



Sleep Disturbance of Evacuees in Minamisanriku Town after Great East Japan Earthquake: Risk Factors and Treatment

Yayoi Nakamura,¹ Tomomi Suda,¹ Aya Murakami,¹ Hiroyuki Sasaki,¹ Ichiro Tsuji,² Yumi Sugawara,² Masafumi Nishizawa,³ Kazuaki Hatsugai³ and Shinichi Egawa¹

¹Division of International Cooperation for Disaster Medicine, International Research Institute of Disaster Science (IRIDeS), Tohoku University, Sendai, Miyagi, Japan

²Department of Public Health, Graduate School of Medicine, Tohoku University, Sendai, Miyagi, Japan

³Minamisanriku Hospital, Motoyoshi-gun, Miyagi, Japan

In 2011, Minamisanriku Town lost all of its medical facilities during the Great East Japan Earthquake. Using 10,459 anonymized disaster medical records of affected people in Minamisanriku Town, we assessed the prevalence and risk factors of sleep disturbance, which is known to exacerbate non-communicable diseases (NCDs) and anxiety disorder. Because sleep disturbance is a part of mental health issues, we divided the patients into two groups: patients ($n = 492$) with mental health issues other than sleep disturbance and the remaining ($n = 9,967$) with other comorbidities. Out of 492 patients with mental health issues, 295 patients (60.0%, 114 male, 158 female and 23 unknown) had sleep disturbance who might have required specific treatments. Out of the remaining 9,967 patients, 1,203 patients (12.1%, 361 male and 769 female and 73 unknown) had sleep disturbance. Univariate and multivariate analyses of the 9,967 patients revealed that the odds ratio (OR) of sleep disturbance was higher for female (OR 1.95), elderly persons over 60 (OR 16.15) and residing in evacuation centers (OR 1.36). Patients with two or more NCD had higher risk (OR 1.42). Importantly, sleep disturbance affects younger patients without NCD residing in evacuation center. Emergency medical teams most frequently prescribed benzodiazepines both for sleep induction and anxiolysis. In addition to high risk groups (female, older, with other mental health issues, residing in evacuation center), it is important to survey sleep disturbance in younger and healthier populations especially in evacuation centers and to provide psychosocial and medical support for them.

Keywords: disaster medicine; mental health issue; non-communicable disease; prescription; sleep disturbance
Tohoku J. Exp. Med., 2020 July, 251 (3), 207-216.

Introduction

During the two months after the 2011 Great East Japan Earthquake (GEJE), the medical needs of the people residing in evacuation centers in Minamisanriku Town were treatments for non-communicable diseases (NCDs), infectious diseases and mental health issues rather than trauma (Murakami et al. 2018; Suda et al. 2019). Anonymized disaster medical records (DMRs) show that sleep disturbance was the most frequent diagnosis among mental health issues. DMRs after GEJE were mostly hand-written. They frequently lacked details such as past history, present history, family history, and sometimes even actual diagnosis or the reason for prescriptions. We archived the DMRs of

Minamisanriku Town, which had lost all existing medical facilities to inundation by tsunami waves, into an anonymized digital database as described in earlier report (Suda et al. 2019).

Using PubMed, we searched for the terms “Great East Japan Earthquake, sleep disturbance,” “insomnia disaster,” “Sleep disturbance disaster,” and “disaster evacuation prescription.” As of July 2019, 247 articles were identified. Of those, 35 articles were selected as related. Several researchers documented the increase of patients with sleep disturbance after the disaster. Li et al. (2015) described sleep disturbance exacerbation of hypertension and cardiovascular diseases (CVD). Orui et al. (2017) described sleep dissatisfaction as one reason for people to start drinking

Received January 9, 2020; revised and accepted June 22, 2020. Published online July 15, 2020; doi: 10.1620/tjem.251.207.

Correspondence: Yayoi Nakamura, Division of International Cooperation for Disaster Medicine, International Research Institute of Disaster Science (IRIDeS), Tohoku University, 468-1 Aramaki-aza-Aoba, Aoba-ku, Sendai, Miyagi 980-8572, Japan.

e-mail: yayoin02251996@gmail.com

©2020 Tohoku University Medical Press. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC-BY-NC-ND 4.0). Anyone may download, reuse, copy, reprint, or distribute the article without modifications or adaptations for non-profit purposes if they cite the original authors and source properly.
<https://creativecommons.org/licenses/by-nc-nd/4.0/>

after GEJE. Onose and coworkers reported sleep disturbance as a risk factor of posttraumatic stress disorder (PTSD) among male and female residents (Onose et al. 2015, 2017). Similarly, Miller et al. (2017) emphasized the importance of preventing sleep disturbance after the disaster because sleep disturbance following traumatic events exacerbates PTSD. Several authors reported that sleep disturbance after the disaster was correlated with social and environmental factors, such as lack of emotional support, financial aid, employment support, and changes in the evacuee living environments (Matsumoto et al. 2014; Li et al. 2018).

Our previous study suggested that sleep disturbance was significantly more frequent in older female patients (Suda et al. 2019). Considering that NCD was the most frequent medical needs especially in the older patients, we hypothesized the association between NCD and sleep disturbance. Few reports have described comprehensive epidemiological studies of sleep disturbance in an affected community. Therefore, we specifically examined the epidemiology of sleep disturbance after GEJE to identify its risk factors, especially NCD, and the circumstances of treatment using the anonymized DMRs in Minamisanriku Town.

Patients and Methods

The cross-sectional research study design was based on available anonymized DMRs in Minamisanriku Town from 11 March (Day 0) through 13 May (Day 63) after GEJE. The number of patients was 10,459 with 18,525 diagnoses. As described earlier, we classified the diagnoses into five modules: NCD, infectious disease, mental health issues, trauma and maternal and child health (MCH) issues. According to our previous research (Suda et al. 2019), the most frequent diagnostic group in the NCD module was hypertension ($n = 2,678$), followed by pollinosis ($n = 1,590$), hyperlipidemia ($n = 905$), diabetes ($n = 595$), constipation ($n = 387$) and low-back pain ($n = 349$) with over-

laps. The most frequent diagnosis of infectious disease was acute respiratory infection ($n = 1,425$), followed by acute gastroenteritis ($n = 787$), common cold ($n = 602$) and diarrhea ($n = 93$). Trauma module included wounds ($n = 284$), bruise ($n = 125$) and burns ($n = 45$). MCH was mainly medical examination of pregnant women. Frequent missing values occurred because of the anonymity of DMRs and the disaster aftermath.

