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Associations of socioeconomic factors after a disaster with cardiovascular related symptoms: the Fukushima Health Management Survey

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Abstract

Objective: To investigate the association between socioeconomic factors and the exacerbation of cardiovascular symptoms among evacuees after Great East Japan Earthquake.

Methods: A total of 73,433 subjects were included in the Fukushima Health Management survey. Exacerbation of headache, dizziness, palpitations, and shortness of breath were determined from self-report questionnaires. Socioeconomic factors included living arrangement, loss of employment and decreased income. Odds ratios (OR) and 95% confidence intervals (CI) of socioeconomic factors were estimated for each symptom using multiple logistic regression analyses.

Results: A total of 1,375 individuals reported exacerbation of headache, 881 of dizziness, 768 of palpitations, and 434 of shortness of breath. Evacuation accommodation was associated with all the above symptoms. Compared to participants living in their own home (OR=1.00), subjects living in relatives' homes had increased odds of experiencing exacerbation of headache (1.58; 95% CI 1.20–2.09) and dizziness (1.43; 95% CI 1.02–1.98); subjects living in temporary housing or apartments showed exacerbation of headache (1.55; 95% CI 1.32–1.81), dizziness (1.45; 95% CI 1.20–1.76), palpitations (1.25; 95% CI 1.03–1.51), and shortness of breath (1.75; 95% CI 1.35–2.27); subjects living in evacuation shelters showed exacerbation of headache (1.80; 95% CI 1.10–2.97); and refugees living in temporary housing showed exacerbated headache (1.42; 95% CI 1.15–1.75), dizziness (1.39; 95% CI 1.08–1.78), and shortness of breath (1.50; 95% CI 1.07–2.09). Compared to the evacuees that retained their jobs, unemployed subjects showed increased odds for exacerbation of headache (1.28, 95% CI 1.12–1.46), dizziness (1.26, 95% CI 1.07–1.48), and

palpitations (1.22, 95% CI 1.02–1.46). Decreased income was associated with exacerbation of headache (1.39, 95% CI 1.21–1.60).

Conclusion: After the earthquake, living in non-home conditions was more likely to exacerbate cardiovascular symptoms among evacuees. Loss of employment was another risk factor for exacerbated headache and dizziness.

Keywords: Great East Japan Earthquake, socioeconomic factors, cardiovascular related symptoms

Strengths and limitations of this study

- We examined the associations of socioeconomic factors after a disaster with cardiovascular related symptoms among evacuees of the number of 73,433 subjects after the Great East Japan earthquake.
- Our study is the first to identify an inverse relationship between low socioeconomic status and exacerbated cardiovascular symptoms from an evacuee self-report after a disaster.
- A limitation of the present study was an overall response rate was low (40.7%) and data may have contained sampling biases.
- Another limitation of the present study should be that the information of changes in family relationships (e.g., death, physical separation) among the evacuees after the disaster has not been captured.
- In addition, most questionnaires were collected in the same period (from Jan 2012 to Mar 2012).

Introduction

The Great East Japan Earthquake and the subsequent Fukushima Daiichi nuclear disaster, which occurred in March 2011, was the most destructive catastrophe in Japan to date. Due to concerns over released radiation, most of the residents in nearby towns were forced to evacuate and consequently suffered long-lasting anxiety. Shortly after the disaster, a Fukushima Health Management Survey was conducted to investigate the effects of long-term low-dose radiation exposure caused by the accident and to assess the physical and mental wellbeing of evacuees. This survey included a basic survey, which estimated individual radiation exposure of each resident, and four detailed surveys comprising of a Comprehensive Health Check and thyroid ultrasonography, a mental health and lifestyle survey, and a survey of pregnant women and nursing mothers (1). The Mental Health and Lifestyle Survey used self-report questionnaires to investigate health status and lifestyle of the refugees, including nutrition and diet, perceived symptoms of illness, disaster-related experience, and socioeconomic determinants.

Several previous studies have shown changes in the incidence of cardiovascular events following disasters; however, results are conflicting (2-11). A recent study reported a heterogeneous occurrence of cardiovascular events after the Great East Japan Earthquake (2), while another study reported a significant increase in the incidence of cardioembolic stroke after the earthquake (11). However, neither study examined the incidence of perceived cardiovascular disease symptoms after a disaster, nor did they focus on the effect of refugee socioeconomic status on health problems during their evacuation term. However, considering these aspects is relevant for

reviewing refugee health status, accessing the incidence of various diseases, and providing health guidelines for refugees.

Consequently, we conducted the present study to investigate the risk factors of perceived cardiovascular symptoms following a major disaster. We hypothesized that a decrease in socioeconomic status due to the earthquake would be associated with exacerbated cardiovascular symptoms among evacuees.

Methods

Participants

The primary purpose of the Fukushima Health Management Survey was to monitor the long-term health and lifestyle of Fukushima residents and to provide them with appropriate care (12). The Fukushima Health Management Survey consists of a basic survey and four detailed surveys, namely, the thyroid ultrasound examination, comprehensive health check, mental health and lifestyle survey, and pregnancy and birth survey (for details of these surveys see (1)). The subjects of mental health and lifestyle survey was included in the present study. Briefly, the target population, consists of 210,189 officially registered victims of the Great East Japan Earthquake from the 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 were sent out with 73,569 questionnaires returned with responses, i.e. a response rate of 40.7%. Among the responders, 136 were excluded due to blank or duplicated questionnaires and 9,245 for questionnaires filled in by a proxy. After

exclusion, the data of 73,433 subjects (32,301 men and 41,132 women) were used in our analyses.

The study protocol was approved by the Ethics Committee of Fukushima Medical University. Participants who returned the self-administered questionnaires were considered to have consented to participate.

Data collection and measurement

A questionnaire was used to broadly investigate the health status and lifestyle of the refugees. The exacerbation of headache, dizziness, palpitations, and shortness of breath was determined based on self-reports in the questionnaire. All subjects were asked to answer the question 'Do you have the following perceived symptoms after the earthquake?' and could choose between the replies 'No', 'Yes', and 'Exacerbation'. In the present study we focused on reports of 'exacerbation'.

To evaluate Posttraumatic Stress Disorder (PTSD) symptoms we used the non-military version of the Posttraumatic Stress Disorder Checklist (PCL-S) (12). This is a 17-item self-report checklist based on the Diagnostic and Statistical Manual of Mental Disorders (4th edition, DSM-IV) criteria (13), with each item rated using a Likert-type scale from one ('not at all') to five ('extremely'). Respondents were requested to respond to questions about each PTSD symptom separately and report whether they had experienced a given symptom during the past month. Based on summing the scores from each of the 17 items, a total PCL-S score can range from 17 to 85 (12).

In addition to the PCL-S checklist, the following items were included in the self-assessment and self-report questionnaires:

1. Demographic characteristics

Demographic subject characteristics include gender, age group, mental health status, history of mental illness, incidence of PTSD symptoms, smoking and drinking habits, and current physical activity levels. Age groups were divided into childbearing age (20–49 years), middle age (50–64 years), and old age (65 years and above).

Mental health status, and specifically incidence and severity of depression, was measured by the Japanese version of the K6 Kessler Psychological Distress Scale, which has been validated by previous studies (14, 15). In the K6 assessment, participants were asked if they had experienced any of the following six symptoms during the past 30 days: feeling so depressed that nothing could cheer them up, feeling that everything was an effort, or feeling nervous, hopeless, restless, fidgety, or worthless. Each question was rated on a 5-point Likert-type scale from zero (none of the time) to four (all of the time), with higher scores signifying worse mental health status (total range: 0–24) (12). In addition, we assessed participant's history of mental illness by self-report as 'yes' or 'no'.

We obtained data on smoking and drinking habits using the following metrics, respectively: 'non-smoker', 'ex-smoker', or 'current smoker'; and 'once or more per month', 'less than once per month', or 'ex- drinker'. Participants had four options to assess current physical activity level: 'every day', '2-4 times/week', 'once a week', or 'nearly none'.

2. Socioeconomic variables

Participants were required to select from six options regarding their living arrangements: evacuation shelter, temporary housing, rental housing or apartment, a relative's home, their own home, and other. For analysis, evacuation shelters and

temporary housing were combined due to their similarity, and the last option was considered non-informative due to its ambiguity and thus excluded from analysis. Other socioeconomic variables included change in employment status and change in income. By answering 'Yes' to either question, the participant indicated he/she became unemployed or experienced decreased income since the disaster.

3. Disaster-related variables

Disaster-related variables included experience of the tsunami (yes or no), experience of the nuclear power plant accident (defined as hearing the explosion; yes or no), losing someone close because of the disaster (yes or no), and damage to accommodation (no, partial damage, half of accommodation destroyed, more than a half destroyed, total destruction).

Statistical analysis

The incidence of exacerbation of headache, dizziness, palpitations, and shortness of breath was compared between subjects with different demographic, socioeconomic, and disaster-related characteristics using chi-square tests. For the analyses investigating PTSD incidence, a PCL-S cut-off score of 50 was used, according to Weathers et al (16). Subjects who received a PCL-S of 50 or greater were allocated to the 'high-scoring group' and compared to the low-scoring (PCL-S < 50) group using chi-square tests.

Odds ratios (ORs) and 95% confidence intervals (CIs) of each socioeconomic determinant (living arrangement, unemployment, and decreased income) were estimated by applying multiple logistic regression models. Adjustment variables consisted of sex (male, female), age (20–49, 50–64, ≥65 years), drinking status (once or

more per month, ex-drinker, less than once per month), smoking status (non-smoker, ex-smoker, current smoker), mental health distress (K6<3, K6>=13), hypertension history (yes or no), stroke history (yes or no), heart disease history (yes or no), physical activities (>= once per day, 2–4 times per week, once per week, never), tsunami experience (yes or no), radiation experience (yes or no), damage of accommodation (no, partial, half, more than a half, total), loss of family member (yes or no).

We conducted the above analyses both for separate and combined sexes. All analyses were conducted using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

As shown in the tables, 1,893 individuals reported exacerbation of headaches, 1,229 of dizziness, 626 of palpitations, and 434 exacerbation of shortness of breath.

Demographic characteristics

Table 1 summarizes the demographic characteristics of the subjects. Exacerbation of the above cardiovascular symptoms was significantly more likely to happen in women than in men (3.5% vs. 1.4% for headaches; 2.2% vs. 1.1% for dizziness; 2.0% vs. 0.9% for palpitations; 0.9% vs. 0.8% for shortness of breath). Subjects experiencing exacerbation of headaches, dizziness, or palpitations were more likely to be young (20–49 years), while those experiencing exacerbation of shortness of breath were more likely to be old (>=65 years). Subjects experiencing exacerbation of cardiovascular symptoms were also more likely to suffer from depression (K6>=13) and Posttraumatic Stress Disorder (PCL>=50), and to commonly have a history of hypertension, stroke, or

heart disease. Non-smokers and non-drinkers were no less likely than (ex-) smokers or (ex-) drinkers to experience exacerbation of cardiovascular symptoms. However, symptom exacerbation was most pronounced in subjects who were physically active less than once a day.

Socioeconomic variables

Table 1 also shows refugees living in their own or a relative's home are less likely to experience exacerbated cardiovascular symptoms. Of the refugees living in their own home, 1.4% reported exacerbation of headache, 0.9% of dizziness, 1.6% of palpitations and 1.0% of shortness of breath. The corresponding statistics for refugees living in temporary housing and rental houses/apartments were 2.8%, 1.9%, 1.3%, and 1.2% and 3.5%, 2.1%, 1.8%, and 1.0%, respectively.

In the group that became unemployed due to the disaster, 4.2% subjects reported the exacerbation of headache, 2.5% of dizziness, 2.1% of palpitations and 1.1% of shortness of breath, while the corresponding statistics for the group that did not lose their jobs after the disaster were 2.2%, 1.5%, 1.3%, and 0.8%. In addition, exacerbation of most cardiovascular symptoms was higher in subjects whose income decreased due to the disaster compared to those who maintained income levels (3.6% vs. 2.4% for exacerbation of headache, 2.0% vs. 1.6% for exacerbation of dizziness, and 1.7% vs. 1.4% for exacerbation of palpitation).

Disaster-related variables

Subjects that directly experienced the tsunami and the nuclear power plant accident were more likely to experience exacerbated cardiovascular symptoms. Among those experiencing the tsunami, 3.2% reported exacerbation of headache, 2.2% of dizziness, 1.7% of palpitations, and 1.7% of shortness of breath, compared to 2.4%, 1.6%, 1.5%,

and 0.8%, respectively, of subjects with no experience of the tsunami. The corresponding statistics for subjects that had heard the nuclear power plant accident were 3.1%, 2.1%, 1.9%, and 1.1% compared to 2.1%, 1.2%, 1.0%, and 0.6%, that had not.

Multiple Logistic Regression analyses

Table 3 summarizes the odds ratios (ORs) and 95% CIs of each socioeconomic determinant for exacerbation of headache, dizziness, palpitations, and shortness of breath. Living arrangement emerged as a risk factor for exacerbated cardiovascular symptoms from our models, which were adjusted for multiple demographic-, health-, and disaster-related variables. Compared to participants living in their own home (OR = 1), those living in relatives' homes had higher odds to experience exacerbation of headache (1.58; 95% CI 1.20–2.09) and dizziness (1.43; 95% CI 1.02–1.98). Similarly, subjects living in temporary housing or apartments had higher odds of exacerbated headache (1.55; 95% CI 1.32–1.81), dizziness (1.45; 95% CI 1.20–1.76), palpitations (1.25; 95% CI 1.03–1.51), and shortness of breath (1.75; 95% CI 1.35–2.27). Participants living in evacuation shelters had increased odds of exacerbation of headache (1.80; 95% CI 1.10–2.97) and refugees living in temporary housing similarly had increased odds of exacerbation of headache (1.42; 95% CI 1.15–1.75), dizziness (1.39; 95% CI 1.08–1.78), and shortness of breath (1.50; 95% CI 1.07–2.09).

Loss of employment also emerged as a risk factor for increased odds of cardiovascular symptoms. Compared to the evacuees that remained employed (OR = 1), subjects that had become unemployed were at higher risk of experiencing exacerbation of headache (1.28; 95% CI 1.12–1.46), dizziness (1.26; 95% CI 1.07–1.48), and palpitation (1.22; 95% 1.02–1.46). In an unadjusted model, we found a

significant positive association between unemployment and exacerbation of palpitations; however, after adjusting for multiple relevant variables, this association became non-significant.

There was no association between decreased income and exacerbated cardiovascular symptoms, except for headache. Here, adjusting for multiple variables resulted in an increased odds ratio for exacerbation of headaches both in an analysis combining both sexes (1.39, 95% CI 1.21–1.60) and in separate analyses of men and women.

Discussion

We have demonstrated a decrease in socioeconomic status due to the earthquake was associated with exacerbated cardiovascular symptoms among evacuees of the Great East Japan Earthquake. Compared with participants living in their own home, people of both genders living in relatives' homes, evacuation shelters, temporary housing, or rental houses or apartments were more likely to experience exacerbated headache, dizziness, palpitations, or shortness of breath. Similarly, loss of employment and reduced income due to the disaster increased the risk of exacerbated symptoms.

The following three points should be considered in the context of our results. Firstly, earthquakes are definitely associated with increased cardiovascular disease, including sudden cardiac death and acute myocardial infarction (2-11), which provides some support for the present study. The Athens earthquake, the Newcastle earthquake of Australia, and the Northridge Earthquake (NEQ) of Los Angeles were all associated with increased deaths due to cardiovascular disease (4), though this increase was limited to only a few days post-disaster (4). Increased cardiovascular disease subsequent to the

Hanshin-Awaji earthquake persisted for more than a month. In addition, an increase in the number of subjects with acute myocardial infarction, especially in women, was particularly evident during the first 4 weeks post-disaster (10). After the Great East Japan Earthquake, the incidence of reported cardioembolic stroke increased in the first 3–9 months following the disaster (11), as did the incidence of heart failure and other cardiovascular diseases (6). Our study contributes to the reported incidences of cardiovascular disease by demonstrating exacerbated cardiovascular symptoms among evacuees after a disaster from self-report questionnaires rather than from death certificates.

Secondly, increases in cardiovascular events and exacerbated cardiovascular symptoms can be attributed to post-disaster distress or mental problems. A review suggests that extremely stressful experiences, such as earthquakes, can trigger cardiovascular events (17-19). Acute major stress and chronic stress, i.e. the cumulative load of minor daily stress, can have both long-term consequences, which can be perceived as stressful and a potential threat to one's environment, subsequently inducing a variety of negative emotional responses, such as fear, anxiety, sadness, anger, hostility, and depression (5,20) leading to hypertension or cardiovascular events (17-19). In the current study, all subjects exhibiting exacerbated cardiovascular symptoms were more likely to have depression (K6>=13) or Posttraumatic Stress Disorder (PCL>=50). Logistic regression analyses also showed that depression and Posttraumatic Stress Disorder were both independently associated with exacerbated cardiovascular symptoms (data not shown).

Thirdly, although post-disaster increases in cardiovascular events were widely reported in previous studies, the investigation of socioeconomic determinants of these

events during the evacuation term of refugees was very limited. Previous studies reported that one year after the Wenchuan Earthquake in China, depression severity among refugees varied with income, housing status, and social support (21), indicating that earthquake impact on income was indirectly associated with life satisfaction and depression via its effect on financial status (22). Another study showed that six months after the 2011 Christchurch earthquake in New Zealand, on average lower income per home contributed unequivocally to earthquake-related distress and dysfunction (23).

In the present study, not living in the own home but living in evacuation shelters or temporary housing, was associated with exacerbation of all examined cardiovascular symptoms, which was more robust in women than in men. Evacuation shelters and temporary housing were less spacious, damper, and less comfortable than the refugees' homes. Due to insufficient access to supermarkets or shortages of cooking equipment and utilities, such as gas, evacuees living in shelters would struggle to access balanced meals. A recent cross-sectional study showed a well-balanced diet was associated with better living conditions among refugees after the Great East Japan Earthquake, whereas imbalanced diets, particularly with regard to meat content, were not (24). In addition, having to take refuge in accommodation other than the own home meant that the own neighborhood had been damaged by the disaster, which may lead to shortness of social support. In addition, among the refugees. All of the above factors can be considered predictors of stress among refugees, where women may be more likely to be influenced than men.

Unemployment and decreased income due to the disaster were also associated with exacerbation of some cardiovascular symptoms. These results were expected as poor economic circumstances are expected to exacerbate depression. Low income may be

considered a chronic stressor, increasing psychological distress as a result of limited resource access and opportunities for resource accumulation (23). Previous studies also showed that, following an earthquake, living in a low-income area may contribute to greater psychological distress due to lack of occupational, social, and financial resources. A community study showed that, after the Christchurch earthquake, low household income contributed strongly to earthquake-related distress (23). In the present study, we found a significant association between disaster-related unemployment and exacerbation of some cardiovascular symptoms, but the subsistence allowance provided to refugees by the Japanese government may have reduced effect size by reducing the impact of lowered economic circumstances on refugees.

Our understanding of disaster-related stress on cardiovascular disease remains incomplete. A clinical study on the 1995 Hanshin-Awaji earthquake comparing pre- and post- BP levels in well-controlled hypertension patients showed an increase of 18mmHg in diastolic blood pressure two weeks after the earthquake (25). Although white-coat hypertension contributed partly to the results, whereby patients exhibit increased blood pressure in clinical settings, some patients developed sustained hypertension that persisted for one year after the earthquake (25). One study found increased levels of cholesterol and triglycerides a few weeks after an earthquake (3), whereas other studies failed to show significantly higher total cholesterol or HDL-cholesterol during the first two weeks after the Hanshin-Awaji earthquake (7). Therefore, the extent to which changes in blood lipid profile contributes to exacerbated cardiovascular symptoms several months after the Great East Japan Earthquake remains undetermined. Chronic psychological stress is also associated with increased insulin resistance (5). A recent

study after the Great East Japan Earthquake found the negative effects of the disaster on metabolic factors were greater among evacuees than non-evacuees (26), which may contribute to exacerbated cardiovascular symptoms among evacuees.

The large scale of assessment and assessment under post-disaster conditions provide considerable authority for the present study. In addition, our study is the first to identify an inverse relationship between low socioeconomic status and exacerbated cardiovascular symptoms from an evacuee self-report after a disaster; our results will be useful for generating guidelines for evacuee health. However, the following study limitations should be considered: Firstly, the overall response rate was low (40.7%) and data may have contained sampling biases. Secondly, under the extraordinary and unusual social circumstances that follow a major disaster, health symptoms perceived by evacuees may be strongly influenced by changes in family relationships (e.g., death, physical separation) among the evacuees. However, the present study did not capture this information. The potential associations observed in this study will be investigated over an extended period. Thirdly, although most questionnaires were collected in the same period (from Jan 2012 to Mar 2012), it is possible the timing of the survey affected the perceived cardiovascular symptoms.

In conclusion, the present study was the first to identify a relationship between lower socioeconomic status due to the earthquake with exacerbated cardiovascular symptoms among evacuees after the Great East Japan Earthquake. Our findings will inform future periodic health examinations and health guidelines for evacuees.

