6%)	
Living arrangements	Own home & Relatives' home	8,826 (85.0%)	1,561 (15.0%)	<0.001
	Rental house/apartment	7,782 (74.9%)	2,608 (25.1%)	
	Evacuation shelter/temporary housing	2,322 (73.8%)	826 (26.2%)	
	Missing or unclear	5,757 (73.0%)	2,133 (27.0%)	
Mental health status	K6 < 13	22,428 (83.7%)	4,373 (16.3%)	<0.001
	K6 ≥ 13	2,259 (45.1%)	2,755 (55.0%)	
Posttraumatic stress disorder	No	22,415 (83.8%)	4,343 (16.2%)	<0.001
	yes	2,272 (44.9%)	2,785 (55.1%)	
History of mental disorder	No	24,490 (79.5%)	6,314 (20.5%)	<0.001
	Yes	1,155 (55.3%)	933 (44.7%)	
	Missing	875 (65.9%)	452 (34.1%)	
Alcohol consumption	≥ Once per month	7,086 (76.8%)	2,144 (23.2%)	<0.001
	Ex-drinker	416 (68.7%)	190 (31.4%)	
	< Once per month	16,664 (78.4%)	4,602 (21.6%)	
	Missing	521 (73.1%)	192 (26.9%)	
Smoking status	Current smoker	2,495 (72.0%)	970 (28.0%)	<0.001
	Never-smoker	2,176 (75.8%)	695 (24.2%)	
	Ex-smoker	19,214 (78.8%)	5,171 (21.2%)	
	Missing	802 (73.3%)	292 (26.7%)	
Physical exercise frequency	Nearly Daily	2,994 (80.8%)	712 (19.2%)	<0.001
	2–4 times per week	4,792 (79.3%)	1,252 (20.7%)	
	Weekly	3,213 (78.8%)	866 (21.2%)	
	Never	13,274 (76.2%)	4,151 (23.8%)	
	Missing	414 (73.8%)	147 (26.2%)	
Tsunami experience	No	20,714 (78.7%)	5,601 (21.3%)	<0.001
	Yes	3,973 (72.2%)	1,527 (27.8%)	
Radiation experience	No	13,087 (82.6%)	2,751 (17.4%)	<0.001
	Yes	11,600 (72.6%)	4,377 (27.4%)	
Damage to house	None	7,084 (82.2%)	1,538 (17.8%)	<0.001
	Less than half	12,534 (77.6%)	3,613 (22.4%)	
	Half	1,559 (71.2%)	632 (28.9%)	
	More than half	587 (69.7%)	255 (30.3%)	
	Total	1,258 (73.2%)	460 (26.8%)	
	Missing	1,665 (72.6%)	630 (27.5%)	
Loss of family member	No	19,667 (79.8%)	4,986 (20.2%)	<0.001
	Yes	4,421 (69.6%)	1,934 (30.4%)	

Education status	Missing	599 (74.2%)	208 (25.8%)	
	Elementary school and middle school	5,588 (78.3%)	1,553 (21.8%)	
	Senior middle school	11,380 (76.6%)	3,481 (23.4%)	
	Vocational college	5,464 (79.1%)	1,448 (21.0%)	0.013
	Undergraduate and graduate education	1,369 (81.0%)	321 (19.0%)	
	Missing	886 (73.2%)	325 (26.8%)	
Loss of job	No	19,529 (79.5%)	5,048 (20.5%)	<0.001
	Yes	5,158 (71.3%)	2,080 (28.7%)	
Decreased income	No	20,983 (78.3%)	5,824 (21.7%)	<0.001
	Yes	3,704 (74.0%)	1,304 (26.0%)	

Table 2. Prevalence ratios (PRs) and 95% confidence intervals (CIs) for sleep dissatisfaction, based on modified Poisson regression analyses

		Sleep dissatisfaction		
Men		PR (95% CI) [a]	PR (95% CI) [b]	PR (95% CI) [c]
Living arrangements	**Own home & Relatives' home (reference)**	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Rental house/apartment	3.23 (3.10-3.37)	3.22 (3.09–3.36)	2.16 (2.07–2.26)
	Evacuation shelter/temporary housing	1.80 (1.76-1.84)	1.79 (1.76–1.83)	1.47 (1.44–1.50)
Education status	**Elementary school and middle school (reference)**	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Senior middle school	1.63 (1.58-1.69)	1.35 (1.30–1.40)	1.39 (1.34–1.45)
	Vocational college	2.08 (1.98-2.19)	1.57 (1.48–1.65)	1.65 (1.56–1.74)
	Undergraduate and graduate education	2.66 (2.48-2.85)	1.82 (1.69–1.95)	1.94 (1.81–2.09)
Loss of job	**No (reference)**	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Yes	1.40 (1.38-1.42)	1.42 (1.39-1.44)	1.05 (1.03–1.07)
Decreased income	**No (reference)**	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Yes	1.34 (1.32-1.36)	1.28 (1.27-1.30)	1.15 (1.13–1.17)
Women				
Living arrangements	**Own home & Relatives' home (reference)**	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Rental house/apartment	2.99 (2.90-3.09)	3.01 (2.91–3.11)	1.92 (1.86-1.99)
	Evacuation shelter/temporary housing	1.73 (1.70-1.76)	1.73 (1.71–1.76)	1.39 (1.36–1.41)
Education status	**Elementary school and middle school (reference)**	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Senior middle school	1.17 (1.14-1.20)	1.17 (1.14-1.21)	1.08 (1.05–1.11)
	Vocational college	1.27 (1.22-1.32)	1.27 (1.21–1.32)	1.12 (1.07–1.17)
	Undergraduate and graduate education	1.37 (1.31-1.45)	1.37 (1.30–1.45)	1.17 (1.10–1.23)
Loss of job	**No (reference)**	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Yes	1.40 (1.38-1.42)	1.41 (1.39-1.42)	1.10 (1.09-1.11)
Decreased income	**No (reference)**	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Yes	1.20 (1.18-1.21)	1.18 (1.17-1.20)	1.09 (1.08–1.11)

a. Crude model.

b. Adjusted for age group.

c. Multivariate model. Adjustment included age group, alcohol consumption, smoking status, physical exercise frequency, PTSD, mental health distress, history of mental disorders, educational attainment, living arrangements, change in employment, change in income, tsunami experience, radiation experience, damage to house, and loss of a family member.