Definition of sleep disturbance

Because of the limited information in DMRs, we reviewed the DMRs of sleep disturbance intensively in terms of diagnosis and prescriptions. Definition of sleep disturbance in this study is if there is a diagnosis of sleep disturbance and/or prescription of sleeping/anxiolytic pills. There were 617 patients who got prescribed the pills without any description of sleep disturbance. Of 10,459 patients, there were 492 patients who had mental health issues other than sleep disturbance. Of 492 patients, 295 patients (60.0%) had sleep disturbance. In the remaining 9,967 patients, there were 1,203 patients (12.1%) with sleep disturbance (Fig. 1). Because patients with other mental health issues had very strong association with sleep disturbance, we analyzed them separately.

Risk analysis

The available data of candidate risk factors were sex, age, place of evacuation, and modules. We included the 9,967 patients in the univariate and multivariate analyses and excluded 492 patients with other mental health issues (Fig. 1).

Out of 9,967 DMRs were 669 (6.7%) DMRs without sex information and 261 (2.6%) DMRs without age description. The number of patients with sleep disturbance was increasing dramatically over age 60 (Suda et al. 2019). Thus, we divided the age of patients into three categories; age < 20 , 20-59, and ≥ 60 . We divided the places of evacu-

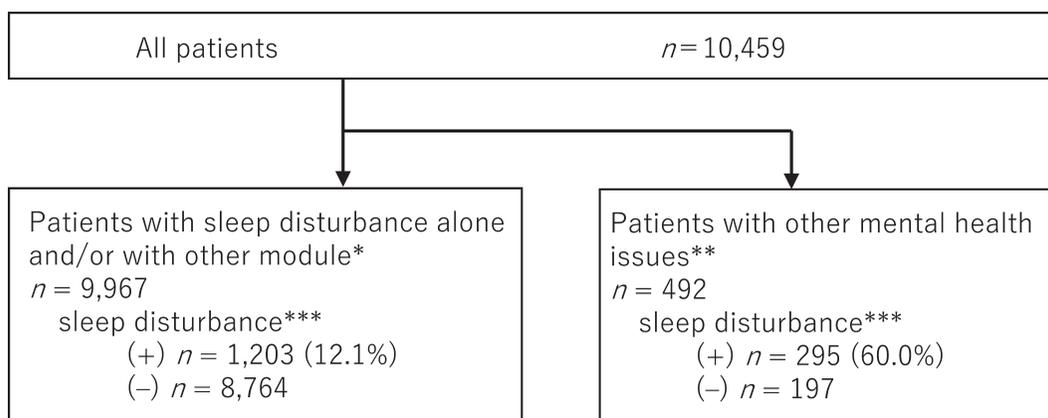


Fig. 1. Study flowchart.

*Other module: Modules other than mental health issues module, i.e., NCD, Infectious disease, trauma, MCH.

**Other mental health issues: Mental conditions other than sleep disturbance (see Fig. 5A).

***Sleep disturbance (+): diagnosis of sleep disturbance or prescriptions of sleeping or anxiolytic pills.

ation into five categories: evacuation centers, own homes, relatives' or friend's house, welfare facilities, and others. The DMRs without detailed information of places such as "company name" and "place name" were categorized into others. Actually, 2,926 (29.4%) DMRs with no information of evacuation location were excluded from analyses. We considered the number of NCD diagnoses (0, 1 and > 1) because patients tend to have multiple diagnoses of NCD. Because of the situation after disaster, we chose "No description" of the module rather than defining that the patients did not have that module.

Prescriptions of sleeping/anti-anxiety pills

We analyzed epidemiological data of the prescriptions by the generic names of medicines, dates of prescription, and the number of days prescribed. The number of days prescribed were divided into four categories: fewer than 8 days (< 8), 8-14 days (8-14), 15-28 days (15-28), and more than 28 days (> 28). Repetition of the same prescriptions to the same patient was included in the analyses.

Statistical analysis

We conducted risk factor analysis using statistical software (JMP ver. 14.3.0; SAS Institute Inc., NC). We applied chi-square tests for univariate analysis of categorical values and Student *t* tests for the comparison of numerical values. We applied logistic regression analysis for multivariate analyses using all candidate factors other than the mental health issues module. Results for which $p < 0.05$ were inferred as statistically significant.

Ethical consideration

This study was approved by the Institutional Review Board of Tohoku University Graduate School of Medicine (2015-1-690). Informed consent was not obtained from patients because it was difficult to obtain in the disaster situation. All DMRs were anonymized by a privacy mark company as described in earlier report (Suda et al. 2019).

Results

Patient characteristics

Fig. 2 presents characteristics of patients with sleep disturbance after GEJE ($n = 1,203$) in Minamisanriku Town. The average age of 1,203 patients was 65.2 years (standard deviation (S.D.) 16.9 years). Of those, 30.0% ($n = 361$) were male, 63.9% ($n = 769$) were female and 6.1% ($n = 73$) were sex unknown. The background male/female ratio in the Town before GEJE was 0.94 (8,431/8,998), which was not statistically different from that of overall DMRs (0.84, 4,463/5,288), as described in an earlier report (Suda et al. 2019). The average ages of male, female, and sex unknown patients with sleep disturbance were, respectively, 62.4 years (S.D. 18.1 years), 66.7 years (S.D. 15.8 years) and 64.1 years (S.D. 19.3 years).

Analysis of sleep disturbance risk factors

Table 1 presents the association of sleep disturbance and risk factors. The univariate analysis examined more female than male patients ($p < 0.0001$). Patients who had sleep disturbance were older ($p < 0.0001$). Significant positive association was found between sleep disturbance and the number of NCD. In infectious disease, trauma, and MCH modules, the ratio of patients with sleep disturbance was lower than that in the reference group. Significant association was not found between sleep disturbance and the place of evacuation.

Multivariate analysis revealed that older age (≥ 60 , OR 16.15, $p < 0.0001$) and middle age (20-59, OR 7.44, $p < 0.0001$) are significantly more associated with sleep disturbance compared to the young age (0-19). Female (OR 1.95, $p < 0.0001$) were significantly more prone to sleep disturbance than men. Evacuation center (OR 1.36, $p = 0.159$) and welfare facility (OR 1.63, $p = 0.286$) residence are risk factors compared to living in one's own home. If the patient had two or more diagnoses of NCD, the risk of sleep disturbance was high (OR 1.42, $p = 0.0058$), but one NCD, infectious disease, trauma, and MCH did not have significant association with sleep disturbance.