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Contributors

WZ and TO designed the study. TO, SY, MM, MH. NH, YS, HY, MH, HT and AO were responsible for the data collection and overseeing study procedures. The analyses was conducted by WZ and TO. The manuscript was made by WZ. All the authors did contribution to the revision of the manuscript. All the authors read and approved the final version of the manuscript.

Declaration of interests

We declare that we have no competing interests.

Patient consent

Obtained.

Data sharing statement

No additional data are available.

References

1. Yasumura S, Hosoya M, Yamashita S, Kamiya K, Abe M, Akashi M, Kodama K, Ozasa K; Fukushima Health Management Survey Group. Study protocol for the Fukushima Health Management Survey. J Epidemiol. 2012; 22: 375-383.

2. Nozaki E, Nakamura A, Abe A, Kagaya Y, Kohzu K, Sato K, Nakajima S, Fukui S, Endo H, Takahashi T, Seki H, Tamaki K, Mochizuki I. Occurrence of cardiovascular events after 2011 Great East Japan Earthquake and tsunami disaster. Int Heart J. 2013; 54: 247-253.

3. Trevisan M, Celentano E, Meucci C, Farinaro E, Jossa F, Krogh V, Giumetti D, Panico S, Scottoni A, Mancini M. Short-term effect of natural disasters on coronary heart disease risk factors. Arteriosclerosis. 1986; 6: 491-494.

4. Kloner RA, Leor J, Poole WK, Perritt R. Population-based analysis of the effect of the Northridge Earthquake on cardiac death in Los Angeles County, California. J Am Coll Cardiol. 1997; 30:1174-1180.

5. Kario K, McEwen BS, Pickering TG. Disasters and the heart: a review of the effects of earthquake-induced stress on cardiovascular disease. Hypertens Res. 2003; 26:355-367.

6. Kario K, Matsuo T, Kayaba K, Soukejima S, Kagamimori S, Shimada K. Earthquake-induced cardiovascular disease and related risk factors in focusing on the Great Hanshin-Awaji Earthquake. J Epidemiol. 1998; 8:131-139.

7. Kario K, Matsuo T. Increased incidence of cardiovascular attacks in the epicenter just after the Hanshin-Awaji earthquake. Thromb Haemost. 1995; 74: 1207.

8. Kario K, Matsuo T, Kobayashi H, Yamamoto K, Shimada K. Earthquake-induced potentiation of acute risk factors in hypertensive elderly patients: possible triggering of cardiovascular events after a major earthquake. J Am Coll Cardiol. 1997; 29: 926-933.

9. Kario K, Matsuo T, Shimada K, Pickering TG. Factors associated with the occurrence and magnitude of earthquake-induced increases in blood pressure. Am J Med. 2001; 111: 379-384.

10. Suzuki S, Sakamoto S, Miki T, Matsuo T. Hanshin-Awaji earthquake and acute myocardial infarction [letter]. Lancet. 1995; 345: 981.

11. Itabashi R, Furui E, Sato S, Yazawa Y, Kawata K, Mori E. Incidence of cardioembolic stroke including paradoxical brain embolism in patients with acute ischemic stroke before and after the Great East Japan Earthquake. 2014; 37:431-437.

12. Yabe H, Suzuki Y, Mashiko H, Nakayama Y, Hisata M, Niwa S, Yasumura S, Yamashita S, Kamiya K, Abe M. Psychological distress after the great East Japan earthquake and fukushima daiichi nuclear power plant accident: results of a mental health and lifestyle survey through the fukushima health management survey in fy2011 and fy2012. Fukushima J Med Sci. 2014; 60:57-67.

13. Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. Psychometric properties of the PTSD Checklist (PCL). Behav Res Ther. 1996; 34: 669-673.

14. Furukawa TA, Kessler RC, Slade T, Andrews G. The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. Psychol Med. 2003; 33:357-362.

15. Sakurai K, Nishi A, Kondo K, Yanagida K, Kawakami N. Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. Psychiatry Clin Neurosci. 2011; 65:434-441.

16. Weathers FW, Litz BT, Herman DS, Huska JA, Keane TM. The PTSD checklist (OCL): Reliability, Validity, and Diagnostic Utility. Paper presented at the Annual Meeting of the International Society for Traumatic Stress Studies, San Antonio, TX. 1993.

17. Pickering TG. Mental stress as a causal factor in the development of hypertension and cardiovascular disease. Curr Hypertens Rep. 2001; 3: 249-254.

18. Kabutoya T, Kario K. Earthquake and blood pressure. Hypertens Res. 2009; 32:732-734.

19. Kario K. Disaster hypertension- its characteristics, mechanism, and management. Circ J. 2012; 76: 553-552.

20. Yokoyama Y, Otsuka K, Kawakami N, Kobayashi S,Ogawa A, Tannno K, Onoda T, Yaegashi Y, Sakata K. Mental health and related factors after the Great East Japan earthquake and tsunami. PLoS One. 2014; 9: e102497.

21. Xu J, Mo L, Xu Z. A cross-sectional study on risk factors of depression severity among survivors of the 2008 Sichuan earthquake. Community Ment Health J. 2013; 49: 847-856.

22. Huang Y, Wong H, Tan HT. Associations between economic loss, financial strain and the psychological status of Wenchuan earthquake surivivors. Disasters. 2015; 39:795-810.

23. Dorahy MJ, Rowlands A, Renouf C, Hanna D, Britt E, Carter JD. Impact of average household income and damage exposure on post-earthquake distress and functioning: A community study following the February 2011 Christchurch earthquake. Br J Psychol. 2015; 106: 526-543.

24. Nishi N, Yoshimura E, Ishikawa-Takata K, Tsuboyama-Kasaoka N, Kubota T, Miyachi M, Tokudome S, Yokoyama Y, Sakata K, Kobayashi S, Ogawa A. Relationship of living conditions with dietary patterns among survivors of the great East Japan earthquake. J Epidemiol. 2013; 5: 376-381.

25. Kario K, Matsuo T, Ishida T, Shimada K. 'White coat' hypertension and the Hanshin-Awaji Earthquake. Lancet. 1995; 345: 1346.

26. Satoh H, Ohira T, Hosoya M, Sakai A, Watanabe T, Ohtsuru A et al. Evacuation after the Fukushima Daiichi Nuclear Power Plant Accident Is a Cause of Diabetes: Results from the Fukushima Health Management Survey. J Diabetes Res. 2015.

Table 1. Characteristics of survey participants and correlated incidence of exacerbation of the Post Traumatic Stress Disorder syndromes headache (first table), dizziness (second table), palpitations (third table), and shortness of breath (fourth table). P values indicate outcomes of Chi-square tests of participants with PCL-S ≥50.

	No	Yes	Exacerbation of headache	P
Sex	No. (%)	No. (%)	No. (%)	
Men	28,553 (88.4)	3,282 (10.2)	466 (1.4)	<0.001
Women	31,408 (76.4)	8,297 (20.2)	1,427 (3.5)	
Age				
15-49	18,998 (75.9)	5,063 (20.2)	966 (3.9)	<0.001
50-64	17,470 (81.9)	3,356 (15.7)	514 (2.4)	
>=65	23,493 (86.8)	3,160 (11.7)	413 (1.5)	
Mental Health Status				
K6<13	53,897 (85.1)	8,370 (13.2)	1,092 (1.7)	<0.001
K6>=13	6,064 (60.2)	3,209 (31.9)	801 (8.9)	
Post Traumatic Stress Disorder				
No	53,560 (85.0)	8,374 (13.3)	1,062 (1.7)	<0.001
Yes	6,401 (61.3)	3,205 (30.7)	831 (8.0)	
Smoking Status				
Never-smoker	32,452 (80.4)	6,819 (16.9)	1,104 (2.7)	<0.001
Ex-smoker	13,541 (85.6)	1,948 (12.3)	338 (2.1)	
Current smoker	11,826 (80.8)	2,414 (16.5)	403 (2.8)	
Drinking Status				
Never-drinker	29,746 (79.8)	6,473(17.4)	1,067 (2.9)	<0.001
Ex-drinker	2,259 (83.1)	381 (14.0)	80 (2.9)	
Current drinker	26,366 (83.6)	4,451 (14.1)	715 (2.3)	
Physical activity				
>= once per day	9,266 (87.6)	1,136 (10.7)	179 (1.7)	<0.001
2-4 times per week	12,085 (83.9)	2,008 (13.9)	309 (2.2)	
Once per week	8,159 (82.4)	1,512 (15.3)	234 (2.4)	
Never	28,452 (78.5)	6,633 (18.3)	1144 (3.2)	
Hypertension History				
No	34,634 (80.8)	7,002 (16.3)	1,216 (2.8)	<0.001
Yes	25,327 (82.8)	4,577 (15.0)	677 (2.2)	
Stroke History				
No	56,835 (81.7)	10,945 (15.7)	1,799 (2.6)	0.580
Yes	3,126 (81.1)	634 (14.5)	94 (2.4)	
Heart Disease History				
No	54,199 (81.9)	10,268 (15.5)	1,691 (2.6)	<0.001

Yes	5,762 (79.2)	1,311 (18.0)	202 (10.7)	
Unemployment				
No	49,300 (83.3)	8,599 (14.5)	1,293 (2.2)	<0.001
Yes	10,661 (74.9)	2,980 (20.9)	600 (4.2)	
Decreased income				
No	49,841 (82.4)	9,208 (15.2)	1,432 (2.4)	<0.001
Yes	10,120 (78.1)	2,371 (18.3)	461 (3.6)	
Living arrangement				
Evacuation Shelter	610 (83.1)	106 (14.4)	213 (2.5)	<0.001
Temporary housing	5,674 (81.3)	1,107 (15.9)	195 (2.8)	
Rental house, apartment	18,133 (78.6)	4,153 (18.0)	796 (3.5)	
Relatives' home	2,252 (81.8)	423 (15.4)	78 (2.8)	
Own home	18,649 (86.3)	2,669 (12.4)	292 (1.4)	
Tsunami experience				
No	48,194 (82.1)	9,058 (15.4)	1,424 (2.4)	<0.001
Yes	11,767 (79.7)	2,521 (17.1)	469 (3.2)	
Experience of the nuclear power plant accident				
No	29,347 (83.8)	4,977 (14.2)	717 (2.1)	<0.001
Yes	30,614 (79.7)	6,602 (17.2)	1,176 (3.1)	
Damage of house				
No	15,295 (82.5)	2,843 (15.3)	413 (2.2)	<0.001
A part of	31,661 (83.3)	5,913 (15.4)	911 (2.4)	
Half	4,125 (79.0)	916 (17.5)	184 (3.5)	
More than a half	1,538 (78.4)	358 (18.2)	67 (3.4)	
Totally	3,086 (80.5)	620 (16.2)	126 (3.3)	
Loss of family member				
No	10,802 (76.7)	2,737 (19.4)	552 (3.9)	<0.001
Yes	46,887 (82.7)	8,492 (15.0)	1,291 (2.3)	

		Exacerbation of dizziness		P
	No	Yes		
Sex	No. (%)	No. (%)	No. (%)	

≥

Men	29,793 (92.2)	2,167 (6.7)	341 (1.1)	<0.001
Women	35,306 (85.8)	4,938 (12.0)	888 (2.2)	
Age				
20-49	22,160 (88.5)	2,360 (9.4)	507 (2.0)	0.905
50-64	19,103 (89.5)	1,935 (9.1)	302 (1.4)	
>=65	23,836 (88.1)	2,810 (10.4)	420 (1.6)	
Mental Health Status				
K6<13	57,801 (91.2)	4,863 (7.7)	695 (1.1)	<0.001
K6>=13	7,298 (72.4)	2,242(22.3)	534 (5.3)	
Post Traumatic Stress				
Disorder				
No	57,505 (91.3)	4,838 (7.7)	653 (1.0)	<0.001
Yes	7,594 (72.8)	2,267 (21.7)	576 (5.5)	
Smoking Status				
Never-smoker	35,541 (88.0)	4,119 (10.2)	715 (1.8)	<0.001
Ex-smoker	14,228 (89.9)	1,373 (8.7)	226 (1.4)	
Current smoker	13,083 (89.4)	1,302 (8.9)	258 (1.8)	
Drinking Status				
Never-drinker	32,656 (87.6)	3,956 (10.6)	674 (1.8)	<0.001
Ex-drinker	2,310 (84.9)	347 (12.8)	63 (2.3)	
Current drinker	28,498 (90.4)	2,571 (8.2)	463 (1.5)	
Physical activity				
>= once per day	9,654(91.2)	796 (7.5)	131 (1.2)	<0.001
2-4 times per week	12,830 (89.1)	1,327 (9.2)	245 (1.7)	
Once per week	8,845 (89.3)	917 (9.3)	143 (1.4)	
Never	31,731(87.6)	3,811 (10.5)	687 (1.9)	
Hypertension History				
No	38,476 (89.8)	3,709 (8.7)	667 (1.6)	<0.001
Yes	26,623 (87.1)	3,396 (11.1)	562 (1.8)	
Stroke History				
No	61,895 (89.0)	6,538 (9.4)	1,146 (1.7)	<0.001
Yes	3,204 (83.1)	567 (14.7)	83 (2.2)	
Heart Disease History				
No	59,187 (89.5)	5,946 (9.0)	1,025 (1.6)	<0.001
Yes	5,912 (81.3)	1,159 (15.9)	204 (2.8)	
Unemployment				

No	52,942 (89.4)	5,376 (9.1)	874 (1.5)	<0.001
Yes	12,157 (85.4)	1,729 (12.1)	355 (2.5)	
Decreased income				
No	53,767 (88.9)	5,746 (9.5)	968 (1.6)	<0.001
Yes	11,332 (87.5)	1,359 (10.5)	261 (2.0)	
Living arrangement				
Evacuation Shelter	627 (80.8)	85 (11.0)	64 (8.2)	<0.001
Temporary housing	6,041 (86.6)	801 (11.5)	134 (1.9)	
Rental house, apartment	20,217 (87.6)	2,376 (10.3)	489 (2.1)	<0.001
Relatives' home	2,436 (88.5)	264 (9.6)	53 (1.9)	
Own home	19,794 (91.6)	1,617 (7.5)	199 (0.9)	
Tsunami experience				
No	52,378 (89.3)	5,390 (9.2)	908 (1.6)	<0.001
Yes	12,721 (86.2)	1,715 (11.6)	321 (2.2)	
Experience of the nuclear power plant accident				
No	31,801 (90.8)	2,814 (8.0)	426 (1.2)	<0.001
Yes	33,298 (86.7)	4,291 (11.2)	803 (2.1)	
Damage of house				
No	16,762 (90.4)	1,531 (8.3)	258 (1.4)	<0.001
A part of	34,218 (88.9)	3,667 (9.5)	600 (1.6)	
Half	4,480 (85.7)	616 (11.8)	129 (2.5)	
More than a half	1,668 (85.0)	247 (12.6)	48 (2.5)	
Totally	3,308 (86.3)	438 (11.4)	86 (2.2)	
Loss of family member				
No	11,885 (84.3)	1,843 (13.1)	363 (2.6)	<0.001
Yes	50,854 (89.7)	4,991 (8.8)	825 (1.5)	

	No	Yes	Exacerbation of palpitation	P
Sex	No. (%)	No. (%)	No. (%)	
Men	30,254 (83.7)	4,770 (13.2)	1,127 (3.1)	<0.001
Women	35,306 (89.7)	3,444 (8.7)	808 (2.1)	

Age				
20-49	23,317 (93.2)	1,303 (5.2)	407 (1.6)	<0.001
50-64	19,478 (91.3)	1,539 (7.2)	323 (1.5)	
>=65	24,339 (89.9)	2,372 (8.8)	355 (1.3)	
Mental Health Status				
K6<13	59,443 (93.8)	3,354 (5.3)	562 (0.9)	<0.001
K6>=13	7,691 (76.4)	1,860 (18.5)	523 (5.2)	
Post Traumatic Stress Disorder				
No	59,105 (93.8)	3,349 (5.3)	542 (0.9)	<0.001
Yes	8,029 (76.9)	1,865 (17.9)	543 (5.2)	
Smoking Status				
Never-smoker	36,836 (91.2)	2,886 (7.2)	653 (1.6)	<0.001
Ex-smoker	14,449 (91.3)	1,164 (7.4)	214 (1,4)	
Current smoker	13,503 (92.2)	944 (6.5)	196 (1.3)	
Drinking Status				
Never-drinker	33,888 (90.9)	2,801 (7.5)	597 (1.6)	<0.001
Ex-drinker	2,406 (88.5)	253 (9.3)	61 (2.2)	
Current drinker	29,119 (92.4)	2,006 (6.4)	407 (1.3)	
Physical activity				
>= once per day	9,916 (93.7)	569 (5.4)	96 (0.9)	<0.001
2-4 times per week	13,210 (91.7)	997 (6.9)	195 (1.4)	
Once per week	9,090 (91.8)	676 (6.8)	139 (1.4)	
Never	32,790 (90.5)	2,802 (7.7)	637 (1.8)	
Hypertension History				
No	39,969 (93.3)	2,299 (5.4)	584 (1.4)	<0.001
Yes	27,165 (88.8)	2,915 (9.5)	501 (1.6)	
Stroke History				
No	63,799 (91.7)	4,757 (6.8)	1,799 (1.5)	<0.001
Yes	3,335 (86.5)	457 (11.9)	94 (1.6)	
Heart Disease History				
No	61,793 (93.3)	10,268 (15.5)	1,691 (2.6)	<0.001
Yes	5,441 (74.8)	1,311 (21.3)	202 (4.0)	
Unemployment				
No	54,410 (91.9)	3,992 (6.7)	790 (1.4)	<0.001
Yes	12,724 (89.4)	1,222 (8.6)	295 (2.1)	

Decreased income				
No	55,339 (91.5)	4,272 (7.1)	870 (1.4)	0.052
Yes	11,795 (91.1)	942 (7.3)	215 (1.7)	
Living arrangement	No	Yes	Exacerbation of shortness of breath	P
Evacuation Shelter	672 (91.6)	57 (7.8)	5 (0.7)	
Temporary housing	6,339 (90.9)	548 (7.9)	85 (1.3)	
Rental house, apartment	20,662 (92.8)	1,599 (7.2)	214 (1.0)	
Relatives' home	2490 (90.5)	214 (7.8)	49 (1.8)	
Own home	20,178 (93.4)	1,223 (5.7)	45 (1.6)	
Tsunami experience				
No	53,935 (91.9)	3,911 (6.7)	830 (1.4)	<0.001
Yes	13,199 (89.4)	1,303 (8.8)	255 (1.7)	
Experience of the nuclear power plant accident				
No	32,691 (93.3)	1,992 (5.7)	358 (1.0)	<0.001
Yes	34,443 (89.7)	3,222 (8.4)	727 (1.9)	
Damage of house				
No	17,284 (93.2)	1,034 (5.6)	233 (1.3)	<0.001
A part of	35,128 (91.3)	2,798 (7.3)	559 (1.5)	
Half	4,684 (89.7)	458 (8.8)	83 (1.6)	
More than a half	1,738 (88.5)	187 (9.5)	38 (1.9)	
Totally	3,473 (90.6)	293 (7.7)	66 (1.7)	
Loss of family member				
No	12,434 (88.2)	1,361 (9.7)	296 (2.1)	<0.001
Yes	52,250 (92.2)	3,661 (6.5)	759 (1.3)	

	No. (%)	No. (%)	No. (%)	
Sex				
Men	28,735 (92.4)	2,309 (7.4)	257 (0.8)	<0.001
Women	35,401 (92.6)	2,662 (6.5)	369 (0.9)	
Age				
20-49	24,022 (96.0)	858 (3.4)	147 (0.6)	<0.001

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50-64	19,821 (92.9)	1,360 (6.4)	159 (0.8)	
>=65	23,993 (88.7)	2,753 (10.2)	320 (0.4)	
Mental Health Status				
K6<13	59,686 (94.2)	3,318 (5.2)	355 (0.6)	<0.001
K6>=13	8,150 (80.9)	1,653 (16.4)	271 (2.7)	
Post Traumatic Stress				
Disorder				
No	59,449 (94.4)	3,224 (5.1)	323 (0.5)	<0.001
Yes	8,387 (80.4)	1,747 (16.7)	303 (2.9)	
Smoking Status				
Never-smoker	37,690 (93.4)	2,367 (5.9)	318 (0.8)	<0.001
Ex-smoker	14,298 (90.3)	1,358 (8.6)	171 (1.1)	
Current smoker	13,522 (92.3)	998 (6.8)	123 (0.8)	
Drinking Status				
Never-drinker	34,447 (92.4)	2,516 (6.8)	323 (0.9)	0.001
Ex-drinker	2,341 (86.1)	338 (12.4)	41 (1.5)	
Current drinker	29,364 (93.1)	1,920 (6.1)	248 (0.8)	
Physical activity				
>= once per day	9,934 (93.9)	578 (5.5)	69 (0.7)	<0.001
2-4 times per week	13,278 (92.2)	1,001 (7.0)	123 (0.9)	
Once per week	9,136 (92.2)	672 (6.8)	97 (1.0)	
Never	33,405 (92.2)	2,499 (6.9)	325 (0.9)	
Hypertension History				
No	40,466 (94.9)	1,912 (4.5)	276 (0.6)	<0.001
Yes	27,172 (88.9)	3,059 (10.0)	350 (1.1)	
Stroke History				
No	64,581 (92.8)	4,422 (6.4)	576 (0.8)	<0.001
Yes	3,255 (84.5)	549 (14.2)	50 (1.3)	
Heart Disease History				
No	62,270 (94.1)	3,456 (5.2)	432 (0.7)	<0.001
Yes	5,566 (76.5)	1,515 (20.8)	194 (2.7)	
Unemployment				
No	54,833 (92.6)	3,889 (6.6)	470 (0.8)	<0.001
Yes	13,003 (91.3)	1,082 (7.6)	156 (1.1)	
Decreased income				
No	55,879 (92.4)	4,096 (6.8)	506 (0.8)	0.584

Yes	11,957 (92.3)	875 (6.8)	120 (0.9)	
Living arrangement				
Evacuation Shelter	666 (90.7)	63 (8.6)	5 (0.7)	
Temporary housing	6,283 (90.1)	612 (8.8)	81 (1.2)	
Rental house, apartment	21,419 (92.8)	1,439 (6.2)	224 (1.0)	<0.001
Relatives' home	2,449 (90.8)	231 (8.4)	108 (0.5)	
Own home	20,247 (93.7)	1,255 (5.8)	29 (1.0)	
Tsunami experience				
No	54,566 (93.0)	3,652 (6.2)	458 (0.8)	<0.001
Yes	13,270 (89.9)	1,319 (8.9)	168 (1.1)	
Experience of the nuclear power plant accident				
No	33,023 (94.2)	1,817 (5.2)	201 (0.6)	<0.001
Yes	34,813 (90.7)	3,154 (8.2)	425 (1.1)	
Damage of house				
No	17,545 (94.6)	903 (4.9)	103 (0.6)	<0.001
A part of	35,368 (91.9)	2,770 (7.2)	347 (0.9)	
Half	4,735 (90.6)	435 (8.3)	55 (1.1)	
More than a half	1,760 (89.7)	180 (9.2)	23 (1.2)	
Totally	3,510 (91.6)	279 (7.3)	43 (1.1)	
Loss of family member				
No	12,589 (89.3)	1,303 (9.3)	199 (1.4)	0.096
Yes	52,823 (93.2)	3,443 (6.1)	404 (0.7)	

Table 2.Odds ratios (PR) and 95% CIs for Post Traumatic Stress Disorder on multiple logistic regression analyses

		Exacerbation of Headache			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) [f]or women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	2.03 (1.58-2.62)	1.58 (1.20-2.09)	1.97 (1.12-3.47)	1.46 (1.06-2.01)
	Rental house, apartment	2.21 (1.93-2.54)	1.55 (1.32-1.81)	1.85 (1.34-2.54)	1.46 (1.22-1.75)
	Evacuation Shelter	2.01 (1.24-3.25)	1.80 (1.10-2.97)	2.24 (0.99-5.07)	1.61 (0.85-3.03)
	Temporary housing	2.13 (1.77-2.56)	1.42 (1.15-1.75)	1.67 (1.10-2.54)	1.36 (1.06-1.73)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.70 (1.53-1.88)	1.28 (1.12-1.46)	1.35 (1.04-1.77)	1.26 (1.08-1.47)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.56 (1.40-1.74)	1.39 (1.21-1.60)	1.38 (1.08-1.77)	1.39 (1.17-1.63)

		Exacerbation of Dizziness			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) [f]or women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.98 (1.46-2.69)	1.43 (1.02-1.98)	0.97 (0.49-1.92)	1.64 (1.13-2.43)
	Rental house, apartment	2.27 (1.91-2.69)	1.45 (1.20-1.76)	1.28 (0.92-1.79)	1.55 (1.23-1.96)
	Evacuation Shelter	1.84 (1.02-3.32)	1.37 (0.73-2.65)	0.85 (0.26-2.76)	1.79 (0.85-3.77)
	Temporary housing	2.09 (1.68-2.61)	1.39 (1.08-1.78)	1.50 (1.00-2.27)	1.34 (0.99-1.83)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.65 (1.45-1.87)	1.26 (1.07-1.48)	1.12 (0.83-1.50)	1.23 (0.99-1.52)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.37 (1.19-1.57)	1.18 (0.99-1.41)	1.00 (0.74-1.36)	1.12 (0.91-1.40)

		Exacerbation of Palpitation			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) for women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.70 (1.23-2.34)	1.24 (0.87-1.75)	1.25 (0.57-2.72)	1.21 (0.82-1.79)
	Rental house, apartment	1.90 (1.60-2.25)	1.25 (1.03-1.51)	1.73 (1.17-2.54)	1.11 (0.89-1.39)
	Evacuation Shelter	0.74 (0.30-1.80)	0.51 (0.19-1.38)	0.92 (0.22-3.90)	0.35 (0.09-1.43)
	Temporary housing	1.32 (1.03-1.69)	0.82 (0.61-1.09)	1.18 (0.68-2.02)	0.72 (0.51-1.01)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.46 (1.27-1.68)	1.22 (1.02-1.46)	1.46 (1.05-2.02)	1.01 (0.79-1.28)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.24 (1.07-1.44)	1.14 (0.94-1.38)	0.84 (0.58-1.19)	1.06 (0.84-1.33)

		Exacerbation of Shortness of Breath			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) for women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.60 (1.02-2.52)	1.15 (0.70-1.89)	0.95 (0.42-2.14)	1.33 (0.71-2.49)
	Rental house, apartment	2.34 (1.85-2.96)	1.75 (1.35-2.27)	1.48 (1.00-2.20)	1.98 (1.39-2.81)
	Evacuation Shelter	1.33 (0.54-3.27)	1.21 (0.48-3.01)	1.73 (0.61-4.97)	0.52 (0.07-3.81)
	Temporary housing	2.29 (1.72-3.06)	1.50 (1.07-2.09)	1.27 (0.76-2.13)	1.73 (1.11-2.69)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.55 (1.29-1.87)	1.13 (0.89-1.47)	1.19 (0.83-1.69)	1.10 (0.77-1.57)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.24 (1.01-1.52)	1.14 (0.89-1.47)	1.14 (0.80-1.62)	0.91 (0.65-1.28)

a. Adjusted for age and sex.

b. Further adjusted for drinking status (once or more per month, ex-drinker, less than once per month), smoking status (non-smoker, ex-smoker, current smoker), mental health distress (K6<3, K6>=13), hypertension history (yes or no), stroke history (yes or no), heart disease history (yes or no), physical activities (>= once per day, 2-4 times per week, once per week, never), tsunami experience (yes or no), radiation experience (yes or no), damage of house (no, a part of, half, more than a half, totally), loss of family member (yes or no).

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract (P1-4)	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction (P6-7)		
Background/rationale **(P6)**	2	Explain the scientific background and rationale for the investigation being reported
Objectives **(P7)**	3	State specific objectives, including any prespecified hypotheses
Methods (P7-11)		
Study design **(P7)**	4	Present key elements of study design early in the paper
Setting **(P7)**	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants **(P7)**	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables **(P8-P10)**	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement **(P8-P10)**	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias (None)	9	Describe any efforts to address potential sources of bias
Study size **(P7-8)**	10	Explain how the study size was arrived at
Quantitative variables **(P8-10)**	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods **(P10-11)**	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results (P11-14)		
Participants **(P11-12)**	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data **(P11-13)**	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data **(P11)**	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results **(P13-14)**	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses **None**	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion (P14-18)		
Key results **(P14-18)**	18	Summarise key results with reference to study objectives
Limitations **(P18)**	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation **(P14-18)**	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability **None**	21	Discuss the generalisability (external validity) of the study results
Other information (P19)		
Funding **(P19)**	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Associations of socioeconomic factors after a disaster with cardiovascular related symptoms among evacuees after the Great East Japan Earthquake in a cross-sectional study: the Fukushima Health Management Survey

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Keywords:	Great East Japan Earthquake, socioeconomic factors, cardiovascular related symptoms

Associations of socioeconomic factors after a disaster with cardiovascular related symptoms among evacuees after the Great East Japan Earthquake in a cross-sectional study: the Fukushima Health Management Survey

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Abstract

Objective: To investigate the association between socioeconomic factors and the exacerbation of cardiovascular symptoms among evacuees after Great East Japan Earthquake.

Methods: A total of 73,433 subjects were included in the Fukushima Health Management survey. Exacerbation of headache, dizziness, palpitations, and shortness of breath were determined from self-report questionnaires. Socioeconomic factors included living arrangement, loss of employment, decreased income and educational years. Odds ratios (OR) and 95% confidence intervals (CI) of socioeconomic factors were estimated for each symptom using multiple logistic regression analyses.

Results: A total of 1,893 (2.6%) individuals reported exacerbation of headache, 1,229 (1.7%) of dizziness, 1,085 (1.5%) of palpitations, and 626 (0.9%) of shortness of breath. Evacuation accommodation was associated with all the above symptoms. Compared to participants living in their own home (OR=1.00), subjects living in relatives' homes had increased odds of experiencing exacerbation of headache (1.58; 95% CI 1.19–2.09) and dizziness (1.42; 95% CI 1.02–1.98); subjects living in rental houses or apartments showed exacerbation of headache (1.54; 95% CI 1.32–1.80), dizziness (1.45; 95% CI 1.20–1.75), palpitations (1.25; 95% CI 1.03–1.51), and shortness of breath (1.76; 95% CI 1.35–2.28); subjects living in evacuation shelters showed exacerbation of headache (1.80; 95% CI 1.09–2.96); and refugees living in temporary housing showed exacerbated headache (1.42; 95% CI 1.15–1.75), dizziness (1.40; 95% CI 1.09–1.79), and shortness of breath (1.49; 95% CI 1.07–2.08). Compared to the evacuees that retained their jobs, unemployed subjects showed increased odds for exacerbation of headache (1.28, 95% CI 1.12–1.46), dizziness (1.26, 95% CI 1.07–1.48), and

palpitations (1.21, 95% CI 1.01–1.45). Decreased income was associated with exacerbation of headache (1.39, 95% CI 1.22–1.60).

Conclusion: After the earthquake, living in non-home conditions was more likely to exacerbate cardiovascular symptoms among evacuees. Loss of employment was another risk factor for exacerbated headache and dizziness.

Keywords: Great East Japan Earthquake, socioeconomic factors, cardiovascular related symptoms

Strengths and limitations of this study

- We examined the associations of socioeconomic factors after a disaster with cardiovascular related symptoms among evacuees of the number of 73,433 subjects after the Great East Japan earthquake.
- Our study is the first to identify an inverse relationship between low socioeconomic status and exacerbated cardiovascular symptoms from an evacuee self-report after a disaster.
- A limitation of the present study was an overall response rate was low (40.7%) and data may have contained sampling biases.
- Another limitation of the present study should be that the information of changes in family relationships (e.g., death, physical separation) among the evacuees after the disaster has not been captured.
- In addition, most questionnaires were collected in the same period (from Jan 2012 to Mar 2012).

Introduction

The Great East Japan Earthquake and the subsequent Fukushima Daiichi nuclear disaster, which occurred in March 2011, was the most destructive catastrophe in Japan to date. Due to concerns over released radiation, most of the residents in nearby towns were forced to evacuate and consequently suffered long-lasting anxiety. Shortly after the disaster, a Fukushima Health Management Survey was conducted to investigate the effects of long-term low-dose radiation exposure caused by the accident and to assess the physical and mental wellbeing of evacuees. This survey included a basic survey, which estimated individual radiation exposure of each resident, and four detailed surveys comprising of a Comprehensive Health Check and thyroid ultrasonography, a mental health and lifestyle survey, and a survey of pregnant women and nursing mothers (1). The Mental Health and Lifestyle Survey used self-report questionnaires to investigate health status and lifestyle of the refugees, including nutrition and diet, perceived symptoms of illness, disaster-related experience, and socioeconomic determinants.

Several previous studies have shown changes in the incidence of cardiovascular events following disasters; however, results are conflicting (2-14). A recent study reported a heterogeneous occurrence of cardiovascular events after the Great East Japan Earthquake (2), while another study reported a significant increase in the incidence of cardioembolic stroke after the earthquake (10). However, neither study examined the incidence of perceived cardiovascular disease symptoms after a disaster, nor did they focus on the effect of refugee socioeconomic status on health problems during their evacuation term. However, considering these aspects is relevant for

reviewing refugee health status, accessing the incidence of various diseases, and providing health guidelines for refugees.

Consequently, we conducted the present study to investigate the risk factors of perceived cardiovascular symptoms following a major disaster. In the present study, socioeconomic determinants included educational years, living arrangement, change of employment and income. Due to the special post-disaster situation, change of employment and income due to the disaster, instead of job and income level were captured. Thus in the present study, a decrease or low socioeconomic status was considered as less educational years, living in non-home conditions, unemployment or decreased income due to the disaster. We hypothesized that a decrease in socioeconomic status due to the earthquake would be associated with exacerbated cardiovascular symptoms among evacuees.

Methods

Participants

The primary purpose of the Fukushima Health Management Survey was to monitor the long-term health and lifestyle of Fukushima residents and to provide them with appropriate care (15). The Fukushima Health Management Survey consists of a basic survey and four detailed surveys, namely, the thyroid ultrasound examination, comprehensive health check, mental health and lifestyle survey, and pregnancy and birth survey (for details of these surveys see (1)). The subjects of mental health and lifestyle survey was included in the present study. Briefly, the target population, consists of 210,189 officially registered victims of the Great East Japan Earthquake from the 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 were sent out with 73,569 questionnaires returned with responses, i.e. a response rate of 40.7%. Among the responders, 136 were excluded due to blank or duplicated questionnaires and 9,245 for questionnaires filled in by a proxy. After exclusion, the data of 73,433 subjects (32,301 men and 41,132 women) were used in our analyses.

The study protocol was approved by the Ethics Committee of Fukushima Medical University. Participants who returned the self-administered questionnaires were considered to have consented to participate.

Data collection and measurement

A questionnaire was used to broadly investigate the health status and lifestyle of the refugees. The exacerbation of headache, dizziness, palpitations, and shortness of breath was determined based on self-reports in the questionnaire. All subjects were asked to answer the question 'Do you have the following perceived symptoms after the earthquake?' and could choose between the replies 'No', 'Yes', and 'Exacerbation'. In the present study we focused on reports of 'exacerbation'.

To evaluate Posttraumatic Stress Disorder (PTSD) symptoms we used the non-military version of the Posttraumatic Stress Disorder Checklist (PCL-S) (15). This is a 17-item self-report checklist based on the Diagnostic and Statistical Manual of Mental Disorders (4th edition, DSM-IV) criteria (16), with each item rated using a Likert-type scale from one ('not at all') to five ('extremely'). Respondents were requested to respond to questions about each PTSD symptom separately and report whether they

had experienced a given symptom during the past month. Based on summing the scores from each of the 17 items, a total PCL-S score can range from 17 to 85 (15).

In addition to the PCL-S checklist, the following items were included in the self-assessment and self-report questionnaires:

1. Demographic characteristics

Demographic subject characteristics include gender, age group, mental health status, history of mental illness, incidence of PTSD symptoms, smoking and drinking habits, and current physical activity levels. Age groups were divided into childbearing age (20–49 years), middle age (50–64 years), and old age (65 years and above).

Mental health status, and specifically incidence and severity of depression, was measured by the Japanese version of the K6 Kessler Psychological Distress Scale, which has been validated by previous studies (17, 18). In the K6 assessment, participants were asked if they had experienced any of the following six symptoms during the past 30 days: feeling so depressed that nothing could cheer them up, feeling that everything was an effort, or feeling nervous, hopeless, restless, fidgety, or worthless. Each question was rated on a 5-point Likert-type scale from zero (none of the time) to four (all of the time), with higher scores signifying worse mental health status (total range: 0–24) (15). In addition, we assessed participant's history of mental illness by self-report as 'yes' or 'no'.

We obtained data on smoking and drinking habits using the following metrics, respectively: 'non-smoker', 'ex-smoker', or 'current smoker'; and 'once or more per month', 'less than once per month', or 'ex- drinker'. Participants had four options to assess current physical activity level: 'every day', '2-4 times/week', 'once a week', or 'nearly none'.

2. Socioeconomic variables

Participants were required to select from six options regarding their living arrangements: evacuation shelter, temporary housing, rental housing or apartment, a relative's home, their own home, and other. The last option was considered non-informative due to its ambiguity and thus excluded from analysis.

Other socioeconomic variables included educational years (< 12 years, >=12 years), change in employment status and change in income. By answering 'Yes' to either question, the participant indicated he/she became unemployed or experienced decreased income since the disaster.

3. Disaster-related variables

Disaster-related variables included experience of the tsunami (yes or no), experience of the nuclear power plant accident (defined as hearing the explosion; yes or no), losing someone close because of the disaster (yes or no), and damage to accommodation (no, partial damage, half of accommodation destroyed, more than a half destroyed, total destruction).

Statistical analysis

The incidence of exacerbation of headache, dizziness, palpitations, and shortness of breath was compared between subjects with different demographic, socioeconomic, and disaster-related characteristics using chi-square tests. For the analyses investigating PTSD incidence, a PCL-S cut-off score of 50 was used, according to Weathers et al (19). Subjects who received a PCL-S of 50 or greater were allocated to the 'high-scoring group' and compared to the low-scoring (PCL-S < 50) group using chi-square tests.

Odds ratios (ORs) and 95% confidence intervals (CIs) of each socioeconomic determinant (living arrangement, unemployment, decreased income and educational years were estimated by applying multiple logistic regression models. Adjustment variables consisted of sex (male, female), age (20–49, 50–64, ≥65 years), drinking status (once or more per month, ex-drinker, less than once per month), smoking status (non-smoker, ex-smoker, current smoker), mental health distress (K6<3, K6>=13), hypertension history (yes or no), stroke history (yes or no), heart disease history (yes or no), physical activities (>= once per day, 2–4 times per week, once per week, never), tsunami experience (yes or no), radiation experience (yes or no), damage of accommodation (no, partial, half, more than a half, total), loss of family member (yes or no).

We conducted the above analyses both for separate and combined sexes. All analyses were conducted using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

As shown in the tables, 1,893 (2.6%) individuals reported exacerbation of headaches, 1,229 (1.7%) of dizziness, 1,085 (1.5%) of palpitations, and 626 (0.9%) exacerbation of shortness of breath.

Demographic characteristics

Table 1 summarizes the demographic characteristics of the subjects. Exacerbation of the above cardiovascular symptoms was significantly more likely to happen in women than in men (3.5% vs. 1.4% for headaches; 2.2% vs. 1.1% for dizziness; 2.0% vs. 0.9% for palpitations; 0.9% vs. 0.8% for shortness of breath). Subjects experiencing

exacerbation of headaches, dizziness, or palpitations were more likely to be young (20–49 years), while those experiencing exacerbation of shortness of breath were more likely to be 50-64 years. Subjects experiencing exacerbation of cardiovascular symptoms were also more likely to suffer from depression (K6>=13) and Posttraumatic Stress Disorder (PCL>=50), and to commonly have a history of hypertension, stroke, or heart disease. Non-smokers and non-drinkers were no less likely than (ex-) smokers or (ex-) drinkers to experience exacerbation of cardiovascular symptoms. However, symptom exacerbation was most pronounced in subjects who were physically active less than once a day.

Socioeconomic variables

Table 1 also shows refugees living in their own or a relative's home are less likely to experience exacerbated cardiovascular symptoms. Of the refugees living in their own home, 1.4% reported exacerbation of headache, 0.9% of dizziness, 1.6% of palpitations and 1.0% of shortness of breath. The corresponding statistics for refugees living in temporary housing and rental houses/apartments were 2.8%, 1.9%, 1.3%, and 1.2% and 3.5%, 2.1%, 1.8%, and 1.0%, respectively.

In the group that became unemployed due to the disaster, 4.2% subjects reported the exacerbation of headache, 2.5% of dizziness, 2.1% of palpitations and 1.1% of shortness of breath, while the corresponding statistics for the group that did not lose their jobs after the disaster were 2.2%, 1.5%, 1.4%, and 0.8%. Exacerbation of most cardiovascular symptoms was higher in subjects whose income decreased due to the disaster compared to those who maintained income levels (3.6% vs. 2.4% for exacerbation of headache, 2.0% vs. 1.6% for exacerbation of dizziness, and 1.7% vs. 1.4% for exacerbation of palpitation).

In addition, exacerbation of most cardiovascular symptoms was higher in subjects who had 12 years education or more compared to those who had less education (2.9% vs. 1.9% for exacerbation of headache, 1.8% vs. 1.4% for exacerbation of dizziness, and 1.6% vs. 1.2% for exacerbation of palpitation).

Disaster-related variables

Subjects that directly experienced the tsunami and the nuclear power plant accident were more likely to experience exacerbated cardiovascular symptoms. Among those experiencing the tsunami, 3.2% reported exacerbation of headache, 2.2% of dizziness, 1.7% of palpitations, and 1.7% of shortness of breath, compared to 2.4%, 1.6%, 1.5%, and 0.8%, respectively, of subjects with no experience of the tsunami. The corresponding statistics for subjects that had heard the nuclear power plant accident were 3.1%, 2.1%, 1.9%, and 1.1% compared to 2.1%, 1.2%, 1.0%, and 0.6%, that had not.