The age distribution of patients with sleep disturbance according to the number of NCD indicates that the mean age of patients without NCD was significantly less than other groups in both sexes (Fig. 3A, B). When no NCD took place, the place of evacuation significantly affected the ratio of sleep disturbance (Fig. 4A and upper column of Fig. 4C, chi-square analysis $p < 0.01$, OR = 2.10, 95% Confidence Interval 1.03-4.27, regression analysis $p < 0.05$), but if the patients had one or more NCDs, no difference of sleep disturbance ratio was found between the evacuation center and own home (Fig. 4B and lower column of Fig. 4C). Similar result was found between own house and welfare facility (OR = 2.78, 95% Confidence Interval 1.02-7.55, regression analysis $p < 0.05$).

Sleep disturbance and other mental health issues

Of 492 patients with other mental health issues (see Fig. 1), 295 patients (60.0%) had sleep disturbance. Within the 295 patients combined with sleep disturbance, the most frequent diseases were, in order, schizophrenia, anxiety disorder, and depression/bipolar disorder (Fig. 5A). The percentage of male patients in age 40-49 was highest among all age groups. The distribution of age was shifted to younger side (Fig. 5B) compared to the whole group with sleep disturbance (see Fig. 2).

Trends of prescription timing and number of days prescribed

Actually, 3,308 prescriptions of sleeping/anti-anxiety pills were issued for 1,498 patients (Table 2). The most frequent type of administration was once a day p.o. (2,661 prescriptions) for sleep induction. Etizolam was the most prescribed benzodiazepine, followed by brotizolam, nitraz-

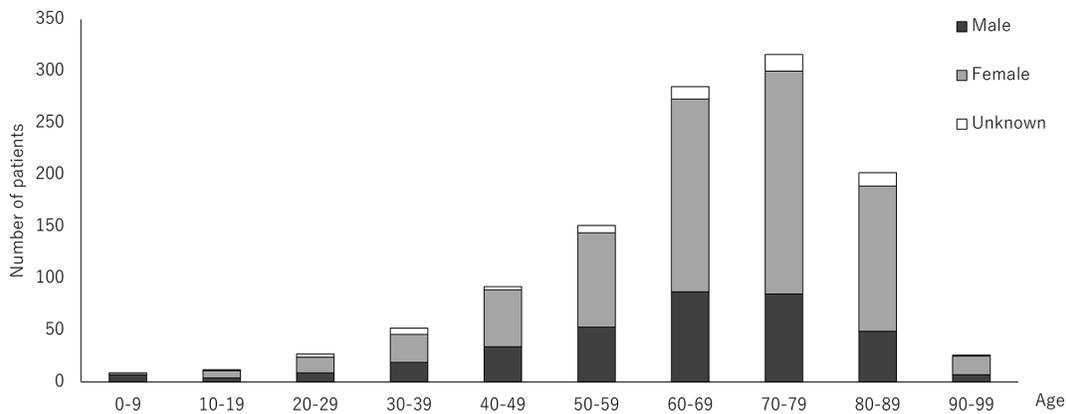


Fig. 2. Characteristics of patients with sleep disturbance ($n = 1,203$). Dark gray, male ($n = 361$); light gray, female ($n = 769$); white, unknown ($n = 73$).

Table 1. Association of risk factors and sleep disturbance ($n = 9,967$).

Variables	Number of patients (%)	Sleep disturbance		Univariate p value	Multi Variate OR	Multi Variate p value	95% Confidence Interval	
		(+)	(-)					
Sex	Male	4,263 (42.8%)	361 (8.5%)	3,902 (91.5%)	< 0.0001	Reference	1.67-2.29	
	Female	5,035 (50.5%)	769 (15.3%)	4,266 (84.7%)				
	Unknown	669 (6.7%)						
Age	0-19	1,472 (14.8%)	21 (1.4%)	1,451 (98.6%)	< 0.0001	Reference	4.13-13.38	
	20-59	3,702 (37.1%)	322 (8.7%)	3,380 (91.3%)				
	≥ 60	4,532 (45.5%)	829 (18.3%)	3,703 (81.7%)				
	Unknown	261 (2.6%)						
Place	Evacuation center	2,968 (29.8%)	392 (13.2%)	2,576 (86.8%)	0.2148	Reference	1.06-1.75	
	Own home	876 (8.8%)	98 (11.2%)	778 (88.8%)				
	Relatives or friend's house	166 (1.7%)	18 (10.8%)	148 (89.2%)				
	Welfare facility	232 (2.3%)	38 (16.4%)	194 (83.6%)				
	Other	2,799 (28.1%)	370 (13.2%)	2,429 (86.9%)				
	Unknown	2,926 (29.4%)						
Module	NCD	No description	2,358 (23.7%)	187 (7.9%)	2,171 (92.1%)	< 0.0001	Reference	0.70-1.16
	One diagnosis	4,673 (46.9%)	460 (9.8%)	4,213 (90.2%)				
	Two or more diagnoses	2,936 (29.5%)	556 (18.9%)	2,380 (81.1%)				
Infectious disease	No description	6,518 (65.4%)	840 (12.9%)	5,678 (87.1%)	0.0006	Reference	0.81-1.18	
	Diagnosed	3,449 (34.6%)	363 (10.5%)	3,086 (89.5%)				
Trauma	No description	9,312 (93.4%)	1,148 (12.3%)	8,164 (87.7%)	< 0.0028	Reference	0.76-1.54	
	Diagnosed	655 (6.6%)	55 (8.4%)	600 (91.6%)				
MCH issue	No description	9,932 (99.7%)	1,203 (12.1%)	8,729 (87.9%)	0.0281	Reference		
	Diagnosed	35 (0.4%)	0 (0%)	35 (100.0%)				

Number of patients (%). Patients without sex, age or place information were respectively regarded as missing values. Percentages of unknown data are per 9,967 records.

OR, odds ratio; NCD, non-communicable disease; MCH, maternal and child health.

epam, triazolam, clonazepam, flunitrazepam, diazepam, and others. The most frequently prescribed non-benzodiazepine hypnotics was zolpidem, followed by zopiclone.

There were 536 prescriptions of multiple p.o. benzodiazepines intended for the removal of anxiety. Etizolam

was used most frequently. Several drugs were occasionally used as drip infusion, i.m. injection, and suppository for sedative purposes. Of the prescriptions, 74 (2.2%) have the drug name, but are missing the prescription type.

Fig. 6 presents trends of prescription timing and num-

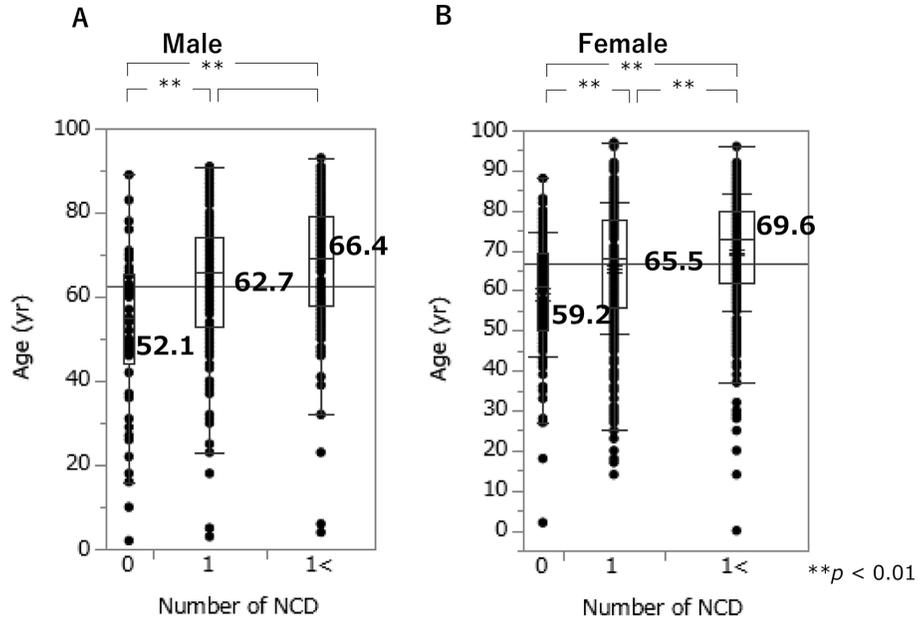


Fig. 3. Age distribution in each number of NCD by sex. Numbers indicate the mean age of each category. Bars indicate mean, 95% CI and SD. A, male patients ($n = 361$); B, female patients ($n = 769$). ** $p < 0.01$, * $p < 0.05$.

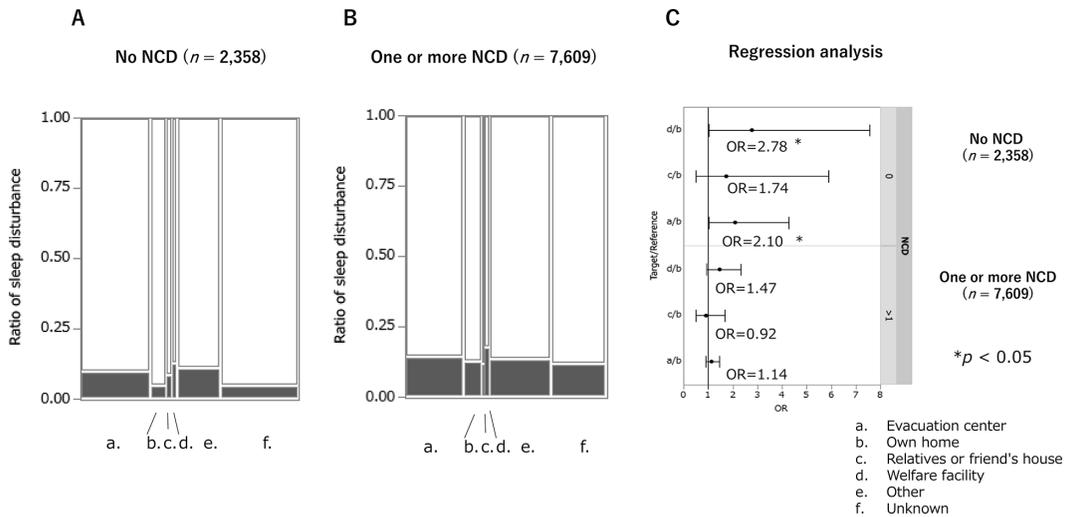


Fig. 4. Ratio of sleep disturbance by evacuation category according to the NCD description. a, evacuation center; b, own house; c, relatives, friend's house; d, welfare facility; e, other; f, unknown. A, no NCD ($n = 2,358$); B, one or more NCD ($n = 7,609$). black, patients with sleep disturbance; white, patients without sleep disturbance.

ber of days prescribed for sleeping and anxiolytic pills. As time passes, longer-term prescriptions are gradually increasing. A small peak occurred around Day 39 (April 18), associated with mental health specialized medical team from Okayama Prefecture visit to the town (Okayama Prefecture 2012) (Ministry of Health Labour and Welfare https://www.mhlw.go.jp/seisakunitsuite/bunya/hukushi_kaigo/shougaisahukushi/kokoro/shinsai/). Shorter-term prescriptions of fewer than fourteen days were used mainly in the first two weeks.

Discussion

This study is the first epidemiological analysis of sleep disturbance in a town that lost all medical facilities by GEJE. Most of the medical services were provided at evacuation centers, houses, and places other than medical facilities. Anonymized DMRs are the only primary records for statistical analyses of such medical needs after GEJE (Suda et al. 2019). We specifically examined risk factors and drug treatments of sleep disturbance of the affected people in