Multiple Logistic Regression analyses

Table 2 summarizes the odds ratios (ORs) and 95% CIs of each socioeconomic determinant for exacerbation of headache, dizziness, palpitations, and shortness of breath. Living arrangement emerged as a risk factor for exacerbated cardiovascular symptoms from our models, which were adjusted for multiple demographic-, health-, and disaster-related variables. Compared to participants living in their own home (OR = 1), those living in relatives' homes had higher odds to experience exacerbation of headache (1.58; 95% CI 1.19–2.09) and dizziness (1.42; 95% CI 1.02–1.98). Similarly, subjects living in rental houses or apartments had higher odds of exacerbated headache (1.54; 95% CI 1.32–1.80), dizziness (1.45; 95% CI 1.20–1.75), palpitations

(1.25; 95% CI 1.03–1.51), and shortness of breath (1.76; 95% CI 1.35–2.28). Participants living in evacuation shelters had increased odds of exacerbation of headache (1.80; 95% CI 1.09–2.96) and refugees living in temporary housing similarly had increased odds of exacerbation of headache (1.42; 95% CI 1.15–1.72), dizziness (1.40; 95% CI 1.09–1.79), and shortness of breath (1.49; 95% CI 1.07–2.08).

Loss of employment also emerged as a risk factor for increased odds of cardiovascular symptoms. Compared to the evacuees that remained employed (OR = 1), subjects that had become unemployed were at higher risk of experiencing exacerbation of headache (1.28; 95% CI 1.12–1.46), dizziness (1.26; 95% CI 1.07–1.48), and palpitation (1.21; 95% 1.01–1.45). In an unadjusted model, we found a significant positive association between unemployment and exacerbation of palpitations; however, after adjusting for multiple relevant variables, this association became non-significant.

There was no association between decreased income and exacerbated cardiovascular symptoms, except for headache. Here, adjusting for multiple variables resulted in an increased odds ratio for exacerbation of headaches both in an analysis combining both sexes (1.39, 95% CI 1.22–1.60) and in separate analyses of men and women.

Educational years was not associated with and exacerbated cardiovascular symptoms in multiple-adjusted models in the present study.

Discussion

We have demonstrated a decrease in socioeconomic status due to the earthquake was associated with exacerbated cardiovascular symptoms among evacuees of the

Great East Japan Earthquake. Compared with participants living in their own home, people of both genders living in relatives' homes, evacuation shelters, temporary housing, or rental houses or apartments were more likely to experience exacerbated headache, dizziness, palpitations, or shortness of breath. Similarly, loss of employment and reduced income due to the disaster increased the risk of exacerbated symptoms.

The following three points should be considered in the context of our results. Firstly, earthquakes are definitely associated with increased cardiovascular disease, including sudden cardiac death and acute myocardial infarction (2-14), which provides some support for the present study. The Hanshin-Awaji earthquake was associated with an increased cardiovascular disease and the increase persisted for more than a month. In addition, an increase in the number of subjects with acute myocardial infarction, especially in women, was particularly evident during the first 4 weeks post-disaster (9). After the Great East Japan Earthquake, the incidence of reported cardioembolic stroke increased in the first 3–9 months following the disaster (10), as did the incidence of other cardiovascular diseases (11-14). Our study contributes to the reported incidences of cardiovascular disease by demonstrating exacerbated cardiovascular symptoms among evacuees after a disaster from self-report questionnaires rather than from death certificates.

Secondly, increases in cardiovascular events and exacerbated cardiovascular symptoms can be attributed to post-disaster distress or mental problems. A review suggests that extremely stressful experiences, such as earthquakes, can trigger cardiovascular events (20-22). Acute major stress and chronic stress, i.e. the cumulative load of minor daily stress, can have both long-term consequences, which can be perceived as stressful and a potential threat to one's environment, subsequently

inducing a variety of negative emotional responses, such as fear, anxiety, sadness, anger, hostility, and depression (4,23) leading to hypertension or cardiovascular events (20-22). In the current study, all subjects exhibiting exacerbated cardiovascular symptoms were more likely to have depression (K6>=13) or Posttraumatic Stress Disorder (PCL>=50). Logistic regression analyses also showed that depression and Posttraumatic Stress Disorder were both independently associated with exacerbated cardiovascular symptoms (data not shown).

Thirdly, although post-disaster increases in cardiovascular events were widely reported in previous studies, the investigation of socioeconomic determinants of these events during the evacuation term of refugees was very limited. Previous studies reported that one year after the Wenchuan Earthquake in China, depression severity among refugees varied with income, housing status, and social support (24), indicating that earthquake impact on income was indirectly associated with life satisfaction and depression via its effect on financial status (25). Another study showed that six months after the 2011 Christchurch earthquake in New Zealand, on average lower income per home contributed unequivocally to earthquake-related distress and dysfunction (26).

In the present study, not living in the own home but living in evacuation shelters or temporary housing, was associated with exacerbation of all examined cardiovascular symptoms, which was more robust in women than in men. Evacuation shelters and temporary housing were less spacious, damper, and less comfortable than the refugees' homes. Due to insufficient access to supermarkets or shortages of cooking equipment and utilities, such as gas, evacuees living in shelters would struggle to access balanced meals. A recent cross-sectional study showed a well-balanced diet was associated with better living conditions among refugees after the Great East Japan Earthquake,

whereas imbalanced diets, particularly with regard to meat content, were not (27). In addition, having to take refuge in accommodation other than the own home meant that the own neighborhood had been damaged by the disaster, which may lead to shortness of social support. In addition, among the refugees. All of the above factors can be considered predictors of stress among refugees, where women may be more likely to be influenced than men.

Unemployment and decreased income due to the disaster were also associated with exacerbation of some cardiovascular symptoms. These results were expected as poor economic circumstances are expected to exacerbate depression. Low income may be considered a chronic stressor, increasing psychological distress as a result of limited resource access and opportunities for resource accumulation (26). Previous studies also showed that, following an earthquake, living in a low-income area may contribute to greater psychological distress due to lack of occupational, social, and financial resources. A community study showed that, after the Christchurch earthquake, low household income contributed strongly to earthquake-related distress (26). In the present study, we found a significant association between disaster-related unemployment and exacerbation of some cardiovascular symptoms, but the subsistence allowance provided to refugees by the Japanese government may have reduced effect size by reducing the impact of lowered economic circumstances on refugees.

Educational level was inversely associated with cardiovascular disease risk in present studies (27, 28). However, in present study, educational years was not associated with exacerbated cardiovascular symptoms. It may due to the post-disaster conditions. In the present study, both earthquake, tsunami and nuclear accident related factors and

unemployment or decreased income due to the disasters had a large influence on the exacerbated cardiovascular symptoms of the subjects, which may weaken the impact from the educational levels.

Our understanding of disaster-related stress on cardiovascular disease remains incomplete. A clinical study on the 1995 Hanshin-Awaji earthquake comparing pre- and post- BP levels in well-controlled hypertension patients showed an increase of 18mmHg in diastolic blood pressure two weeks after the earthquake (29). Although white-coat hypertension contributed partly to the results, whereby patients exhibit increased blood pressure in clinical settings, some patients developed sustained hypertension that persisted for one year after the earthquake (29). One study found increased levels of cholesterol and triglycerides a few weeks after an earthquake (3), whereas other studies failed to show significantly higher total cholesterol or HDL-cholesterol during the first two weeks after the Hanshin-Awaji earthquake (6). Therefore, the extent to which changes in blood lipid profile contributes to exacerbated cardiovascular symptoms several months after the Great East Japan Earthquake remains undetermined. Chronic psychological stress is also associated with increased insulin resistance (4). A recent study after the Great East Japan Earthquake found the negative effects of the disaster on metabolic factors were greater among evacuees than non-evacuees (30), which may contribute to exacerbated cardiovascular symptoms among evacuees.

The large scale of assessment and assessment under post-disaster conditions provide considerable authority for the present study. In addition, our study is the first to identify an inverse relationship between low socioeconomic status and exacerbated cardiovascular symptoms from an evacuee self-report after a disaster; our results will be useful for generating guidelines for evacuee health. However, the

following study limitations should be considered: Firstly, The study was based on a subjectivity of self-response survey. Further information, such as the incidence of cardiovascular disease should be captured. However, though the above-mentioned symptoms would not be logical predict cardiovascular diseases, several previous studies showed headache was suggestive of an incremental risk for stroke (31, 32), and other studies also showed that vertigo or dizziness, chest pain was associated with cardiovascular problems (33, 34). Therefore, our study of the 4 symptoms may be helpful for improvement of evacuees' health to some extent. Secondly, not only the Great East Japan Earthquake but also the accompanied nuclear accident had a large psychological impact on the evacuees, thus the present study may cannot be unconditionally compared with other studies due to the special situation. Thirdly, the overall response rate was low (40.7%) and data may have contained sampling biases. Thirdly, under the extraordinary and unusual social circumstances that follow a major disaster, health symptoms perceived by evacuees may be strongly influenced by changes in family relationships (e.g., death, physical separation) among the evacuees. However, the present study did not capture these information. Moreover, other socioeconomic determinants, such as household income, and other cardiovascular risk factors, such as blood pressure, cholesterol levels, were not captured in the present study either. In addition, although most questionnaires were collected in the same period (from Jan 2012 to Mar 2012), it is possible the timing of the survey affected the perceived cardiovascular symptoms. Finally, other environmental factors, such as temperature, food supplies, medical facilities may also affect cardiovascular problems (35, 36). These information were not collected in the present study. The potential associations observed in this study will be investigated over an extended period.

In conclusion, the present study was the first to identify a relationship between lower socioeconomic status due to the earthquake with exacerbated cardiovascular symptoms among evacuees after the Great East Japan Earthquake. Our findings will inform future periodic health examinations and health guidelines for evacuees.

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Contributors

WZ and TO designed the study. TO, SY, MM, MH. NH, YS, HY, MH, HT and AO were responsible for the data collection and overseeing study procedures. The analyses was conducted by WZ and TO. The manuscript was made by WZ. All the authors did contribution to the revision of the manuscript. All the authors read and approved the final version of the manuscript.

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Declaration of interests

We declare that we have no competing interests.

Patient consent

Obtained.

Data sharing statement

No additional data are available.

References

1. Yasumura S, Hosoya M, Yamashita S, Kamiya K, Abe M, Akashi M, Kodama K, Ozasa K; Fukushima Health Management Survey Group. Study protocol for the Fukushima Health Management Survey. J Epidemiol. 2012; 22: 375-383.

2. Nozaki E, Nakamura A, Abe A, Kagaya Y, Kohzu K, Sato K, Nakajima S, Fukui S, Endo H, Takahashi T, Seki H, Tamaki K, Mochizuki I. Occurrence of cardiovascular events after 2011 Great East Japan Earthquake and tsunami disaster. Int Heart J. 2013; 54: 247-253.

3. Trevisan M, Celentano E, Meucci C, Farinaro E, Jossa F, Krogh V, Giumetti D, Panico S, Scottoni A, Mancini M. Short-term effect of natural disasters on coronary heart disease risk factors. Arteriosclerosis. 1986; 6: 491-494.

4. Kario K, McEwen BS, Pickering TG. Disasters and the heart: a review of the effects of earthquake-induced stress on cardiovascular disease. Hypertens Res. 2003; 26:355-367.

5. Kario K, Matsuo T, Kayaba K, Soukejima S, Kagamimori S, Shimada K. Earthquake-induced cardiovascular disease and related risk factors in focusing on the Great Hanshin-Awaji Earthquake. J Epidemiol. 1998; 8:131-139.

6. Kario K, Matsuo T. Increased incidence of cardiovascular attacks in the epicenter just after the Hanshin-Awaji earthquake. Thromb Haemost. 1995; 74: 1207.

7. Kario K, Matsuo T, Kobayashi H, Yamamoto K, Shimada K. Earthquake-induced potentiation of acute risk factors in hypertensive elderly patients: possible triggering of cardiovascular events after a major earthquake. J Am Coll Cardiol. 1997; 29: 926-933.

8. Kario K, Matsuo T, Shimada K, Pickering TG. Factors associated with the occurrence and magnitude of earthquake-induced increases in blood pressure. Am J Med. 2001; 111: 379-384.

9. Suzuki S, Sakamoto S, Miki T, Matsuo T. Hanshin-Awaji earthquake and acute myocardial infarction [letter]. Lancet. 1995; 345: 981.

10. Itabashi R, Furui E, Sato S, Yazawa Y, Kawata K, Mori E. Incidence of cardioembolic stroke including paradoxical brain embolism in patients with acute ischemic stroke before and after the Great East Japan Earthquake. 2014; 37:431-437.

11 Suzuki H, Ohira T, Takeishi Y,Hosoya M, Yasumura S,Satoh H,Kawasaki Y4,Takahashi A, Sakai A,Ohtsuru A,Kobashi G, Ozasa K, Yamashita S, Kamiya K, Abe M; Fukushima Health Management Survey Group. Increased prevalence of atrial fibrillation after the Great East Japan Earthquake: Results from the Fukushima Health Management Survey. Int J Cardiol. 2015; 198: 102-105.

12. Aoki T, Takahashi J,Fukumoto Y,Yasuda S,Ito K,Miyata S,Shinozaki T,Inoue K,Yagi T, Komaru T,Katahira Y, Obata A,Hiramoto T, Sukegawa H, Ogata K, Shimokawa H. Effect of the Great East Japan earthquake on Cardiovascular Diseases. Circ J. 2013; 77: 490-493.

13. Aoki T,Fukumoto Y,Yasuda S,Sakata Y,Ito K,Takahashi J,Miyata S,Tsuji I, Shimokawa H. The Great East Japan Earthquake Disaster and cardiovascular diseases. Eur Heart J. 2012; 33:2796-2803.

14. Yamauchi H,Yoshihisa A,Iwaya S,Owada T,Sato T,Suzuki S,Yamaki T,Sugimoto K,Kunii H,Nakazato K,Suzuki H,Saitoh S,Takeishi Y. Clinical Features of Patients

With Decompensated Heart Failure After the Great East Japan Earthquake. Am J Cardiol. 2013; 112: 94-99.

15. Yabe H, Suzuki Y, Mashiko H, Nakayama Y, Hisata M, Niwa S, Yasumura S, Yamashita S, Kamiya K, Abe M. Psychological distress after the great East Japan earthquake and fukushima daiichi nuclear power plant accident: results of a mental health and lifestyle survey through the fukushima health management survey in fy2011 and fy2012. Fukushima J Med Sci. 2014; 60:57-67.

16. Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. Psychometric properties of the PTSD Checklist (PCL). Behav Res Ther. 1996; 34: 669-673.

17. Furukawa TA, Kessler RC, Slade T, Andrews G. The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. Psychol Med. 2003; 33:357-362.

18. Sakurai K, Nishi A, Kondo K, Yanagida K, Kawakami N. Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. Psychiatry Clin Neurosci. 2011; 65:434-441.

19. Weathers FW, Litz BT, Herman DS, Huska JA, Keane TM. The PTSD checklist (OCL): Reliability, Validity, and Diagnostic Utility. Paper presented at the Annual Meeting of the International Society for Traumatic Stress Studies, San Antonio, TX. 1993.

20 Pickering TG. Mental stress as a causal factor in the development of hypertension and cardiovascular disease. Curr Hypertens Rep. 2001; 3: 249-254.

21. Kabutoya T, Kario K. Earthquake and blood pressure. Hypertens Res. 2009; 32:732-734.

22. Kario K. Disaster hypertension- its characteristics, mechanism, and management. Circ J. 2012; 76: 553-552.

23. Yokoyama Y, Otsuka K, Kawakami N, Kobayashi S,Ogawa A, Tannno K, Onoda T, Yaegashi Y, Sakata K. Mental health and related factors after the Great East Japan earthquake and tsunami. PLoS One. 2014; 9: e102497.

24. Xu J, Mo L, Xu Z. A cross-sectional study on risk factors of depression severity among survivors of the 2008 Sichuan earthquake. Community Ment Health J. 2013; 49: 847-856.

25. Huang Y, Wong H, Tan HT. Associations between economic loss, financial strain and the psychological status of Wenchuan earthquake surivivors. Disasters. 2015; 39:795-810.

26. Dorahy MJ, Rowlands A, Renouf C, Hanna D, Britt E, Carter JD. Impact of average household income and damage exposure on post-earthquake distress and functioning: A community study following the February 2011 Christchurch earthquake. Br J Psychol. 2015; 106: 526-543.

27. Shea S, Lima J, Diez-Roux A, Jorgensen NW, McClelland RL Socioeconomic Status and Poor Health Outcome at 10 Years of Follow-Up in the Multi-Ethnic Study of Atherosclerosis. PLoS One. 2016; 11

28. Veronesi G, Tunstall-Pedoe H, Ferrario MM, Kee F, Kuulasmaa K, Chambless LE6, Amouyel P, Arveiler D, Bobak M, Ferrieres J, Giampaoli S, Jørgensen T, Peters A, Salomaa V, Soderberg S, Tamosiunas A, Cesana G; MORGAM Project. Combined effect of educational status and cardiovascular risk factors on the incidence of coronary heart disease and stroke in European cohorts: Implications for

prevention. Eur J Prev Cardiol. 2016 Nov 11. pii: 2047487316679521. [Epub ahead of print]

29 Kario K, Matsuo T, Ishida T, Shimada K. 'White coat' hypertension and the Hanshin-Awaji Earthquake. Lancet. 1995; 345: 1346.

30. Satoh H, Ohira T, Hosoya M, Sakai A, Watanabe T, Ohtsuru A et al. Evacuation after the Fukushima Daiichi Nuclear Power Plant Accident Is a Cause of Diabetes: Results from the Fukushima Health Management Survey. J Diabetes Res. 2015.

31. Tsai CL, Chou CH, Lee PJ, Yin JH, Chen SY, Lin CC, Sung YF, Yang FC, Chung CH, Chien WC, Tsai CK, Lee JT. The potential impact of primary headache disorders on stroke risk. J Headache Pain. 2016; 17: 108.

32. Hu X, Zhou Y, Zhao H, Peng C. Migraine and the risk of stroke: an updated meta-analysis of prospective cohort studies. Neurol Sci. 2016 Oct 26. [Epub ahead of print]

33. Doijiri R, Uno H, Miyashita K, Ihara M , Nagatsuka K. How Commonly Is Stroke Found in Patients with Isolated Vertigo or Dizziness Attack? J Stroke Cerebrovasc Dis. 2016; 25: 2549-2552.

34. Haasenritter J, Stanze D,Widera G,Wilimzig C,Abu Hani M,Sonnichsen AC, Bosner S, Rochon J,Donner-Banzhoff N. Does the patient with chest pain have a coronary heart disease? Diagnostic value of single symptoms and signs--a meta-analysis. Croat Med J. 2012; 53:432-441.

35. Sun Z. Cardiovascular responses to cold exposure. Front Biosci (Elite Ed). 2010; 2: 495-503.

36. Nakamura M, Tanaka F, Nakajima S, Honma M, Sakai T, Kawakami M, Endo H, Onodera M, Niiyama M, Komatsu T, Sakamaki K, Onoda T, Sakata K, Morino Y, Takahashi T, Makita S. Comparison of the incidence of acute decompensated heart failure before and after the major tsunami in Northeast Japan. Am J Cardiol. 2012; 110:1856-1860.

Table 1. Characteristics of survey participants and correlated incidence of exacerbation of cardiovascular related symptoms.