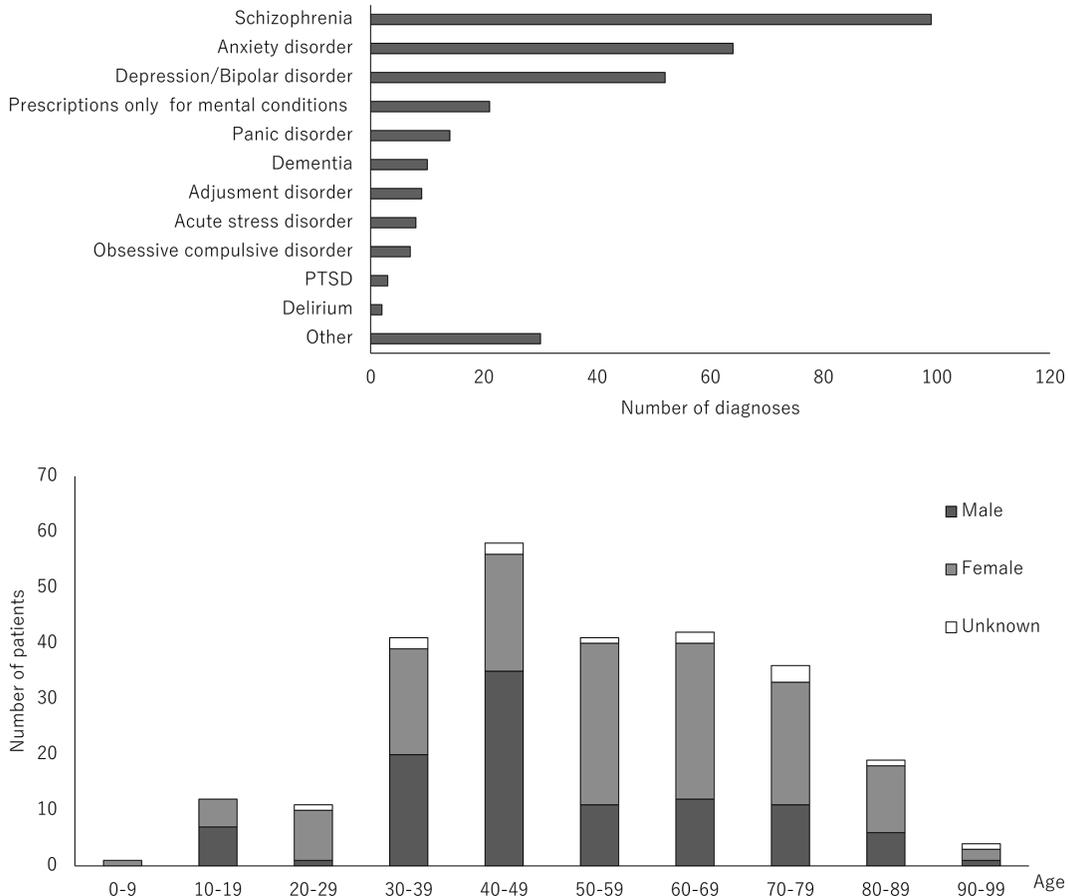


Fig. 5. Other mental health issues in addition to sleep disturbance.
 A: Diagnosis of other mental health issues in addition to sleep disturbance ($n = 295$). Individual patient might have multiple diagnoses. Diagnosis can be temporary or preliminary because of disaster aftermath. PTSD, post-traumatic stress disorder.
 B: Characteristics of Patients with other mental health issues in addition to sleep disturbance ($n = 295$) dark gray, male ($n = 114$); light gray, female ($n = 158$); white, unknown ($n = 23$).

Minamisanriku Town. Accurate diagnosis of insomnia was impossible. Therefore, we used “sleep disturbance” to represent the symptoms. We regarded patients who received prescriptions of sleeping or anxiolytic pills as having “sleep disturbance.” Results revealed 295 patients (60.0%) with sleep disturbance out of 492 patients with other mental health issues, and 1,203 patients (12.1%) within the remaining 9,967 patients in Minamisanriku Town.

Sex and age as risk factors

Results of several studies suggest that women and older people need specific strategies because they are mentally vulnerable to situations such as disasters. Onose et al. (2017) described that women are significantly more susceptible to PTSD. A strong risk factor associated with the development of PTSD is past or current sleep medication in patients with CVD of both sexes. In the present study, being female was found to be a significant risk factor of sleep disturbance (OR 1.95, $p < 0.0001$). The age group of 60 and older has the highest risk (OR 16.15), followed by the age group of 20-59 (OR 7.44). Older age women might

have past sleep medication and tend to request continued medication.

It is difficult to say that men were not adversely affected after the disaster. The post-disaster situation presented possibilities for women to consult doctors easily: men might have refrained from consulting a doctor. In terms of modes of stress response systems, sex differences are expected to exist. Overall, women can be expected to respond to stress better than men do (Bangasser et al. 2014). Consequently, sex-based approaches and mental health care targeting sleep disturbance are important to reduce PTSD and NCD burdens after a disaster.

Place of evacuation as a risk factor

Housing types were associated with alcohol consumption after GEJE (Murakami et al. 2017). Some earlier studies demonstrated that social factors such as places in which patients live, incomes, jobs, and losses of family or friends were related to sleep disturbance (Matsumoto et al. 2015; Kawano et al. 2016). Shelter crowding is known to be associated with sleep disturbance (Kawano et al. 2016).

Table 2. Drugs and types of prescription.

Once a day or single use (p.o.)		Multiple times a day (p.o.)		Other type of prescription (d.i.v., i.m., injection, suppository, doctor order, etc.)			
Etizolam (B)	910	Etizolam (B)	285	Diazepam (B)	18		
Brotizolam (B)	524	Clotiazepam (B)	70	Hydroxyzine pamoate (H)	15		
Zolpidem (NB)	416	Diazepam (B)	66	Brotizolam (B)	2		
Nitrazepam (B)	167	Alprazolam (B)	54	Etizolam (B)	1		
Zopiclone (NB)	167	Cloxacolam (B)	17	Nitrazepam (B)	1		
Triazolam (B)	119	Lorazepam (B)	13	Dose and type missing	74		
Clotiazepam (B)	80	Other	31				
Flunitrazepam (B)	66						
Diazepam (B)	53						
Ethyl loflazepate (B)	53						
Rilmazafone (B)	45						
Alprazolam (B)	25						
Lorazepam (B)	12						
Other	24						
Total	2,661	Total	536			Total	111

Generic name and number of prescriptions. Total 3,308 prescriptions of sleeping/anti-anxiety pills were issued for 1,498 patients. A patient might receive multiple prescriptions. Drugs with fewer than 10 prescriptions were included in Other. B, benzodiazepines; NB, non-benzodiazepines; H, histamine receptor antagonist.