	Exacerbation of headache	Exacerbation of dizziness	Exacerbation of palpitation	Exacerbation of shortness of breath
	No. (%)	No. (%)	No. (%)	No. (%)
Sex				
Men	466 (1.4)	341 (1.1)	277 (0.9)	257 (0.8)
Women	1,427 (3.5)	888 (2.2)	808 (2.0)	369 (0.9)
Age				
20-49	966 (3.9)	507 (2.0)	407 (1.6)	147 (0.6)
50-64	514 (2.4)	302 (1.4)	323 (1.5)	159 (0.8)
>=65	413 (1.4)	420 (1.6)	355 (1.3)	320 (0.4)
Mental Health Status				
K6<13	1,092 (1.7)	695 (1.1)	562 (0.9)	355 (0.6)
K6>=13	801 (8.9)	534 (5.3)	523 (5.2)	271 (2.7)
Post Traumatic Stress Disorder				
No	1,062 (1.7)	653 (1.0)	542 (0.9)	323 (0.5)
Yes	831 (8.0)	576 (5.5)	543 (5.2)	303 (2.9)
Smoking Status				
Never-smoker	1,104 (2.7)	715 (1.8)	653 (1.6)	318 (0.8)
Ex-smoker	338 (2.1)	226 (1.4)	214 (1,4)	171 (1.1)

Current smoker	403 (2.8)	258 (1.8)	196 (1.3)	123 (0.8)
Drinking Status				
Never-drinker	1,067 (2.9)	674 (1.8)	597 (1.6)	323 (0.9)
Ex-drinker	80 (2.9)	63 (2.3)	61 (2.2)	41 (1.5)
Current drinker	715 (2.3)	463 (1.5)	407 (1.3)	248 (0.8)
Physical activity				
>= once per day	179 (1.7)	131 (1.2)	96 (0.9)	69 (0.7)
2-4 times per week	309 (2.2)	245 (1.7)	195 (1.4)	123 (0.9)
Once per week	234 (2.4)	143 (1.4)	139 (1.4)	97 (1.0)
Never	1144 (3.2)	687 (1.9)	637 (1.8)	325 (0.9)
Hypertension History				
No	1,216 (2.8)	667 (1.6)	584 (1.4)	276 (0.6)
Yes	677 (2.2)	562 (1.8)	501 (1.6)	350 (1.1)
Stroke History				
No	1,799 (2.6)	1,146 (1.7)	1,799 (1.5)	576 (0.8)
Yes	94 (2.4)	83 (2.2)	94 (1.6)	50 (1.3)
Heart Disease History				
No	1,691 (2.6)	1,025 (1.6)	1,691 (2.6)	432 (0.7)
Yes	202 (10.7)	204 (2.8)	202 (4.0)	194 (2.7)
Unemployment				
No	1,293 (2.2)	874 (1.5)	790 (1.4)	470 (0.8)
Yes	600 (4.2)	355 (2.5)	295 (2.1)	156 (1.1)
Decreased income				

No	1,432 (2.4)	968 (1.6)	870 (1.4)	506 (0.8)
Yes	461 (3.6)	261 (2.0)	215 (1.7)	120 (0.9)
Living arrangement				
Evacuation Shelter Temporary	213 (2.5)	12 (1.6)	5 (0.7)	5 (0.7)
housing	195 (2.8)	134 (1.9)	89 (1.3)	81 (1.2)
Rental house, apartment	796 (3.5)	489 (2.1)	421 (1.8)	224 (1.0)
Relatives' home	78 (2.8)	53 (1.9)	209 (1.0)	108 (0.5)
Own home	292 (1.4)	199 (0.9)	45 (1.6)	29 (1.0)
Tsunami experience				
No	1,424 (2.4)	908 (1.6)	830 (1.4)	458 (0.8)
Yes	469 (3.2)	321 (2.2)	255 (1.7)	168 (1.1)
Experience of the nuclear power plant accident				
No	717 (2.1)	426 (1.2)	358 (1.0)	201 (0.6)
Yes	1,176 (3.1)	803 (2.1)	727 (1.9)	425 (1.1)
Damage of house				
No	413 (2.2)	258 (1.4)	233 (1.3)	103 (0.6)
A part of	911 (2.4)	600 (1.6)	559 (1.5)	347 (0.9)
Half	184 (3.5)	129 (2.5)	83 (1.6)	55 (1.1)
More than a half	67 (3.4)	48 (2.5)	38 (1.9)	23 (1.2)
Totally	126 (3.3)	86 (2.2)	66 (1.7)	43 (1.1)
Loss of family member				
No	552 (3.9)	363 (2.6)	296 (2.1)	199 (1.4)

Yes	1,291 (2.3)	825 (1.5)	759 (1.3)	404 (0.7)	
Educational years					
<12 years (reference)	352 (1.9)	265 (1.4)	223 (1.2)	202 (1.1)	
>=12 years	1,471 (2.9)	916 (1.8)	822 (1.6)	397 (0.8)	

Table 2.Odds ratios (PR) and 95% CIs for cardiovascular related symptoms on multiple logistic regression analyses

		Exacerbation of Headache			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) [f]or women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	2.03 (1.58-2.62)	1.58 (1.19-2.09)	1.95 (1.11-2.57)	1.46 (1.06-2.02)
	Rental house, apartment	2.21 (1.93-2.54)	1.54 (1.32-1.80)	1.83 (1.34-2.53)	1.46 (1.22-1.75)
	Evacuation Shelter	2.01 (1.24-3.25)	1.80 (1.09-2.96)	2.24 (0.99-5.16)	1.61 (0.85-3.03)
	Temporary housing	2.13 (1.77-2.56)	1.42 (1.15-1.72)	1.69 (1.11-3.43)	1.36 (1.06-1.73)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.70 (1.53-1.88)	1.28 (1.12-1.46)	1.36 (1.04-1.78)	1.26 (1.09-1.47)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.56 (1.40-1.74)	1.39 (1.22-1.60)	1.39 (1.08-1.78)	1.39 (1.17-1.63)
Educational years	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	>=12 years	1.02 (0.89-1.16)	1.04 (0.81-1.63)	1.25 (0.91-1.73)	0.97 (0.80-1.17)

		Exacerbation of Dizziness			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) [f]or women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.98 (1.46-2.69)	1.42 (1.02-1.98)	0.96 (0.49-1.91)	1.66 (1.13-2.43)
	Rental house, apartment	2.27 (1.91-2.69)	1.45 (1.20-1.75)	1.28 (0.92-1.79)	1.55 (1.23-1.96)
	Evacuation Shelter	1.84 (1.02-3.32)	1.39 (0.74-2.59)	0.85 (0.26-2.77	1.83 (0.87-3.84)
	Temporary housing	2.09 (1.68-2.61)	1.40 (1.09-1.79)	1.51 (1.00-2.28)	1.36 (1.00-1.85)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.65 (1.45-1.87)	1.26 (1.07-1.48)	1.27 (0.94-1.73)	1.20 (0.98-1.45)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.37 (1.19-1.57)	1.18 (0.99-1.40)	1.12 (0.83-1.51)	1.22 (0.98-1.51)
Educational years	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	>=12 years	1.17 (1.01-1.37)	1.13 (0.94-1.36)	1.08 (0.80-1.47)	1.14 (0.90-1.44)

		Exacerbation of Palpitation			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) for women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.70 (1.23-2.34)	1.23 (0.87-1.74)	1.25 (0.57-2.71)	1.21 (0.82-1.78)
	Rental house, apartment	1.90 (1.60-2.25)	1.25 (1.03-1.51)	1.73 (1.17-2.53)	1.11 (0.89-1.39)
	Evacuation Shelter	0.74 (0.30-1.80)	0.51 (0.19-1.39)	0.93 (0.22-3.92)	0.35 (0.09-1.45)
	Temporary housing	1.32 (1.03-1.69)	0.82 (0.62-1.10)	1.19 (0.69-2.04)	0.72 (0.51-1.01)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.46 (1.27-1.68)	1.21 (1.01-1.45)	1.29 (0.91-1.83)	1.20 (0.97-1.48)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.24 (1.07-1.44)	1.14 (0.94-1.38)	1.46 (1.05-2.03)	1.00 (0.80-1.28)
Educational years	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	>=12 years	1.28 (1.09-1.50)	1.14 (0.93-1.39)	1.15 (0.79-1.67)	1.00 (0.81-1.23)

		Exacerbation of Shortness of Breath			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) for women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.60 (1.02-2.52)	1.16 (0.71-1.90)	0.95 (0.42-2.16)	1.33 (0.72-2.63)
	Rental house, apartment	2.34 (1.85-2.96)	1.76 (1.35-2.28)	1.50 (1.01-2.22)	1.98 (1.39-2.81)
	Evacuation Shelter	1.33 (0.54-3.27)	1.20 (0.48-3.00)	1.73 (0.60-4.95)	0.52 (0.07-3.79)
	Temporary housing	2.29 (1.72-3.06)	1.49 (1.07-2.08)	1.25 (0.75-2.09)	1.72 (1.10-2.68)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.55 (1.29-1.87)	1.13 (0.89-1.44)	1.06 (0.73-1.55)	1.17 (0.85-1.60)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.24 (1.01-1.52)	1.14 (0.89-1.47)	1.18 (0.83-1.69)	1.10 (0.77-1.57)
Educational years	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	>=12 years	0.94 (0.78-1.13)	0.84 (0.67-1.06)	0.76 (0.54-1.07)	0.90 (0.66-1.23

a. Adjusted for age and sex.

b. Further adjusted for drinking status (once or more per month, ex-drinker, less than once per month), smoking status (non-smoker, ex-smoker, current smoker), mental health distress (K6<3, K6>=13), hypertension history (yes or no), stroke history (yes or no), heart disease history (yes or no), physical activities (>= once per day, 2-4 times per week, once per week, never), tsunami experience (yes or no), radiation experience (yes or no), damage of house (no, a part of, half, more than a half, totally), loss of family member (yes or no).

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract (P1-4)	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction (P6-7)		
Background/rationale **(P6)**	2	Explain the scientific background and rationale for the investigation being reported
Objectives **(P7)**	3	State specific objectives, including any prespecified hypotheses
Methods (P7-11)		
Study design **(P7)**	4	Present key elements of study design early in the paper
Setting **(P7)**	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants **(P7)**	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables **(P8-P10)**	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement **(P8-P10)**	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias (None)	9	Describe any efforts to address potential sources of bias
Study size **(P7-8)**	10	Explain how the study size was arrived at
Quantitative variables **(P8-10)**	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods **(P10-11)**	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results (P11-14)		
Participants **(P11-12)**	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data **(P11-13)**	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data **(P11)**	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results **(P13-14)**	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses **None**	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion (P14-18)		
Key results **(P14-18)**	18	Summarise key results with reference to study objectives
Limitations **(P18)**	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation **(P14-18)**	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability **None**	21	Discuss the generalisability (external validity) of the study results
Other information (P19)		
Funding **(P19)**	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

STROBE Statement—checklist of items that should be included in reports of observational studies

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Continued on next page

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Effects of socioeconomic factors after a disaster on cardiovascular related symptoms among evacuees after the Great East Japan Earthquake in a population-based cross-sectional study: the Fukushima Health Management Survey

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Keywords:	Great East Japan Earthquake, socioeconomic factors, cardiovascular related symptoms

Effects of socioeconomic factors after a disaster on cardiovascular related symptoms among evacuees after the Great East Japan Earthquake in a population-based cross-sectional study: the Fukushima Health Management Survey

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Abstract

Objective: To investigate the association between socioeconomic factors and the exacerbation of cardiovascular symptoms among evacuees after Great East Japan Earthquake.

Methods: A total of 73,433 subjects were included in the Fukushima Health Management survey. Exacerbation of headache, dizziness, palpitations, and shortness of breath were determined from self-report questionnaires. Socioeconomic factors included living arrangement, loss of employment and decreased income. Odds ratios (OR) and 95% confidence intervals (CI) of socioeconomic factors were estimated for each symptom using multiple logistic regression analyses.

Results: A total of 1,375 individuals reported exacerbation of headache, 881 of dizziness, 768 of palpitations, and 434 of shortness of breath. Evacuation accommodation was associated with all the above symptoms. Compared to participants living in their own home (OR=1.00), subjects living in relatives' homes had increased odds of experiencing exacerbation of headache (1.58; 95% CI 1.20–2.09) and dizziness (1.43; 95% CI 1.02–1.98); subjects living in temporary housing or apartments showed exacerbation of headache (1.55; 95% CI 1.32–1.81), dizziness (1.45; 95% CI 1.20–1.76), palpitations (1.25; 95% CI 1.03–1.51), and shortness of breath (1.75; 95% CI 1.35–2.27); subjects living in evacuation shelters showed exacerbation of headache (1.80; 95% CI 1.10–2.97); and refugees living in temporary housing showed exacerbated headache (1.42; 95% CI 1.15–1.75), dizziness (1.39; 95% CI 1.08–1.78), and shortness of breath (1.50; 95% CI 1.07–2.09). Compared to the evacuees that retained their jobs, unemployed subjects showed increased odds for exacerbation of headache (1.28, 95% CI 1.12–1.46), dizziness (1.26, 95% CI 1.07–1.48), and

palpitations (1.22, 95% CI 1.02–1.46). Decreased income was associated with exacerbation of headache (1.39, 95% CI 1.21–1.60).

Conclusion: After the earthquake, living in non-home conditions was more likely to exacerbate cardiovascular symptoms among evacuees. Loss of employment was another risk factor for exacerbated headache and dizziness.

Keywords: Great East Japan Earthquake, socioeconomic factors, cardiovascular related symptoms

Strengths and limitations of this study

- Our study is the first to identify an inverse relationship between low socioeconomic status and exacerbated cardiovascular related symptoms among evacuees of the number of 73,433 subjects after the Great East Japan earthquake.
- A limitation of the present study was based on a subjectivity of self-response survey. And the exacerbated symptoms would not be logical predict cardiovascular diseases.
- An overall response rate was low (40.7%) and data may have contained sampling biases.
- Another limitation of the present study was the information of changes in family relationships (e.g., death, physical separation) among the evacuees after the disaster has not been captured.
- In addition, most questionnaires were collected in the same period (from Jan 2012 to Mar 2012).

Introduction

The Great East Japan Earthquake and the subsequent Fukushima Daiichi nuclear disaster, which occurred in March 2011, was the most destructive catastrophe in Japan to date. Due to concerns over released radiation, most of the residents in nearby towns were forced to evacuate and consequently suffered long-lasting anxiety. Shortly after the disaster, a Fukushima Health Management Survey was conducted to investigate the effects of long-term low-dose radiation exposure caused by the accident and to assess the physical and mental wellbeing of evacuees. This survey included a basic survey, which estimated individual radiation exposure of each resident, and four detailed surveys comprising of a Comprehensive Health Check and thyroid ultrasonography, a mental health and lifestyle survey, and a survey of pregnant women and nursing mothers (1). The Mental Health and Lifestyle Survey used self-report questionnaires to investigate health status and lifestyle of the refugees, including nutrition and diet, perceived symptoms of illness, disaster-related experience, and socioeconomic determinants.

Several previous studies have shown changes in the incidence of cardiovascular events following disasters; however, results are conflicting (2-11). A recent study reported a heterogeneous occurrence of cardiovascular events after the Great East Japan Earthquake (2), while another study reported a significant increase in the incidence of cardioembolic stroke after the earthquake (11). However, neither study examined the incidence of perceived cardiovascular disease symptoms after a disaster, nor did they focus on the effect of refugee socioeconomic status on health problems during their evacuation term. However, considering these aspects is relevant for

reviewing refugee health status, accessing the incidence of various diseases, and providing health guidelines for refugees.

Consequently, we conducted the present study to investigate the risk factors of perceived cardiovascular symptoms following a major disaster. In the present study, socioeconomic determinants included educational years, living arrangement, change of employment and income. Due to the special post-disaster situation, change of employment and income due to the disaster, instead of job and income level were captured. Thus in the present study, a decrease or low socioeconomic status was considered as less educational years, living in non-home conditions, unemployment or decreased income due to the disaster. We hypothesized that a decrease in socioeconomic status due to the earthquake would be associated with exacerbated cardiovascular symptoms among evacuees.

Methods

Participants

The primary purpose of the Fukushima Health Management Survey was to monitor the long-term health and lifestyle of Fukushima residents and to provide them with appropriate care (12). The Fukushima Health Management Survey consists of a basic survey and four detailed surveys, namely, the thyroid ultrasound examination, comprehensive health check, mental health and lifestyle survey, and pregnancy and birth survey (for details of these surveys see (1)). The subjects of mental health and lifestyle survey was included in the present study. Briefly, the target population, consists of 210,189 officially registered victims of the Great East Japan Earthquake from the 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 were sent out with 73,569 questionnaires returned with responses, i.e. a response rate of 40.7%. Among the responders, 136 were excluded due to blank or duplicated questionnaires and 9,245 for questionnaires filled in by a proxy. After exclusion, the data of 73,433 subjects (32,301 men and 41,132 women) were used in our analyses.

The study protocol was approved by the Ethics Committee of Fukushima Medical University. Participants who returned the self-administered questionnaires were considered to have consented to participate.

Data collection and measurement

A questionnaire was used to broadly investigate the health status and lifestyle of the refugees. The exacerbation of headache, dizziness, palpitations, and shortness of breath was determined based on self-reports in the questionnaire. All subjects were asked to answer the question 'Do you have the following perceived symptoms after the earthquake?' and could choose between the replies 'No', 'Yes', and 'Exacerbation'. In the present study we focused on reports of 'exacerbation'.

To evaluate Posttraumatic Stress Disorder (PTSD) symptoms we used the non-military version of the Posttraumatic Stress Disorder Checklist (PCL-S) (12). This is a 17-item self-report checklist based on the Diagnostic and Statistical Manual of Mental Disorders (4th edition, DSM-IV) criteria (13), with each item rated using a Likert-type scale from one ('not at all') to five ('extremely'). Respondents were requested to respond to questions about each PTSD symptom separately and report whether they

had experienced a given symptom during the past month. Based on summing the scores from each of the 17 items, a total PCL-S score can range from 17 to 85 (12).

In addition to the PCL-S checklist, the following items were included in the self-assessment and self-report questionnaires:

1. Demographic characteristics

Demographic subject characteristics include gender, age group, mental health status, history of mental illness, incidence of PTSD symptoms, smoking and drinking habits, and current physical activity levels. Age groups were divided into childbearing age (20–49 years), middle age (50–64 years), and old age (65 years and above).

Mental health status, and specifically incidence and severity of depression, was measured by the Japanese version of the K6 Kessler Psychological Distress Scale, which has been validated by previous studies (14, 15). In the K6 assessment, participants were asked if they had experienced any of the following six symptoms during the past 30 days: feeling so depressed that nothing could cheer them up, feeling that everything was an effort, or feeling nervous, hopeless, restless, fidgety, or worthless. Each question was rated on a 5-point Likert-type scale from zero (none of the time) to four (all of the time), with higher scores signifying worse mental health status (total range: 0–24) (12). In addition, we assessed participant's history of mental illness by self-report as 'yes' or 'no'.

We obtained data on smoking and drinking habits using the following metrics, respectively: 'non-smoker', 'ex-smoker', or 'current smoker'; and 'once or more per month', 'less than once per month', or 'ex- drinker'. Participants had four options to assess current physical activity level: 'every day', '2-4 times/week', 'once a week', or 'nearly none'.

2. Socioeconomic variables

Participants were required to select from six options regarding their living arrangements: evacuation shelter, temporary housing, rental housing or apartment, a relative's home, their own home, and other. The last option was considered non-informative due to its ambiguity and thus excluded from analysis.

Other socioeconomic variables included educational years (< 12 years, >=12 years), change in employment status and change in income. By answering 'Yes' to either question, the participant indicated he/she became unemployed or experienced decreased income since the disaster.

3. Disaster-related variables

Disaster-related variables included experience of the tsunami (yes or no), experience of the nuclear power plant accident (defined as hearing the explosion; yes or no), losing someone close because of the disaster (yes or no), and damage to accommodation (no, partial damage, half of accommodation destroyed, more than a half destroyed, total destruction).

Statistical analysis

The incidence of exacerbation of headache, dizziness, palpitations, and shortness of breath was compared between subjects with different demographic, socioeconomic, and disaster-related characteristics using chi-square tests. For the analyses investigating PTSD incidence, a PCL-S cut-off score of 50 was used, according to Weathers et al (16-19). Subjects who received a PCL-S of 50 or greater were allocated to the 'high-scoring group' and compared to the low-scoring (PCL-S < 50) group using chi-square tests.

Odds ratios (ORs) and 95% confidence intervals (CIs) of each socioeconomic determinant (living arrangement, unemployment, decreased income and educational years were estimated by applying multiple logistic regression models. Adjustment variables consisted of sex (male, female), age (20–49, 50–64, ≥65 years), drinking status (once or more per month, ex-drinker, less than once per month), smoking status (non-smoker, ex-smoker, current smoker), mental health distress (K6<3, K6>=13), hypertension history (yes or no), stroke history (yes or no), heart disease history (yes or no), physical activities (>= once per day, 2–4 times per week, once per week, never), tsunami experience (yes or no), radiation experience (yes or no), damage of accommodation (no, partial, half, more than a half, total), loss of family member (yes or no).

We conducted the above analyses both for separate and combined sexes. All analyses were conducted using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

As shown in the tables, 1,893 (2.6%) individuals reported exacerbation of headaches, 1,229 (1.7%) of dizziness, 626 (0.9%) of palpitations, and 434 (0.6%) exacerbation of shortness of breath.

Demographic characteristics

Table 1 summarizes the demographic characteristics of the subjects. Exacerbation of the above cardiovascular symptoms was significantly more likely to happen in women than in men (3.5% vs. 1.4% for headaches; 2.2% vs. 1.1% for dizziness; 2.0% vs. 0.9% for palpitations; 0.9% vs. 0.8% for shortness of breath). Subjects experiencing

exacerbation of headaches, dizziness, or palpitations were more likely to be young (20–49 years), while those experiencing exacerbation of shortness of breath were more likely to be 50-64 years. Subjects experiencing exacerbation of cardiovascular symptoms were also more likely to suffer from depression (K6>=13) and Posttraumatic Stress Disorder (PCL>=50), and to commonly have a history of hypertension, stroke, or heart disease. Non-smokers and non-drinkers were no less likely than (ex-) smokers or (ex-) drinkers to experience exacerbation of cardiovascular symptoms. However, symptom exacerbation was most pronounced in subjects who were physically active less than once a day.

Socioeconomic variables

Table 1 also shows refugees living in their own or a relative's home are less likely to experience exacerbated cardiovascular symptoms. Of the refugees living in their own home, 1.4% reported exacerbation of headache, 0.9% of dizziness, 1.6% of palpitations and 1.0% of shortness of breath. The corresponding statistics for refugees living in temporary housing and rental houses/apartments were 2.8%, 1.9%, 1.3%, and 1.2% and 3.5%, 2.1%, 1.8%, and 1.0%, respectively.