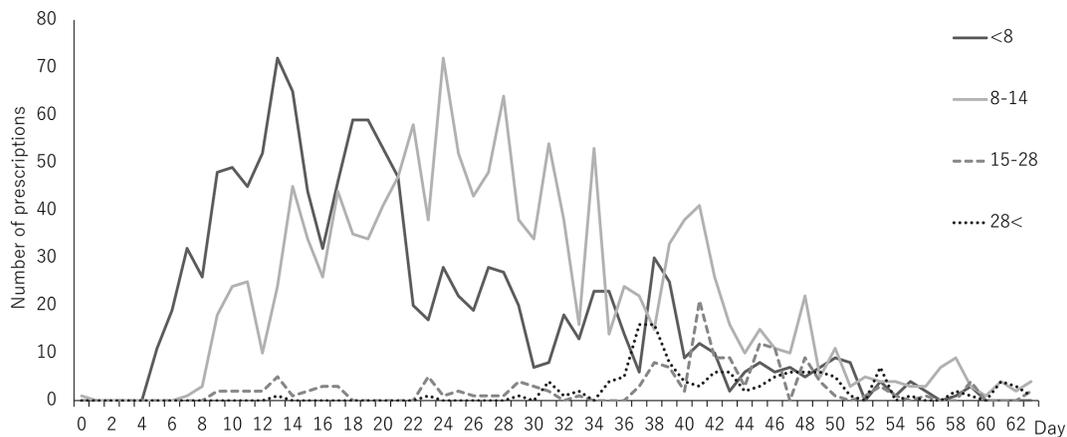


Fig. 6. Trend of prescription timing and the number of days prescribed sleeping and anti-anxiety pills. March 11 as Day 0.

Individual patients might receive short-term or medium-term prescriptions repeatedly.

dark gray line, prescription for less than 8 days; light gray line, prescription for 8-14 days; dashed line, for 15-28 days; dotted line, for more than 28 days.

Our study also indicated evacuation centers as independent risk factors of sleep disturbance (OR 1.36). Interestingly, the evacuation center was a risk factor for patients with sleep disturbance especially in a younger population without NCD compared to the people staying in their own homes (Table 1, Figs. 3, 4A, C). At the same time, the sleeping disturbance ratio for patients with NCD were not different between those residing at an evacuation center and at their own homes (Fig. 4B). Staying in welfare facility also can be a risk factor of sleep disturbance in the population without NCD (Fig. 4A, C). We did not find sta-

tistical difference of age of patients between evacuation center and own house, nor welfare facility and own house regardless of presence of NCD (data not shown) suggesting that welfare facility was used as an evacuation center. These results suggest that aside of high-risk groups, surveillance of sleep disturbance in younger and healthier population especially in evacuation centers and providing psychosocial and medical support is crucially important.

Sleep disturbance and other mental health issues

Our results suggest a strong association between sleep

disturbance and other mental health issues (Figs. 1, 5A). Some patients obtained prescriptions as a continuation of past prescriptions of sleeping or anxiolytic pills. It was not possible to analyze statistically whether the patients received those pills with or without appropriate diagnoses. The usage of sleeping pills or anxiolytic pills by patients with psychiatric diseases such as schizophrenia or bipolar disorder should be managed carefully by experts, even after a disaster. According to Ministry of Health, Labour and Welfare (https://www.mhlw.go.jp/seisakunitsuite/bunya/hukushi_kaigo/shougaihashukushi/kokoro/shinsai/), the total number of responders engaged in mental health care was 3,504 people, 57 teams until March 2012. Consequently, urgent needs of specialized support for psychiatric patients and psychiatric hospitals established the disaster psychiatric assistance team (DPAT) in 2013 as a measure for national preparedness for future disasters (Kawashima 2017; Takahashi et al. 2020).

Sleep disturbance is a natural human response after disaster. It is known to be a risk factor for PTSD (Onose et al. 2015, 2017; Miller et al. 2017). Anxiety disorder is a broad concept characterized by feelings of anxiety and fear. Anxiety disorder might include PTSD, panic disorder, adjustment disorder, acute stress disorder, and obsessive compulsive disorder. Sleep disturbance might exacerbate these symptoms.

Other comorbidities and sleep disturbance

Multivariate analysis showed only number of NCDs affect the sleep disturbance (OR 1.42, $p = 0.0058$, Table 1). However, Fig. 3 depicts that patients with sleep disturbance without NCD were younger than such patients with NCDs, irrespective of sex. Fig. 4 suggests that patients without NCD had higher risk when they resided in an evacuation center or welfare facility. However, when the patients had NCD, no significant difference was found by place of evacuation. The association of specific diseases and sleep disturbance should be investigated further because the possibility exists of a lack of correct diagnosis for the respective diseases.

In addition to the direct loss of the medications themselves, Nakaya pointed out that psychological distress attributable to the disaster (Nakaya et al. 2017): it disturbed the regular intake of medication for chronic diseases. For patients, both disaster experiences and medication losses after the disaster can be expected to have contributed to stress. Consequently, patients might develop sleep disturbances. It is therefore important to continue medications for patients with NCD. Patients with NCD might readily consult a doctor because they already understood their diseases and symptoms better than people without diseases. In a systematic review of the humanitarian response literature, Rifkin et al. (2018) pointed out that sleep loss in extreme temperatures and weather by climate change or disasters can be a strong contributor to NCD burdens. They emphasized the importance of sleep health as part of the humani-

tarian response.

In multivariate analysis, patients with infectious disease (OR 0.98) and trauma (OR 1.08) module did not have significant risk of sleep disturbance. Musculoskeletal pain is also known to be associated with sleep disturbance (Yabe et al. 2018). However, we included orthopedic issues without injury into the NCD module.

No significant association was found between sleep disturbance and MCH issues. Even if pregnant women and infants were unable to sleep well, the medical teams would not provide sleep medication. However, pregnant and nursing women might experience severe stress from the crisis that can affect pregnancy and the mothers' and infant's health.

Treatment of sleep disturbance

Benzodiazepines and non-benzodiazepines were frequently used both for sleep induction and for reducing anxiety. Results revealed many types of drugs and their administration. Of 3,308 prescriptions, most were for once-a-day administration ($n = 2,661$, 80.4%) that would be used for sleep induction. Mostly, benzodiazepines were used. Zolpidem was the most frequently used among the non-benzodiazepines. According to clinical guidelines, zolpidem improved short-term outcomes for adults with insomnia, but the comparative effectiveness and long-term efficacy of pharmacotherapies for insomnia are not known (Wilt et al. 2016).