In the group that became unemployed due to the disaster, 4.2% subjects reported the exacerbation of headache, 2.5% of dizziness, 2.1% of palpitations and 1.1% of shortness of breath, while the corresponding statistics for the group that did not lose their jobs after the disaster were 2.2%, 1.5%, 1.4%, and 0.8%. Exacerbation of most cardiovascular symptoms was higher in subjects whose income decreased due to the disaster compared to those who maintained income levels (3.6% vs. 2.4% for exacerbation of headache, 2.0% vs. 1.6% for exacerbation of dizziness, and 1.7% vs. 1.4% for exacerbation of palpitation).

In addition, exacerbation of most cardiovascular symptoms was higher in subjects who had 12 years education or more compared to those who had less education (2.9% vs. 1.9% for exacerbation of headache, 1.8% vs. 1.4% for exacerbation of dizziness, and 1.6% vs. 1.2% for exacerbation of palpitation).

Disaster-related variables

Subjects that directly experienced the tsunami and the nuclear power plant accident were more likely to experience exacerbated cardiovascular symptoms. Among those experiencing the tsunami, 3.2% reported exacerbation of headache, 2.2% of dizziness, 1.7% of palpitations, and 1.7% of shortness of breath, compared to 2.4%, 1.6%, 1.5%, and 0.8%, respectively, of subjects with no experience of the tsunami. The corresponding statistics for subjects that had heard the nuclear power plant accident were 3.1%, 2.1%, 1.9%, and 1.1% compared to 2.1%, 1.2%, 1.0%, and 0.6%, that had not.

Multiple Logistic Regression analyses

Table 2 summarizes the odds ratios (ORs) and 95% CIs of each socioeconomic determinant for exacerbation of headache, dizziness, palpitations, and shortness of breath. Living arrangement emerged as a risk factor for exacerbated cardiovascular symptoms from our models, which were adjusted for multiple demographic-, health-, and disaster-related variables. Compared to participants living in their own home (OR = 1), those living in relatives' homes had higher odds to experience exacerbation of headache (1.58; 95% CI 1.19–2.09) and dizziness (1.42; 95% CI 1.02–1.98). Similarly, subjects living in rental houses or apartments had higher odds of exacerbated headache (1.54; 95% CI 1.32–1.80), dizziness (1.45; 95% CI 1.20–1.75), palpitations

(1.25; 95% CI 1.03–1.51), and shortness of breath (1.76; 95% CI 1.35–2.28). Participants living in evacuation shelters had increased odds of exacerbation of headache (1.80; 95% CI 1.09–2.96) and refugees living in temporary housing similarly had increased odds of exacerbation of headache (1.42; 95% CI 1.15–1.72), dizziness (1.40; 95% CI 1.09–1.79), and shortness of breath (1.49; 95% CI 1.07–2.08).

Loss of employment also emerged as a risk factor for increased odds of cardiovascular symptoms. Compared to the evacuees that remained employed (OR = 1), subjects that had become unemployed were at higher risk of experiencing exacerbation of headache (1.28; 95% CI 1.12–1.46), dizziness (1.26; 95% CI 1.07–1.48), and palpitation (1.21; 95% 1.01–1.45). In an unadjusted model, we found a significant positive association between unemployment and exacerbation of palpitations; however, after adjusting for multiple relevant variables, this association became non-significant.

There was no association between decreased income and exacerbated cardiovascular symptoms, except for headache. Here, adjusting for multiple variables resulted in an increased odds ratio for exacerbation of headaches both in an analysis combining both sexes (1.39, 95% CI 1.22–1.60) and in separate analyses of men and women.

Educational years was not associated with and exacerbated cardiovascular symptoms in multiple-adjusted models in the present study.

Discussion

We have demonstrated a decrease in socioeconomic status due to the earthquake was associated with exacerbated cardiovascular symptoms among evacuees of the

Great East Japan Earthquake. Compared with participants living in their own home, people of both genders living in relatives' homes, evacuation shelters, temporary housing, or rental houses or apartments were more likely to experience exacerbated headache, dizziness, palpitations, or shortness of breath. Similarly, loss of employment and reduced income due to the disaster increased the risk of exacerbated symptoms.

The following three points should be considered in the context of our results. Firstly, earthquakes are definitely associated with increased cardiovascular disease, including sudden cardiac death and acute myocardial infarction (2-14), which provides some support for the present study. The Hanshin-Awaji earthquake was associated with an increased cardiovascular disease and the increase persisted for more than a month. In addition, an increase in the number of subjects with acute myocardial infarction, especially in women, was particularly evident during the first 4 weeks post-disaster (9). After the Great East Japan Earthquake, the incidence of reported cardioembolic stroke increased in the first 3–9 months following the disaster (10), as did the incidence of other cardiovascular diseases (11-14). Our study contributes to the reported incidences of cardiovascular disease by demonstrating exacerbated cardiovascular symptoms among evacuees after a disaster from self-report questionnaires rather than from death certificates.

Secondly, increases in cardiovascular events and exacerbated cardiovascular symptoms can be attributed to post-disaster distress or mental problems. A review suggests that extremely stressful experiences, such as earthquakes, can trigger cardiovascular events (20-22). Acute major stress and chronic stress, i.e. the cumulative load of minor daily stress, can have both long-term consequences, which can be perceived as stressful and a potential threat to one's environment, subsequently

inducing a variety of negative emotional responses, such as fear, anxiety, sadness, anger, hostility, and depression (4,23) leading to hypertension or cardiovascular events (20-22). A recent study suggest that post-traumatic stress disorder (PTSD) was frequently noted in CVD patients at 6 months after the Great East Japan Earthquake. The patients with PTSD were more likely to experience a composite of death, acute myocardial infarction, stroke and heart disease (24). In the current study, all subjects exhibiting exacerbated cardiovascular symptoms were more likely to have depression (K6>=13) or Posttraumatic Stress Disorder (PCL>=50). Logistic regression analyses also showed that depression and Posttraumatic Stress Disorder were both independently associated with exacerbated cardiovascular symptoms (data not shown).

Thirdly, although post-disaster increases in cardiovascular events were widely reported in previous studies, the investigation of socioeconomic determinants of these events during the evacuation term of refugees was very limited. Previous studies reported that one year after the Wenchuan Earthquake in China, depression severity among refugees varied with income, housing status, and social support (25), indicating that earthquake impact on income was indirectly associated with life satisfaction and depression via its effect on financial status (26). Another study showed that six months after the 2011 Christchurch earthquake in New Zealand, on average lower income per home contributed unequivocally to earthquake-related distress and dysfunction (27). A recent study also showed that at 6 months after the Great East Japan Earthquake, Tsunami experience, property loss and poverty were associated with PTSD in CVD patients and had an had an adverse prognostic impact (24).

In the present study, not living in the own home but living in evacuation shelters or temporary housing, was associated with exacerbation of all examined cardiovascular

symptoms, which was more robust in women than in men. Evacuation shelters and temporary housing were less spacious, damper, and less comfortable than the refugees' homes. Due to insufficient access to supermarkets or shortages of cooking equipment and utilities, such as gas, evacuees living in shelters would struggle to access balanced meals. A recent cross-sectional study showed a well-balanced diet was associated with better living conditions among refugees after the Great East Japan Earthquake, whereas imbalanced diets, were not (27,28). In addition, having to take refuge in accommodation other than the own home meant that the own neighborhood had been damaged by the disaster, which may lead to shortness of social support. In addition, among the refugees. All of the above factors can be considered predictors of stress among refugees, where women may be more likely to be influenced than men.

Unemployment and decreased income due to the disaster were also associated with exacerbation of some cardiovascular symptoms. These results were expected as poor economic circumstances are expected to exacerbate depression. Low income may be considered a chronic stressor, increasing psychological distress as a result of limited resource access and opportunities for resource accumulation (29). Previous studies also showed that, following an earthquake, living in a low-income area may contribute to greater psychological distress due to lack of occupational, social, and financial resources. A community study showed that, after the Christchurch earthquake, low household income contributed strongly to earthquake-related distress (29). In the present study, we found a significant association between disaster-related unemployment and exacerbation of some cardiovascular symptoms, but the subsistence allowance provided to refugees by the Japanese government may have

reduced effect size by reducing the impact of lowered economic circumstances on refugees.

Educational level was inversely associated with cardiovascular disease risk in present studies (30, 31). However, in present study, educational years was not associated with exacerbated cardiovascular symptoms. It may due to the post-disaster conditions. In the present study, both earthquake, tsunami and nuclear accident related factors and unemployment or decreased income due to the disasters had a large influence on the exacerbated cardiovascular symptoms of the subjects, which may weaken the impact from the educational levels.

Our understanding of disaster-related stress on cardiovascular disease remains incomplete. A clinical study on the 1995 Hanshin-Awaji earthquake comparing pre- and post- BP levels in well-controlled hypertension patients showed an increase of 18mmHg in diastolic blood pressure two weeks after the earthquake (32). Although white-coat hypertension contributed partly to the results, whereby patients exhibit increased blood pressure in clinical settings, some patients developed sustained hypertension that persisted for one year after the earthquake (32). One study found increased levels of cholesterol and triglycerides a few weeks after an earthquake (3), whereas other studies failed to show significantly higher total cholesterol or HDL-cholesterol during the first two weeks after the Hanshin-Awaji earthquake (6). Therefore, the extent to which changes in blood lipid profile contributes to exacerbated cardiovascular symptoms several months after the Great East Japan Earthquake remains undetermined. Chronic psychological stress is also associated with increased insulin resistance (4). A recent study after the Great East Japan Earthquake found the negative effects of the disaster

on metabolic factors were greater among evacuees than non-evacuees (33), which may contribute to exacerbated cardiovascular symptoms among evacuees.

The large scale of assessment and assessment under post-disaster conditions provide considerable authority for the present study. In addition, our study is the first to identify an inverse relationship between low socioeconomic status and exacerbated cardiovascular symptoms from an evacuee self-report after a disaster; our results will be useful for generating guidelines for evacuee health. However, the following study limitations should be considered: Firstly, The study was based on a subjectivity of self-response survey. It is reasonable to understand these symptoms as those related to stress and/or autonomic nervous system disorders. Further information, such as the incidence of cardiovascular disease should be captured. However, though the above-mentioned symptoms would not be logical predict cardiovascular diseases, several previous studies showed headache was suggestive of an incremental risk for stroke (34, 35), and other studies also showed that vertigo or dizziness, chest pain was associated with cardiovascular problems (36, 37). We also conducted a sub-analyses suggest that all the above-mentioned symptoms were associated with the diagnosis of hypertension in the last year by self-report and exacerbation of dizziness, palpitation and shortness of breath was associated with the diagnosis of heart disease in the last year by self-report among the evacuees (data not shown). Therefore, our study of the 4 symptoms may be helpful for improvement of evacuees' health to some extent. Secondly, not only the Great East Japan Earthquake but also the accompanied nuclear accident had a large psychological impact on the evacuees, thus the present study may cannot be unconditionally compared with other studies due to the special situation. Thirdly, the overall response rate was low (40.7%) and data may have contained

sampling biases. Thirdly, under the extraordinary and unusual social circumstances that follow a major disaster, health symptoms perceived by evacuees may be strongly influenced by changes in family relationships (e.g., death, physical separation) among the evacuees. However, the present study did not capture these information. Moreover, other socioeconomic determinants, such as household income, and other cardiovascular risk factors, such as blood pressure, cholesterol levels, were not captured in the present study either. In addition, although most questionnaires were collected in the same period (from Jan 2012 to Mar 2012), it is possible the timing of the survey affected the perceived cardiovascular symptoms. Finally, other environmental factors, such as temperature, food supplies, medical facilities may also affect cardiovascular problems (38, 39). These information were not collected in the present study. The potential associations observed in this study will be investigated over an extended period.

In conclusion, the present study was the first to identify a relationship between lower socioeconomic status due to the earthquake with exacerbated cardiovascular symptoms among evacuees after the Great East Japan Earthquake. Our findings will inform future periodic health examinations and health guidelines for evacuees.

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Contributors

WZ and TO designed the study. TO, SY, MM, MH. NH, YS, HY, MH, HT and AO were responsible for the data collection and overseeing study procedures. The analyses was conducted by WZ and TO. The manuscript was made by WZ. All the authors did contribution to the revision of the manuscript. All the authors read and approved the final version of the manuscript.

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Declaration of interests

We declare that we have no competing interests.

Patient consent

Obtained.

Data sharing statement

No additional data are available.

References

1. Yasumura S, Hosoya M, Yamashita S, Kamiya K, Abe M, Akashi M, Kodama K, Ozasa K; Fukushima Health Management Survey Group. Study protocol for the Fukushima Health Management Survey. J Epidemiol. 2012; 22: 375-383.

2. Nozaki E, Nakamura A, Abe A, Kagaya Y, Kohzu K, Sato K, Nakajima S, Fukui S, Endo H, Takahashi T, Seki H, Tamaki K, Mochizuki I. Occurrence of cardiovascular events after 2011 Great East Japan Earthquake and tsunami disaster. Int Heart J. 2013; 54: 247-253.

3. Trevisan M, Celentano E, Meucci C, Farinaro E, Jossa F, Krogh V, Giumetti D, Panico S, Scottoni A, Mancini M. Short-term effect of natural disasters on coronary heart disease risk factors. Arteriosclerosis. 1986; 6: 491-494.

4. Kario K, McEwen BS, Pickering TG. Disasters and the heart: a review of the effects of earthquake-induced stress on cardiovascular disease. Hypertens Res. 2003; 26:355-367.

5. Kario K, Matsuo T, Kayaba K, Soukejima S, Kagamimori S, Shimada K. Earthquake-induced cardiovascular disease and related risk factors in focusing on the Great Hanshin-Awaji Earthquake. J Epidemiol. 1998; 8:131-139.

6. Kario K, Matsuo T. Increased incidence of cardiovascular attacks in the epicenter just after the Hanshin-Awaji earthquake. Thromb Haemost. 1995; 74: 1207.

7. Kario K, Matsuo T, Kobayashi H, Yamamoto K, Shimada K. Earthquake-induced potentiation of acute risk factors in hypertensive elderly patients: possible triggering

of cardiovascular events after a major earthquake. J Am Coll Cardiol. 1997; 29: 926-933.

8. Kario K, Matsuo T, Shimada K, Pickering TG. Factors associated with the occurrence and magnitude of earthquake-induced increases in blood pressure. Am J Med. 2001; 111: 379-384.

9. Suzuki S, Sakamoto S, Miki T, Matsuo T. Hanshin-Awaji earthquake and acute myocardial infarction [letter]. Lancet. 1995; 345: 981.

10.Itabashi R, Furui E, Sato S, Yazawa Y, Kawata K, Mori E. Incidence of cardioembolic stroke including paradoxical brain embolism in patients with acute ischemic stroke before and after the Great East Japan Earthquake. Cerebrovasc Dis .2014; 37:431-437.

11 Suzuki H, Ohira T, Takeishi Y,Hosoya M, Yasumura S,Satoh H,Kawasaki Y4,Takahashi A, Sakai A,Ohtsuru A,Kobashi G, Ozasa K, Yamashita S, Kamiya K, Abe M; Fukushima Health Management Survey Group. Increased prevalence of atrial fibrillation after the Great East Japan Earthquake: Results from the Fukushima Health Management Survey. Int J Cardiol. 2015; 198: 102-105.

12. Aoki T, Takahashi J,Fukumoto Y,Yasuda S,Ito K,Miyata S,Shinozaki T,Inoue K,Yagi T, Komaru T,Katahira Y, Obata A,Hiramoto T, Sukegawa H, Ogata K, Shimokawa H. Effect of the Great East Japan earthquake on Cardiovascular Diseases. Circ J. 2013; 77: 490-493.

13. Aoki T,Fukumoto Y,Yasuda S,Sakata Y,Ito K,Takahashi J,Miyata S,Tsuji I, Shimokawa H. The Great East Japan Earthquake Disaster and cardiovascular diseases. Eur Heart J. 2012; 33:2796-2803.

14. Yamauchi H,Yoshihisa A,Iwaya S,Owada T,Sato T,Suzuki S,Yamaki T,Sugimoto K,Kunii H,Nakazato K,Suzuki H,Saitoh S,Takeishi Y. Clinical Features of Patients With Decompensated Heart Failure After the Great East Japan Earthquake. Am J Cardiol. 2013; 112: 94-99.

15. Yabe H, Suzuki Y, Mashiko H, Nakayama Y, Hisata M, Niwa S, Yasumura S, Yamashita S, Kamiya K, Abe M. Psychological distress after the great East Japan earthquake and fukushima daiichi nuclear power plant accident: results of a mental health and lifestyle survey through the fukushima health management survey in fy2011 and fy2012. Fukushima J Med Sci. 2014; 60:57-67.

16. Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. Psychometric properties of the PTSD Checklist (PCL). Behav Res Ther. 1996; 34: 669-673.

17. Furukawa TA, Kessler RC, Slade T, Andrews G. The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. Psychol Med. 2003; 33:357-362.

18. Sakurai K, Nishi A, Kondo K, Yanagida K, Kawakami N. Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. Psychiatry Clin Neurosci. 2011; 65:434-441.

19. Weathers FW, Litz BT, Herman DS, Huska JA, Keane TM. The PTSD checklist (OCL): Reliability, Validity, and Diagnostic Utility. Paper presented at the Annual Meeting of the International Society for Traumatic Stress Studies, San Antonio, TX. 1993.

20 Pickering TG. Mental stress as a causal factor in the development of hypertension and cardiovascular disease. Curr Hypertens Rep. 2001; 3: 249-254.

21. Kabutoya T, Kario K. Earthquake and blood pressure. Hypertens Res. 2009; 32:732-734.

22. Kario K. Disaster hypertension- its characteristics, mechanism, and management. Circ J. 2012; 76: 553-552.

23.Yokoyama Y, Otsuka K, Kawakami N, Kobayashi S,Ogawa A, Tannno K, Onoda T, Yaegashi Y, Sakata K. Mental health and related factors after the Great East Japan earthquake and tsunami. PLoS One. 2014; 9: e102497.

24. 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. Predictors and prognostic impact of post-traumatic stress disorder after the great East Japan earthquake in patients with cardiovascular disease. Circ J. 2015; 79: 664-667.

25. Xu J, Mo L, Xu Z. A cross-sectional study on risk factors of depression severity among survivors of the 2008 Sichuan earthquake. Community Ment Health J. 2013; 49: 847-856.

26. Huang Y, Wong H, Tan HT. Associations between economic loss, financial strain and the psychological status of Wenchuan earthquake surivivors. Disasters. 2015; 39:795-810.

27. Nishi N, Yoshimura E, Ishikawa-Takata K, Tsuboyama-Kasaoka N, Kubota T, Miyachi M, Tokudome S, Yokoyama Y, Sakata K, Kobayashi S, Ogawa A. Relationship of living conditions with dietary patterns among survivors of the great East Japan earthquake. J Epidemiol. 2013; 5: 376-381.

28. Zhang W, Ohira T, Abe M, Kamiya K, Yamashita S, Yasumura S, Ohtsuru A, Masaharu M, Harigane M, Horikoshi N, Suzuki Y, Yabe H, Yuuki M, Nagai M, Takahashi H, Nakano H; Fukushima Health Management Survey Group. Evacuation after the Great East Japan Earthquake was associated with poor dietary intake: The Fukushima Health Management Survey. J Epidemiol. 2017; 27: 14-23.

29. Dorahy MJ, Rowlands A, Renouf C, Hanna D, Britt E, Carter JD. Impact of average household income and damage exposure on post-earthquake distress and functioning: A community study following the February 2011 Christchurch earthquake. Br J Psychol. 2015; 106: 526-543.

30. Shea S, Lima J, Diez-Roux A, Jorgensen NW, McClelland RL Socioeconomic Status and Poor Health Outcome at 10 Years of Follow-Up in the Multi-Ethnic Study of Atherosclerosis. PLoS One. 2016; 11

31. Veronesi G, Tunstall-Pedoe H, Ferrario MM, Kee F, Kuulasmaa K, Chambless LE6, Amouyel P, Arveiler D, Bobak M, Ferrieres J, Giampaoli S, Jørgensen T, Peters A, Salomaa V, Soderberg S, Tamosiunas A, Cesana G; MORGAM Project. Combined effect of educational status and cardiovascular risk factors on the incidence of coronary heart disease and stroke in European cohorts: Implications for prevention. Eur J Prev Cardiol. 2016 Nov 11. pii: 2047487316679521. [Epub ahead of print]

32. Kario K, Matsuo T, Ishida T, Shimada K. 'White coat' hypertension and the Hanshin-Awaji Earthquake. Lancet. 1995; 345: 1346.

33. Satoh H, Ohira T, Hosoya M, Sakai A, Watanabe T, Ohtsuru A et al. Evacuation after the Fukushima Daiichi Nuclear Power Plant Accident Is a Cause of Diabetes: Results from the Fukushima Health Management Survey. J Diabetes Res. 2015.

34. Tsai CL, Chou CH, Lee PJ, Yin JH, Chen SY, Lin CC, Sung YF, Yang FC, Chung CH, Chien WC, Tsai CK, Lee JT. The potential impact of primary headache disorders on stroke risk. J Headache Pain. 2016; 17: 108.

35. Hu X, Zhou Y, Zhao H, Peng C. Migraine and the risk of stroke: an updated meta-analysis of prospective cohort studies. Neurol Sci. 2016 Oct 26. [Epub ahead of print]

36. Doijiri R, Uno H, Miyashita K, Ihara M , Nagatsuka K. How Commonly Is Stroke Found in Patients with Isolated Vertigo or Dizziness Attack? J Stroke Cerebrovasc Dis. 2016; 25: 2549-2552.

37. Haasenritter J, Stanze D,Widera G,Wilimzig C,Abu Hani M,Sonnichsen AC, Bosner S, Rochon J,Donner-Banzhoff N. Does the patient with chest pain have a coronary heart disease? Diagnostic value of single symptoms and signs--a meta-analysis. Croat Med J. 2012; 53:432-441.

38. Sun Z. Cardiovascular responses to cold exposure. Front Biosci (Elite Ed). 2010; 2: 495-503.

39. Nakamura M, Tanaka F, Nakajima S, Honma M, Sakai T, Kawakami M, Endo H, Onodera M, Niiyama M, Komatsu T, Sakamaki K, Onoda T, Sakata K, Morino Y, Takahashi T, Makita S. Comparison of the incidence of acute decompensated heart failure before and after the major tsunami in Northeast Japan. Am J Cardiol. 2012; 110:1856-1860.

635

Table 1. Characteristics of survey participants and correlated incidence of exacerbation of cardiovascular related symptoms.

	Exacerbation of headache	Exacerbation of dizziness	Exacerbation of palpitation	Exacerbation of shortness of breath
	No. (%)	No. (%)	No. (%)	No. (%)
Sex				
Men	466 (1.4)	341 (1.1)	277 (0.9)	257 (0.8)
Women	1,427 (3.5)	888 (2.2)	808 (2.0)	369 (0.9)
Age				
20-49	966 (3.9)	507 (2.0)	407 (1.6)	147 (0.6)
50-64	514 (2.4)	302 (1.4)	323 (1.5)	159 (0.8)
>=65	413 (1.4)	420 (1.6)	355 (1.3)	320 (0.4)
Mental Health Status				
K6<13	1,092 (1.7)	695 (1.1)	562 (0.9)	355 (0.6)
K6>=13	801 (8.9)	534 (5.3)	523 (5.2)	271 (2.7)
Post Traumatic Stress Disorder				
No	1,062 (1.7)	653 (1.0)	542 (0.9)	323 (0.5)
Yes	831 (8.0)	576 (5.5)	543 (5.2)	303 (2.9)
Smoking Status				
Never-smoker	1,104 (2.7)	715 (1.8)	653 (1.6)	318 (0.8)
Ex-smoker	338 (2.1)	226 (1.4)	214 (1,4)	171 (1.1)

Current smoker	403 (2.8)	258 (1.8)	196 (1.3)	123 (0.8)
Drinking Status				
Never-drinker	1,067 (2.9)	674 (1.8)	597 (1.6)	323 (0.9)
Ex-drinker	80 (2.9)	63 (2.3)	61 (2.2)	41 (1.5)
Current drinker	715 (2.3)	463 (1.5)	407 (1.3)	248 (0.8)
Physical activity				
>= once per day	179 (1.7)	131 (1.2)	96 (0.9)	69 (0.7)
2-4 times per week	309 (2.2)	245 (1.7)	195 (1.4)	123 (0.9)
Once per week	234 (2.4)	143 (1.4)	139 (1.4)	97 (1.0)
Never	1144 (3.2)	687 (1.9)	637 (1.8)	325 (0.9)
Hypertension History				
No	1,216 (2.8)	667 (1.6)	584 (1.4)	276 (0.6)
Yes	677 (2.2)	562 (1.8)	501 (1.6)	350 (1.1)
Stroke History				
No	1,799 (2.6)	1,146 (1.7)	1,799 (1.5)	576 (0.8)
Yes	94 (2.4)	83 (2.2)	94 (1.6)	50 (1.3)
Heart Disease History				
No	1,691 (2.6)	1,025 (1.6)	1,691 (2.6)	432 (0.7)
Yes	202 (10.7)	204 (2.8)	202 (4.0)	194 (2.7)
Unemployment				
No	1,293 (2.2)	874 (1.5)	790 (1.4)	470 (0.8)
Yes	600 (4.2)	355 (2.5)	295 (2.1)	156 (1.1)
Decreased income				

No	1,432 (2.4)	968 (1.6)	870 (1.4)	506 (0.8)
Yes	461 (3.6)	261 (2.0)	215 (1.7)	120 (0.9)
Living arrangement				
Evacuation Shelter Temporary	213 (2.5)	12 (1.6)	5 (0.7)	5 (0.7)
housing	195 (2.8)	134 (1.9)	89 (1.3)	81 (1.2)
Rental house, apartment	796 (3.5)	489 (2.1)	421 (1.8)	224 (1.0)
Relatives' home	78 (2.8)	53 (1.9)	209 (1.0)	108 (0.5)
Own home	292 (1.4)	199 (0.9)	45 (1.6)	29 (1.0)
Tsunami experience				
No	1,424 (2.4)	908 (1.6)	830 (1.4)	458 (0.8)
Yes	469 (3.2)	321 (2.2)	255 (1.7)	168 (1.1)
Experience of the nuclear power				
plant accident				
No	717 (2.1)	426 (1.2)	358 (1.0)	201 (0.6)
Yes	1,176 (3.1)	803 (2.1)	727 (1.9)	425 (1.1)
Damage of house				
No	413 (2.2)	258 (1.4)	233 (1.3)	103 (0.6)
A part of	911 (2.4)	600 (1.6)	559 (1.5)	347 (0.9)
Half	184 (3.5)	129 (2.5)	83 (1.6)	55 (1.1)
More than a half	67 (3.4)	48 (2.5)	38 (1.9)	23 (1.2)
Totally	126 (3.3)	86 (2.2)	66 (1.7)	43 (1.1)
Loss of family member				
No	552 (3.9)	363 (2.6)	296 (2.1)	199 (1.4)

Yes	1,291 (2.3)	825 (1.5)	759 (1.3)	404 (0.7)	
Educational years					
<12 years (reference)	352 (1.9)	265 (1.4)	223 (1.2)	202 (1.1)	
>=12 years	1,471 (2.9)	916 (1.8)	822 (1.6)	397 (0.8)	

Table 2.Odds ratios (PR) and 95% CIs for cardiovascular related symptoms on multiple logistic regression analyses

		Exacerbation of Headache			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) [f]or women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	2.03 (1.58-2.62)	1.58 (1.19-2.09)	1.95 (1.11-2.57)	1.46 (1.06-2.02)
	Rental house, apartment	2.21 (1.93-2.54)	1.54 (1.32-1.80)	1.83 (1.34-2.53)	1.46 (1.22-1.75)
	Evacuation Shelter	2.01 (1.24-3.25)	1.80 (1.09-2.96)	2.24 (0.99-5.16)	1.61 (0.85-3.03)
	Temporary housing	2.13 (1.77-2.56)	1.42 (1.15-1.72)	1.69 (1.11-3.43)	1.36 (1.06-1.73)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.70 (1.53-1.88)	1.28 (1.12-1.46)	1.36 (1.04-1.78)	1.26 (1.09-1.47)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.56 (1.40-1.74)	1.39 (1.22-1.60)	1.39 (1.08-1.78)	1.39 (1.17-1.63)
Educational years	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	>=12 years	1.02 (0.89-1.16)	1.04 (0.81-1.63)	1.25 (0.91-1.73)	0.97 (0.80-1.17)

		Exacerbation of Dizziness			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) [f]or women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.98 (1.46-2.69)	1.42 (1.02-1.98)	0.96 (0.49-1.91)	1.66 (1.13-2.43)
	Rental house, apartment	2.27 (1.91-2.69)	1.45 (1.20-1.75)	1.28 (0.92-1.79)	1.55 (1.23-1.96)
	Evacuation Shelter	1.84 (1.02-3.32)	1.39 (0.74-2.59)	0.85 (0.26-2.77	1.83 (0.87-3.84)
	Temporary housing	2.09 (1.68-2.61)	1.40 (1.09-1.79)	1.51 (1.00-2.28)	1.36 (1.00-1.85)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.65 (1.45-1.87)	1.26 (1.07-1.48)	1.27 (0.94-1.73)	1.20 (0.98-1.45)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.37 (1.19-1.57)	1.18 (0.99-1.40)	1.12 (0.83-1.51)	1.22 (0.98-1.51)
Educational years	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	>=12 years	1.17 (1.01-1.37)	1.13 (0.94-1.36)	1.08 (0.80-1.47)	1.14 (0.90-1.44)

		Exacerbation of Palpitation			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) for women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.70 (1.23-2.34)	1.23 (0.87-1.74)	1.25 (0.57-2.71)	1.21 (0.82-1.78)
	Rental house, apartment	1.90 (1.60-2.25)	1.25 (1.03-1.51)	1.73 (1.17-2.53)	1.11 (0.89-1.39)
	Evacuation Shelter	0.74 (0.30-1.80)	0.51 (0.19-1.39)	0.93 (0.22-3.92)	0.35 (0.09-1.45)
	Temporary housing	1.32 (1.03-1.69)	0.82 (0.62-1.10)	1.19 (0.69-2.04)	0.72 (0.51-1.01)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.46 (1.27-1.68)	1.21 (1.01-1.45)	1.29 (0.91-1.83)	1.20 (0.97-1.48)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.24 (1.07-1.44)	1.14 (0.94-1.38)	1.46 (1.05-2.03)	1.00 (0.80-1.28)
Educational years	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	>=12 years	1.28 (1.09-1.50)	1.14 (0.93-1.39)	1.15 (0.79-1.67)	1.00 (0.81-1.23)

		Exacerbation of Shortness of Breath			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) for women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.60 (1.02-2.52)	1.16 (0.71-1.90)	0.95 (0.42-2.16)	1.33 (0.72-2.63)
	Rental house, apartment	2.34 (1.85-2.96)	1.76 (1.35-2.28)	1.50 (1.01-2.22)	1.98 (1.39-2.81)
	Evacuation Shelter	1.33 (0.54-3.27)	1.20 (0.48-3.00)	1.73 (0.60-4.95)	0.52 (0.07-3.79)
	Temporary housing	2.29 (1.72-3.06)	1.49 (1.07-2.08)	1.25 (0.75-2.09)	1.72 (1.10-2.68)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.55 (1.29-1.87)	1.13 (0.89-1.44)	1.06 (0.73-1.55)	1.17 (0.85-1.60)
Decreased income	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.24 (1.01-1.52)	1.14 (0.89-1.47)	1.18 (0.83-1.69)	1.10 (0.77-1.57)
Educational years	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	>=12 years	0.94 (0.78-1.13)	0.84 (0.67-1.06)	0.76 (0.54-1.07)	0.90 (0.66-1.23

a. Adjusted for age and sex.

b. Further adjusted for drinking status (once or more per month, ex-drinker, less than once per month), smoking status (non-smoker, ex-smoker, current smoker), mental health distress (K6<3, K6>=13), hypertension history (yes or no), stroke history (yes or no), heart disease history (yes or no), physical activities (>= once per day, 2-4 times per week, once per week, never), tsunami experience (yes or no), radiation experience (yes or no), damage of house (no, a part of, half, more than a half, totally), loss of family member (yes or no).

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract (P1-4)	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction (P6-7)		
Background/rationale **(P6)**	2	Explain the scientific background and rationale for the investigation being reported
Objectives **(P7)**	3	State specific objectives, including any prespecified hypotheses
Methods (P7-11)		
Study design **(P7)**	4	Present key elements of study design early in the paper
Setting **(P7)**	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants **(P7)**	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables **(P8-P10)**	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement **(P8-P10)**	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias (None)	9	Describe any efforts to address potential sources of bias
Study size **(P7-8)**	10	Explain how the study size was arrived at
Quantitative variables **(P8-10)**	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods **(P10-11)**	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results (P11-14)		
Participants **(P11-12)**	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data **(P11-13)**	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data **(P11)**	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results **(P13-14)**	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses **None**	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion (P14-20)		
Key results **(P14-20)**	18	Summarise key results with reference to study objectives
Limitations **(P18-20)**	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation **(P14-18)**	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability **(P19-20)**	21	Discuss the generalisability (external validity) of the study results
Other information (P20)		
Funding **(P20)**	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Effects of socioeconomic factors on cardiovascular related symptoms among residents in Fukushima after the Great East Japan Earthquake: A cross-sectional study using data from the Fukushima Health Management Survey

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Keywords:	Great East Japan Earthquake, socioeconomic factors, cardiovascular related symptoms

Effects of socioeconomic factors on cardiovascular related symptoms among residents in Fukushima after the Great East Japan Earthquake: A cross-sectional study using data from the Fukushima Health Management Survey

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Abstract

Objective: To investigate the association between socioeconomic factors and the exacerbation of cardiovascular symptoms among evacuees after the Great East Japan Earthquake.

Methods: A sample of 73,433 individuals were included in the Fukushima Health Management survey. Self-report questionnaires were used to determine the influence of socioeconomic factors, including living arrangement, loss of employment, and decreased income on the exacerbation of headache, dizziness, palpitations, and shortness of breath. Odds ratios (OR) and 95% confidence intervals (CIs) of the effect of socioeconomic factors were estimated for each symptom using multiple logistic regression analyses.

Results: Exacerbation of headaches were reported by 1,375 individuals, dizziness by 881, palpitations by 768, and shortness of breath by 434 individuals. Evacuation accommodation was associated with all of these symptoms. Compared to participants living in their own home (OR=1.00), individuals living in relatives' homes had increased probability of experiencing exacerbation of headache (1.58; 95% CI 1.20–2.09) and dizziness (1.43; 95% CI 1.02–1.98); those living in temporary housing or apartments experienced exacerbation of headache (1.55; 95% CI 1.32–1.81), dizziness (1.45; 95% CI 1.20–1.76), palpitations (1.25; 95% CI 1.03–1.51), and shortness of breath (1.75; 95% CI 1.35–2.27); participants living in evacuation shelters experienced exacerbation of headache (1.80; 95% CI 1.10–2.97); and refugees living in temporary housing also experienced exacerbation of headache (1.42; 95% CI 1.15–1.75), dizziness (1.39; 95% CI 1.08–1.78), and shortness of breath (1.50; 95% CI 1.07–2.09). Compared to the evacuees that retained their jobs, unemployed individuals showed increased probability

of exacerbation of headache (1.28, 95% CI 1.12–1.46), dizziness (1.26, 95% CI 1.07–1.48), and palpitations (1.22, 95% CI 1.02–1.46). Decreased income was associated with exacerbation of headache (1.39, 95% CI 1.21–1.60).

Conclusion: After the earthquake, living in non-home conditions was more likely to result in exacerbated cardiovascular symptoms among evacuees. Loss of employment was another risk factor related to exacerbated headache and dizziness.

Keywords: cardiovascular symptoms, Great East Japan Earthquake, socioeconomic factors

Strengths and limitations of this study

- Our study is the first to identify an inverse relationship between low socioeconomic status and exacerbated cardiovascular related symptoms after the Great East Japan earthquake using a sample of 73,433 evacuees.

- The present study was based on a subjective self-response survey. Moreover, the exacerbated symptoms are not necessarily logical predictors of cardiovascular diseases.

- Overall, the response rate to questionnaires was low (40.7%) and potential sampling skews may have biased the data.

- A further limitation of the present study was that information regarding changes in family relationships (e.g. death and physical separation) among the evacuees after the disaster was not captured.

- Additionally, most questionnaires were collected over a short time period (from Jan 2012 to Mar 2012).

Introduction

The Great East Japan Earthquake and the subsequent Fukushima Daiichi nuclear disaster, which occurred in March 2011, were together the most destructive catastrophe in Japan, to date. Due to concerns regarding released radiation, most residents in nearby towns were forced to evacuate and consequently suffered long-lasting anxiety. Shortly after the disaster, a Fukushima Health Management Survey was conducted to investigate the effects of long-term low-dose radiation exposure caused by the accident and to assess the physical and mental wellbeing of evacuees. This study included a basic survey which estimated each resident's radiation exposure and four detailed surveys: a Comprehensive Health Check, a thyroid ultrasonography, a Mental Health and Lifestyle Survey, and a survey of pregnant women and nursing mothers (1). The Mental Health and Lifestyle Survey utilized self-report questionnaires to investigate the health status and lifestyle of refugees by querying information regarding nutrition and diet, perceived symptoms of illness, disaster-related experience, and socioeconomic factors.

Several previous studies have identified changes in the incidence of cardiovascular events following disasters, however, results are conflicting (2-14). A recent study reported a heterogeneous occurrence of cardiovascular events after the Great East Japan Earthquake (2), while another study reported a significant increase in the incidence of cardioembolic stroke after the earthquake (10). However, neither study examined the incidence of perceived cardiovascular disease symptoms after a disaster, nor did they focus on the effect of refugee socioeconomic status on health problems during the evacuation period. Yet, these aspects should be considered because they

are relevant for reviewing refugee health status, assessing the incidence of various diseases, and for providing health guidelines for refugees.

Consequently, we conducted the present study to investigate the risk factors of perceived cardiovascular symptoms following a major disaster. In the present study, the socioeconomic factors included: the number of years of education, living arrangement, change of employment, and income. Due to the particular post-disaster situation, change of employment and income due to the disaster were captured instead of job and income level. Thus, in the present study, fewer years of education, living in non-home conditions, and unemployment or decreased income due to the disaster represented decreased socioeconomic status. We hypothesized that a decrease in socioeconomic status due to the earthquake would be associated with exacerbated cardiovascular symptoms among evacuees.

Methods

Participants

The primary purpose of the Fukushima Health Management Survey was to monitor the long-term health and lifestyle of Fukushima residents and to provide them with appropriate care (15). The Fukushima Health Management Survey consisted of a basic survey and four detailed surveys, namely: a thyroid ultrasound examination, Comprehensive Health Check, Mental Health and Lifestyle Survey, and pregnancy and birth survey (for details of these surveys see (1)). Individuals participating in the Mental Health and Lifestyle Survey were included in the present study. Briefly, the target population consisted of 210,189 officially registered victims of the Great East Japan Earthquake. They were evacuated from the following 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 were sent out, of which 73,569 were returned with responses (40.7% response rate). Of the returned questionnaires, 136 were excluded because they were blank or duplicated and 9,245 because they were filled in by a proxy. After these exclusions, data from 73,433 individuals (32,301 men and 41,132 women) were used for our analyses.

The study protocol was approved by the Ethics Committee of Fukushima Medical University. Participants who returned self-administered questionnaires were considered to have consented to participation in the study.

Data collection and measurement

To investigate the health status and lifestyle of the refugees, the exacerbation of headache, dizziness, palpitations, and shortness of breath was determined using a self-report questionnaire. All participants were asked to answer the question 'Do you have the following perceived symptoms after the earthquake?' and could choose between the replies 'No', 'Yes', and 'Exacerbation'. In the present study we focused on reports of 'Exacerbation'.

To evaluate Posttraumatic Stress Disorder (PTSD) symptoms we used the non-military version of the Posttraumatic Stress Disorder Checklist (PCL-S) (15): a checklist of 17 self-reported items. The list is based on the Diagnostic and Statistical Manual of Mental Disorders (4th edition, DSM-IV) criteria (16), and each item is rated using a Likert-type scale from one ('not at all') to five ('extremely'). Participants were requested to respond to the questions about each PTSD symptom separately and to

indicate whether they had experienced a given symptom during the past month. Based on the sum of the scores of all 17 items, a total PCL-S score could range from 17 to 85 (15).

In addition to the PCL-S checklist, the following items were included in the self-assessment and self-report questionnaires:

1. Demographic characteristics

The demographic characteristics that were surveyed included individuals' gender, age group, mental health status, history of mental illness, incidence of PTSD symptoms, smoking and drinking habits, and current physical activity levels. Age groups were divided into childbearing age (20–49 years), middle age (50–64 years), and old age (65 years and older).

Mental health status, and specifically incidence and severity of depression, was measured using the Japanese version of the K6 Kessler Psychological Distress Scale, which has been validated by previous studies (17, 18). For the K6 assessment, participants were asked if they had experienced any of the following symptoms during the past 30 days: feeling so depressed that nothing could cheer them up, feeling that everything was an effort, or feeling nervous, hopeless, restless, fidgety, or worthless. Each question was rated on a 5-point Likert-type scale from zero (never experienced) to four (experienced all of the time), with higher scores signifying worse mental health status (the range of the scores was 0–24) (15). Additionally, we assessed participants' history of mental illness via a 'yes' or 'no' question.

We obtained data on smoking and alcohol consumption habits using the following categories, respectively: 'non-smoker', 'ex-smoker', or 'current smoker'; and alcohol consumption 'once or more per month', 'less than once per month', or 'ex-drinker'.

Participants had four options to assess current physical activity level: ‘daily’, ‘2–4 times/week’, ‘weekly’, or ‘nearly none’.