Some benzodiazepines were administered three times each day for anxiolytic purposes that might improve the sleep conditions. Etizolam was the most frequently used drug both once-a-day and three times-a-day administration (Table 2), suggesting that it was used both for sleep induction and anxiolysis. After introduced in Japan, etizolam has been administered commonly for patients who have muscular stiffness and sleep disturbance from anxiety. Etizolam has stronger sleep induction, stronger anxiolysis, moderate muscle relaxation and short time duration. Chronic use of etizolam can induce tolerance, withdrawal symptoms and dependence. The combination of alcohol and etizolam accelerates the induction of tolerance (Altamura et al. 2013). For sleeping induction, brotizolam and zolpidem were frequently used next to etizolam. Brotizolam is a benzodiazepine with short peak time with moderate muscle relaxation. Actually, zolpidem is a non-benzodiazepine with short peak time without muscle relaxation. Both drugs are used commonly in Japan. Melatonin antagonist became available in Japan in 2010, but only one patient was prescribed it as a continuation of past prescription. Orexin antagonist was not available in 2011 (available after 2014). The choice of drug depends mainly on the availability and the doctor's decision at the service site. The Japanese Association of Disaster Medicine (JADM) recommends an essential drug list for use in work in affected areas in the acute phase up to 10 days. It includes diazepam, brotizolam, and etizolam as sleeping or anxiolytic pills (JADM

2019).

The number of days prescribed tends to be longer in the later phase, possibly because of the recovery of supply systems. Although prescription for longer periods according to the request of patients is unavoidable, guidelines (Wilt et al. 2016) recommend refraining from using longer-term medications for sleep disturbance to the greatest degree possible because sleeping pills are associated with dementia, fractures and major injuries, especially in older patients.

Cognitive behavioral therapy for insomnia (CBT-i) is an effective treatment for chronic sleep disturbance (Trauer et al. 2015), but we were unable to find descriptions in DMRs, whether health care workers used such behavioral therapy in post-disaster situations. After the 1995 Great Hanshin Awaji Earthquake, the mental health of affected people attracted the attention of health responders in Japan, particularly addressing the development and treatment of PTSD and prevention of long-term isolation of older persons. As a standard concept of psychological intervention after a disaster (World Health Organization 2011; Shultz and Forbes 2014), Psychological First Aid (PFA) emphasizes the importance of routine sleeping (not sleeping all day), getting support from a trusted person if the affected person has trouble sleeping, and refraining from drinking much alcohol because of upsetting thoughts or memories, nervous feeling or extreme sadness about the event. The National Center for Neurology and Psychiatry developed the national guidelines for the community mental health treatment in disasters, which stated that most psychological symptoms after disasters are natural common and transient reactions, that psychological debriefing was not proven to be effective for the future prevention of PTSD, and that PFA was the most recommended psychosocial counter measure immediately after a disaster (Kim 2011). Isolation is associated with age-related disorders such as sleep disturbance (Cacioppo et al. 2002). Enrichment of social capital is the key action to prevent the isolation. Continuous care and behavioral therapy for sleep disturbance should be coordinated with the psychosocial supporters and local healthcare providers.

Limitation

This study has several limitations. The study design was a cross-sectional research based on anonymized DMRs. Therefore, we were unable to verify the causal relationship between sleep disturbance and other physical or mental outcomes. Because of selection bias, this study cannot estimate the prevalence of sleep disturbance in the whole population of Minamisanriku Town. No epidemiological study has explored the prevalence of sleep disturbance before disaster. Moreover, it is difficult to find out when the patients developed sleep disturbance.

Because of anonymity, relief aid workers can sometimes be patients; elimination of duplication might not be perfect. Responders might have more stress and sleep dis-

turbance. Individual circumstances of disaster loss and damage are also diverse, but such information was not available.

Some information bias might affect this study. After a disaster, it must be difficult for doctors to write DMRs precisely. DMRs are not showing all information from patients. Some DMRs lack information related to background data, symptoms, and treatments. Close to 30% of DMRs lacked the precise information on the place of evacuation. Doctors would make treatment decisions on based on patient-reported sleep problems. Prescriptions can be a simple continuation of past prescriptions. Evaluation of outcomes and continuation of treatments are almost impossible because of the nature of DMRs.

Conclusion

Sleep disturbance, the major component of mental health issues after disasters, affects 60.0% of patients with other mental health issues and 12.1% of remaining patients seeking care. Older age, being female, and residence at an evacuation center were identified as independent risk factors. Patients reporting other mental health issues frequently showed association with sleep disturbances that require specific treatments. A population with younger age consulted physicians solely because of sleep disturbance compared to patients with other comorbidities. In addition to addressing the needs of high-risk groups, it is important to survey sleep disturbance in younger and healthier populations and to provide psychosocial and medical support.

Acknowledgments

This study is partly supported by JSPS KAKENHI Grant Number 17H00840, 17H06108, Grant-in-Aid from Pfizer Health Research Foundation, the Joint Usage / Research Center, "Research Center for Zoonosis Control, Hokkaido University from the Ministry of Education, Culture, Sports, Science, and Technology of Japan (MEXT) and Alumni of Pancreatic Surgeons of Tohoku University (Suigetsukai). We appreciate Nurse Head of Shizugawa Hospital (current Minamisanriku Hospital), Ms. Aiko Hoshi for suggesting the usage of prehospital disaster medical records.

We truly appreciate Hiroe Terakawa, Mari Sato, Risa Fujiwara, Hirotsugu Kawasaki and Yo Chida for their technical assistance.

Conflict of Interest

The authors declare no conflict of interest.

References

- Altamura, A.C., Moliterno, D., Paletta, S., Maffini, M., Mauri, M.C. & Bareggi, S. (2013) Understanding the pharmacokinetics of anxiolytic drugs. *Expert Opin. Drug Metab. Toxicol.*, **9**, 423-440.
- Bangasser, D.A. & Valentino, R.J. (2014) Sex differences in stress-related psychiatric disorders: neurobiological perspectives. *Front. Neuroendocrinol.*, **35**, 303-319.

- Cacioppo, J.T., Hawkley, L.C., Crawford, L.E., Ernst, J.M., Burleson, M.H., Kowalewski, R.B., Malarkey, W.B., Van Cauter, E. & Berntson, G.G. (2002) Loneliness and health: potential mechanisms. *Psychosom. Med.*, **64**, 407-417.
- Japanese Association for Disaster Medicine (JADM) (2019) Essential drug list for acute phase in disaster. <https://jadm.or.jp/contents/model/index.html> [Accessed: December 5, 2019] (in Japanese).
- Kawano, T., Nishiyama, K., Morita, H., Yamamura, O., Hiraide, A. & Hasegawa, K. (2016) Association between shelter crowding and incidence of sleep disturbance among disaster evacuees: a retrospective medical chart review study. *BMJ Open*, **6**, e009711.
- Kawashima, Y. (2017) Disaster psychiatric assistance team (DPAT): the present situation and future measures to address disaster psychiatry in Japan. *Prehosp. Disaster Med.*, **32**, S15.
- Kim, Y. (2011) Great East Japan Earthquake and early mental-health-care response. *Psychiatry Clin. Neurosci.*, **65**, 539-548.
- Li, X., Buxton, O.M., Hikichi, H., Haneuse, S., Aida, J., Kondo, K. & Kawachi, I. (2018) Predictors of persistent sleep problems among older disaster survivors: a natural experiment from the 2011 Great East Japan Earthquake and tsunami. *Sleep*, **1**, 41.
- Li, Y., Vgontzas, A.N., Fernandez-Mendoza, J., Bixler, E.O., Sun, Y., Zhou, J., Ren, R., Li, T. & Tang, X. (2015) Insomnia with physiological hyperarousal is associated with hypertension. *Hypertension*, **65**, 644-650.
- Matsumoto, S., Yamaoka, K., Inoue, M., Inoue, M. & Muto, S.; Teikyo Ishinomaki Research Group (2015) Implications for social support on prolonged sleep difficulties among a disaster-affected population: second report from a cross-sectional survey in Ishinomaki, Japan. *PLoS One*, **10**, e0130615.
- Matsumoto, S., Yamaoka, K., Inoue, M. & Muto, S.; Teikyo Ishinomaki Research Group & Health & Life Revival Council in the Ishinomaki district (2014) Social ties may play a critical role in mitigating sleep difficulties in disaster-affected communities: a cross-sectional study in the Ishinomaki area, Japan. *Sleep*, **37**, 137-145.
- Miller, K.E., Brownlow, J.A., Woodward, S. & Gehrman, P.R. (2017) Sleep and dreaming in posttraumatic stress disorder. *Curr. Psychiatry Rep.*, **19**, 71.
- Murakami, A., Sasaki, H., Pascapurnama, D.N. & Egawa, S. (2018) Noncommunicable diseases after the Great East Japan Earthquake: systematic review, 2011-2016. *Disaster Med. Public Health Prep.*, **12**, 396-407.
- Murakami, A., Sugawara, Y., Tomata, Y., Sugiyama, K., Kaiho, Y., Tanji, F. & Tsuji, I. (2017) Association between housing type and gamma-GTP increase after the Great East Japan Earthquake. *Soc. Sci. Med.*, **189**, 76-85.
- Nakaya, N., Nakamura, T., Tsuchiya, N., Narita, A., Tsuji, I., Hozawa, A. & Tomita, H. (2017) Psychological distress and the risk of withdrawing from hypertension treatment after an earthquake disaster. *Disaster Med. Public Health Prep.*, **11**, 179-182.
- Okayama Prefecture (2012) Report of mental health care team activity at Great East Japan Earthquake. <http://www.pref.okayama.jp/page/detail-95480.html> [Accessed: October 2019] (in Japanese).
- Onose, T., Nochioka, K., Sakata, Y., Miura, M., Tadaki, S., Ushigome, R., Yamauchi, T., Sato, K., Tsuji, K., Abe, R., Miyata, S., Takahashi, J. & Shimokawa, H.; CHART-2 Investigators (2015) Predictors and prognostic impact of post-traumatic stress disorder after the Great East Japan Earthquake in patients with cardiovascular disease. *Circ. J.*, **79**, 664-667.
- Onose, T., Sakata, Y., Nochioka, K., Miura, M., Yamauchi, T., Tsuji, K., Abe, R., Oikawa, T., Kasahara, S., Sato, M., Shiroto, T., Miyata, S., Takahashi, J. & Shimokawa, H.; CHART-2 Investigators (2017) Sex differences in post-traumatic stress disorder in cardiovascular patients after the Great East Japan Earthquake: a report from the CHART-2 Study. *Eur. Heart J. Qual. Care Clin. Outcomes*, **3**, 224-233.
- Orui, M., Ueda, Y., Suzuki, Y., Maeda, M., Ohira, T., Yabe, H. & Yasumura, S. (2017) The relationship between starting to drink and psychological distress, sleep disturbance after the Great East Japan Earthquake and nuclear disaster: the Fukushima Health Management Survey. *Int. J. Environ. Res. Public Health*, **14**, pii: E1281.
- Rifkin, D.I., Long, M.W. & Perry, M.J. (2018) Climate change and sleep: a systematic review of the literature and conceptual framework. *Sleep Med. Rev.*, **42**, 3-9.
- Shultz, J.M. & Forbes, D. (2014) Psychological first aid: rapid proliferation and the search for evidence. *Disaster Health*, **2**, 3-12.
- Suda, T., Murakami, A., Nakamura, Y., Sasaki, H., Tsuji, I., Sugawara, Y., Hatsugai, K., Nishizawa, M. & Egawa, S. (2019) Medical needs in Minamisanriku Town after the Great East Japan Earthquake. *Tohoku J. Exp. Med.*, **248**, 73-86.
- Takahashi, S., Takagi, Y., Fukuo, Y., Arai, T., Watari, M. & Tachikawa, H. (2020) Acute mental health needs duration during major disasters: a phenomenological experience of Disaster Psychiatric Assistance Teams (DPATs) in Japan. *Int. J. Environ. Res. Public Health*, **17**, pii: E1530.
- Trauer, J.M., Qian, M.Y., Doyle, J.S., Rajaratnam, S.M. & Cunnington, D. (2015) Cognitive behavioral therapy for chronic insomnia: a systematic review and meta-analysis. *Ann. Intern. Med.*, **163**, 191-204.
- Wilt, T.J., MacDonald, R., Brasure, M., Olson, C.M., Carlyle, M., Fuchs, E., Khawaja, I.S., Diem, S., Koffel, E., Ouellette, J., Butler, M. & Kane, R.L. (2016) Pharmacologic treatment of insomnia disorder: an evidence report for a clinical practice guideline by the American College of Physicians. *Ann. Intern. Med.*, **165**, 103-112.
- World Health Organization (2011) Psychological first aid: Guide for field workers. https://apps.who.int/iris/bitstream/handle/10665/44615/9789241548205_eng.pdf;jsessionid=B67C9BBE52D35DED38375B56084973C0?sequence=1 [Accessed: November 11, 2019]
- Yabe, Y., Hagiwara, Y., Sekiguchi, T., Sugawara, Y., Tsuchiya, M., Koide, M., Itaya, N., Yoshida, S., Sogi, Y., Yano, T., Tsuji, I. & Itoi, E. (2018) Sleep disturbance is associated with new onset and continuation of lower back pain: a longitudinal study among survivors of the Great East Japan Earthquake. *Tohoku J. Exp. Med.*, **246**, 9-14.