2. Socioeconomic variables

Participants were required to select a description of their living arrangements from six options: evacuation shelter, temporary housing, rental housing or apartment, a relative’s home, their own home, and other. The last option was considered non-informative due to its ambiguity and was thus excluded from analysis.

Other socioeconomic variables included number of years of education (< 12 years, ≥12 years), change in employment status, and change in income level. By answering ‘Yes’ to a change in employment status or income, the participant indicated s/he became unemployed or experienced decreased income since the disaster.

3. Disaster-related variables

Disaster-related variables included experience of the tsunami (yes or no), experience of the nuclear power plant accident (defined as hearing the explosion; yes or no), losing someone close as a result of the disaster (yes or no), and damage to accommodation (none, partial damage, half destroyed, more than half destroyed, total destruction).

Statistical analyses

The incidence of exacerbation of headache, dizziness, palpitations, and shortness of breath was compared between individuals with different demographic, socioeconomic, and disaster-related characteristics using chi-square tests. For the analyses of PTSD incidence, a PCL-S score of 50 was used as a cut-off (19). Individuals with a PCL-S of

50 or greater were apportioned to the 'high-scoring group' and compared to the 'low-scoring group' (PCL-S < 50) using chi-square tests.

Odds ratios (ORs) and 95% confidence intervals (CIs) for each socioeconomic characteristic (living arrangement, employment status, income level, and number of years of education) were calculated using multiple logistic regression models. Adjustment variables included sex (male, female), age (20–49, 50–64, ≥65 years), alcohol consumption (once or more per month, ex-drinker, less than once per month), smoking status (non-smoker, ex-smoker, current smoker), mental health distress (K6<3, K6≥13), hypertension history (yes or no), stroke history (yes or no), heart disease history (yes or no), physical activity (≥ daily, 2–4 times per week, weekly, never), tsunami experience (yes or no), radiation experience (yes or no), damage to accommodation (none, partial, half, more than half, total), and loss of family member (yes or no).

We conducted the above analyses separately based on sex as well as with both sexes combined. All analyses were conducted using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

From the sample of 73,433 individuals, 1,893 (2.6%) reported exacerbation of headaches, 1,229 (1.7%) exacerbation of dizziness, 626 (0.9%) exacerbation of palpitations, and 434 (0.6%) exacerbation of shortness of breath (Table 1).

Demographic characteristics

The demographic characteristics of the population are summarized in Table 1. Exacerbation of cardiovascular symptoms was significantly higher in women than in

men (3.5% versus 1.4% for headaches; 2.2% versus 1.1% for dizziness; 2.0% versus 0.9% for palpitations; and 0.9% versus 0.8% for shortness of breath). Young (20–49 years) individuals were more likely to experience exacerbation of headaches, dizziness, or palpitations, while the 50–64 years age group more frequently experienced exacerbation of shortness of breath. Individuals experiencing exacerbation of cardiovascular symptoms were also more likely to suffer from depression (K6≥13) and Posttraumatic Stress Disorder (PCL≥50), and commonly had a history of hypertension, stroke, or heart disease. Neither smoking nor alcohol consumption increased the occurrence of exacerbated cardiovascular symptoms. Notably, symptom exacerbation was most pronounced in individuals who were not physically active daily.

Socioeconomic variables

Refugees living in their own or a relative's home were less likely to experience exacerbated cardiovascular symptoms (Table 1). Of the refugees living in their own home: 1.4% reported exacerbation of headache, 0.9% of dizziness, 1.6% of palpitations, and 1.0% of shortness of breath. The corresponding statistics for refugees living in temporary housing and rental houses or apartments were: 2.8%, 1.9%, 1.3%, and 1.2% and 3.5%, 2.1%, 1.8%, and 1.0%, respectively.

In the group that were unemployed due to the disaster: 4.2% of the individuals reported exacerbation of headache, 2.5% of dizziness, 2.1% of palpitations, and 1.1% shortness of breath, while the corresponding statistics for the group that did not lose their jobs after the disaster were: 2.2%, 1.5%, 1.4%, and 0.8%. Exacerbation of most cardiovascular symptoms was higher in subjects whose income decreased due to the disaster compared to those who maintained income levels (3.6% versus 2.4% for

exacerbation of headache, 2.0% versus 1.6% for exacerbation of dizziness, and 1.7% versus 1.4% for exacerbation of palpitation).

Additionally, exacerbation of most cardiovascular symptoms was higher among individuals who were educated for 12 years or more compared to those who were less educated (2.9% versus 1.9% for exacerbation of headache, 1.8% versus 1.4% for exacerbation of dizziness, and 1.6% versus 1.2% for exacerbation of palpitation).

Disaster-related variables

The group that experienced the tsunami and the nuclear power plant accident were more likely to experience exacerbated cardiovascular symptoms. Among those who had experienced the tsunami: 3.2% reported exacerbation of headache, 2.2% of dizziness, 1.7% of palpitations, and 1.7% of shortness of breath, compared to 2.4%, 1.6%, 1.5%, and 0.8%, respectively, among those with no experience of the tsunami. The corresponding statistics for individuals that had heard the nuclear power plant accident were 3.1%, 2.1%, 1.9%, and 1.1% compared to 2.1%, 1.2%, 1.0%, and 0.6% for those that had not.

Multiple Logistic Regression analyses

Table 2 summarizes the odds ratios (ORs) and 95% CIs of each socioeconomic characteristics for exacerbation of headache, dizziness, palpitations, and shortness of breath. Living arrangement emerged as a risk factor for exacerbated cardiovascular symptoms from our models, which were adjusted for multiple demographic-, health-, and disaster-related variables. Compared to participants living in their own home (OR = 1), those living in relatives' homes had greater probability of experiencing exacerbation of headache (1.58; 95% CI 1.19–2.09) and dizziness (1.42; 95% CI 1.02–1.98).

Similarly, those living in rental houses or apartments had greater chance of experiencing exacerbated headache (1.54; 95% CI 1.32–1.80), dizziness (1.45; 95% CI 1.20–1.75), palpitations (1.25; 95% CI 1.03–1.51), and shortness of breath (1.76; 95% CI 1.35–2.28). Participants living in evacuation shelters had increased probability of experiencing exacerbation of headache (1.80; 95% CI 1.09–2.96) and refugees living in temporary housing similarly had increased likelihood of experiencing exacerbation of headache (1.42; 95% CI 1.15–1.72), dizziness (1.40; 95% CI 1.09–1.79), and shortness of breath (1.49; 95% CI 1.07–2.08).

Loss of employment also emerged as a risk factor that increased the probability of cardiovascular symptom exacerbation. Compared to evacuees that remained employed (OR = 1), those that lost their employment were at higher risk of experiencing exacerbation of headache (1.28; 95% CI 1.12–1.46), dizziness (1.26; 95% CI 1.07–1.48), and palpitation (1.21; 95% CI 1.01–1.45). In an unadjusted model, we found a significant positive association between unemployment and exacerbation of palpitations; however, after adjusting for multiple relevant variables, this association was not significant.

There was no association between decreased income and exacerbated cardiovascular symptoms, except for headaches. In this case, adjusting for multiple variables resulted in an increased odds ratio for exacerbation of headaches both in an analysis combining the sexes (1.39, 95% CI 1.22–1.60) and in separate analyses of men and women. Number of years of education was also not associated with exacerbated cardiovascular symptoms in multiple-adjusted models in the present study.

Discussion

We demonstrated that a decrease in socioeconomic status due to the Great East Japan Earthquake was associated with exacerbated cardiovascular symptoms among evacuees. Compared with participants living in their own home, people of both genders living in relatives' homes, evacuation shelters, temporary housing, or rental houses or apartments were more likely to experience exacerbation of headache, dizziness, palpitations, or shortness of breath. Similarly, loss of employment and reduced income due to the disaster increased the risk of experiencing exacerbated symptoms.

The following three points should be considered in the context of our results. Firstly, earthquakes are definitely associated with increased cardiovascular disease, including sudden cardiac death and acute myocardial infarction (2-14), and our results are consistent with these earlier findings. The Hanshin-Awaji earthquake was associated with increased cardiovascular disease that persisted for longer than a month. Further, an increase in the number of individuals with acute myocardial infarction, especially women, was particularly evident during the four weeks immediately following the disaster (9). After the Great East Japan Earthquake, the incidences of reported cardioembolic stroke increased in the 3–9 months following the disaster (10), as did the incidence of other cardiovascular diseases (11-14). Our study contributes to the reported incidences of cardiovascular disease using self-report questionnaires rather than death certificates and by demonstrating that exacerbated cardiovascular symptoms occurred among evacuees after the disaster.

Secondly, increases in cardiovascular events and exacerbated cardiovascular symptoms can be attributed to post-disaster distress or mental problems. Studies have suggested that extremely stressful experiences, such as earthquakes, can trigger cardiovascular events (20-22). Acute major stress and chronic stress (i.e. the

cumulative load of minor daily stress) can have long-term consequences, which can be perceived as stressful themselves and a potential threat to one's environment, thereby inducing a variety of negative emotional responses, such as fear, anxiety, sadness, anger, hostility, and depression (4,23). In turn, these emotional responses may lead to hypertension or cardiovascular events (20-22). A recent study suggests that PTSD was frequently noted in cardiovascular disease patients six months after the Great East Japan Earthquake. The patients with PTSD were more likely to experience a combination of acute myocardial infarction, stroke, heart disease, and death (24). In the current study, all individuals exhibiting exacerbated cardiovascular symptoms were more likely to have depression (K6 ≥13) or Posttraumatic Stress Disorder (PCL ≥50). Logistic regression analyses also showed that depression and Posttraumatic Stress Disorder were both independently associated with exacerbated cardiovascular symptoms (data not shown).

Thirdly, although post-disaster increases in cardiovascular events were widely reported in previous studies, investigation of socioeconomic factors that influenced these events during the evacuation term of refugees was limited. Previous studies reported that one year after the Wenchuan Earthquake in China, depression severity among refugees varied with income, housing status, and social support (25). This indicated that, through its impact on income, the earthquake was indirectly associated with life satisfaction and depression (26). Another study showed that six months after the 2011 Christchurch earthquake in New Zealand, on average lower income per home contributed unequivocally to earthquake-related distress and dysfunction (27). A recent study also showed that six months after the Great East Japan Earthquake tsunami

experience, property loss, and poverty were associated with PTSD in cardiovascular disease patients and had an adverse prognostic impact (24).

This study revealed that living in evacuation shelters or temporary housing, rather than one's own home, was associated with exacerbation of all the examined cardiovascular symptoms, and the statistical results were more robust in women than in men. Evacuation shelters and temporary housing were less spacious, damper, and less comfortable than refugees' homes.

Due to insufficient access to supermarkets or shortages of cooking equipment and utilities such as gas, evacuees living in shelters may not have access to balanced meals. A recent cross-sectional study showed a well-balanced diet was associated with better living conditions among refugees after the Great East Japan Earthquake, whereas imbalanced diets were not (28, 29). Furthermore, the simple fact of being unable to stay in one's own home and requiring refuge accommodation meant that one's neighborhood had been damaged during the disaster, and this may have led to insufficient social support. All of the above factors can be considered predictors of stress among refugees, and this may affect women more strongly than men.

Unemployment and decreased income due to the disaster were also associated with the exacerbation of some cardiovascular symptoms. These results were predictable as poor economic circumstances are expected to exacerbate depression. Low income may be considered a chronic stressor, increasing psychological distress as a result of limited access to resources and opportunities for accumulation of resources (27).

Previous studies have shown that, following an earthquake, living in a low-income area may contribute to greater psychological distress due to a lack of occupational, social, and financial resources. A community study revealed that, after the Christchurch

earthquake, low household income contributed strongly to earthquake-related distress (27). In the present study, we found a significant association between disaster-related unemployment and exacerbation of some cardiovascular symptoms. However, the subsistence allowance given to refugees by the Japanese government may have reduced this effect by reducing the impact of refugees' lowered economic circumstances.

Educational level was inversely associated with cardiovascular disease risk in previous studies (30, 31). However, in our study, the number of years that individuals had been educated was not associated with exacerbated cardiovascular symptoms. This may be due to post-disaster conditions. In the present study, factors related to the earthquake, tsunami, and the nuclear accident, and unemployment or decreased income due to the disasters had a large influence on exacerbated cardiovascular symptoms. This result may have superseded any potential impact of education levels.

Our understanding of disaster-related stress on cardiovascular disease remains incomplete. A clinical study from the 1995 Hanshin-Awaji earthquake compared pre- and post- blood pressure levels in well-controlled hypertension patients and showed an 18mmHg increase in diastolic blood pressure two weeks after the earthquake (32). Although 'white-coat hypertension' (patients exhibiting increased blood pressure in clinical settings) partly contributed to the results, some patients developed sustained hypertension that persisted for one year after the earthquake (32). One study found that there were increased levels of cholesterol and triglycerides in patients a few weeks after an earthquake (3), whereas another studies failed to show significantly higher total cholesterol or HDL-cholesterol during the two weeks following the Hanshin-Awaji

earthquake (6). Thus, the extent to which changes in the blood lipid profile contribute to exacerbated cardiovascular symptoms several months after the Great East Japan Earthquake remains unknown. Chronic psychological stress is also associated with increased insulin resistance (4). A recent study after the Great East Japan Earthquake found that the negative effects of the disaster on metabolic factors were greater among evacuees than non-evacuees (33), which may also contribute to the occurrence of exacerbated cardiovascular symptoms among evacuees.

Although the results of the present study is limited to residents in the Fukushima prefecture after the Great East Japan Earthquake, it would provide inspiration for the future studies among evacuees after disasters. As well, our study suggests early improvements in the provision of living conditions for the evacuees could be achieved by several ways: providing speedy restorations of the access to their own homes; providing more employment opportunity for the evacuees and providing more financial support. For future disasters, the present study would provide epidemiological basic for governments and authorities to act as soon as possible for preparation.

The large scale of assessment and assessment under post-disaster conditions provides considerable credibility for the present study. Additionally, our study is the first to identify an inverse relationship between low socioeconomic status and exacerbated cardiovascular symptoms from an evacuee self-report questionnaire after a disaster; thus, our results will be useful for generating guidelines for evacuee health. However, the following limitations of this study should be considered. Firstly, the study was based on a subjective self-response survey. However it is reasonable to expect respondents to understand that the studied symptoms are related to stress and/or autonomic nervous system disorders. Further information, such as the incidence

of cardiovascular disease, should be captured. Although the studied symptoms are not necessarily logical predictors of cardiovascular diseases, several previous studies have shown that headaches are suggestive of an incremental risk of stroke (34, 35), and other studies have also shown that vertigo or dizziness and chest pain are associated with cardiovascular problems (36, 37). We also conducted an analyses on a subsample of individuals' self-reported information, which suggested that all of the discussed symptoms were associated with a diagnosis of hypertension in the last year, and that exacerbation of dizziness, palpitation, and shortness of breath were associated with a diagnosis of heart disease in the last year (data not shown). Therefore, our study of these four symptoms may be helpful for developing plans to improve evacuees' health to some extent.

Secondly, both the Great East Japan Earthquake and also the accompanied nuclear accident had a large psychological impact on the evacuees. Due to this unusual situation, the present study cannot be entirely compared with other studies. Thirdly, the overall response rate to questionnaires was low (40.7%) and sampling skews may have resulted in biased data.

Fourthly, under the unusual social circumstances that follow a major disaster, the health symptoms perceived by evacuees may be strongly influenced by changes in family relationships (e.g. death and physical separation) among the evacuees. However, the present study did not capture these data. Moreover, other socioeconomic factors, such as household income, and other cardiovascular risk factors, such as blood pressure and cholesterol levels, were also not captured in the present study. Additionally, although most questionnaires were collected in the same period (from Jan 2012 to Mar 2012), it is possible that the timing of the survey affected the perceived

cardiovascular symptoms. Finally, other environmental factors, such as temperature, food supplies, and medical facilities may also affect cardiovascular problems (38, 39). These data were also not collected in the present study. The potential associations observed in this study will be further investigated over an extended period.

In conclusion, the present study was the first to identify a relationship between lower socioeconomic status due to the Great East Japan Earthquake and exacerbated cardiovascular symptoms among evacuees. Our findings will provide baseline information for future periodic health examinations and for the development of health guidelines for evacuees.

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Contributors

WZ and TO designed the study. TO, SY, MM, MH. NH, YS, HY, MH, HT, and AO were responsible for data collection and supervising the study. The analyses were conducted by WZ and TO. The manuscript was written by WZ. All the authors assisted with revision of the manuscript, and read and approved the final version of the manuscript.

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Declaration of interests

We declare that we have no competing interests.

Patient consent

Obtained.

Data sharing statement

No additional data are available.

References

1. Yasumura S, Hosoya M, Yamashita S, Kamiya K, Abe M, Akashi M, Kodama K, Ozasa K; Fukushima Health Management Survey Group. Study protocol for the Fukushima Health Management Survey. J Epidemiol. 2012; 22: 375-383.

2. Nozaki E, Nakamura A, Abe A, Kagaya Y, Kohzu K, Sato K, Nakajima S, Fukui S, Endo H, Takahashi T, Seki H, Tamaki K, Mochizuki I. Occurrence of cardiovascular events after 2011 Great East Japan Earthquake and tsunami disaster. Int Heart J. 2013; 54: 247-253.

3. Trevisan M, Celentano E, Meucci C, Farinaro E, Jossa F, Krogh V, Giumetti D, Panico S, Scottoni A, Mancini M. Short-term effect of natural disasters on coronary heart disease risk factors. Arteriosclerosis. 1986; 6: 491-494.

4. Kario K, McEwen BS, Pickering TG. Disasters and the heart: a review of the effects of earthquake-induced stress on cardiovascular disease. Hypertens Res. 2003; 26:355-367.

5. Kario K, Matsuo T, Kayaba K, Soukejima S, Kagamimori S, Shimada K. Earthquake-induced cardiovascular disease and related risk factors in focusing on the Great Hanshin-Awaji Earthquake. J Epidemiol. 1998; 8:131-139.

6. Kario K, Matsuo T. Increased incidence of cardiovascular attacks in the epicenter just after the Hanshin-Awaji earthquake. Thromb Haemost. 1995; 74: 1207.

7. Kario K, Matsuo T, Kobayashi H, Yamamoto K, Shimada K. Earthquake-induced potentiation of acute risk factors in hypertensive elderly patients: possible triggering of cardiovascular events after a major earthquake. J Am Coll Cardiol. 1997; 29: 926-933.

8. Kario K, Matsuo T, Shimada K, Pickering TG. Factors associated with the occurrence and magnitude of earthquake-induced increases in blood pressure. Am J Med. 2001; 111: 379-384.

9. Suzuki S, Sakamoto S, Miki T, Matsuo T. Hanshin-Awaji earthquake and acute myocardial infarction [letter]. Lancet. 1995; 345: 981.

10. Itabashi R, Furui E, Sato S, Yazawa Y, Kawata K, Mori E. Incidence of cardioembolic stroke including paradoxical brain embolism in patients with acute ischemic stroke before and after the Great East Japan Earthquake. Cerebrovasc Dis .2014; 37:431-437.

11 Suzuki H, Ohira T, Takeishi Y,Hosoya M, Yasumura S,Satoh H,Kawasaki Y4,Takahashi A, Sakai A,Ohtsuru A,Kobashi G, Ozasa K, Yamashita S, Kamiya K, Abe M; Fukushima Health Management Survey Group. Increased prevalence of atrial fibrillation after the Great East Japan Earthquake: Results from the Fukushima Health Management Survey. Int J Cardiol. 2015; 198: 102-105.

12. Aoki T, Takahashi J,Fukumoto Y,Yasuda S,Ito K,Miyata S,Shinozaki T,Inoue K,Yagi T, Komaru T,Katahira Y, Obata A,Hiramoto T, Sukegawa H, Ogata K, Shimokawa H. Effect of the Great East Japan earthquake on Cardiovascular Diseases. Circ J. 2013; 77: 490-493.

13. Aoki T,Fukumoto Y,Yasuda S,Sakata Y,Ito K,Takahashi J,Miyata S,Tsuji I, Shimokawa H. The Great East Japan Earthquake Disaster and cardiovascular diseases. Eur Heart J. 2012; 33:2796-2803.

14. Yamauchi H,Yoshihisa A,Iwaya S,Owada T,Sato T,Suzuki S,Yamaki T,Sugimoto K,Kunii H,Nakazato K,Suzuki H,Saitoh S,Takeishi Y. Clinical Features of Patients

With Decompensated Heart Failure After the Great East Japan Earthquake. Am J Cardiol. 2013; 112: 94-99.

15. Yabe H, Suzuki Y, Mashiko H, Nakayama Y, Hisata M, Niwa S, Yasumura S, Yamashita S, Kamiya K, Abe M. Psychological distress after the great East Japan earthquake and fukushima daiichi nuclear power plant accident: results of a mental health and lifestyle survey through the fukushima health management survey in fy2011 and fy2012. Fukushima J Med Sci. 2014; 60:57-67.

16. Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. Psychometric properties of the PTSD Checklist (PCL). Behav Res Ther. 1996; 34: 669-673.

17. Furukawa TA, Kessler RC, Slade T, Andrews G. The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. Psychol Med. 2003; 33:357-362.

18. Sakurai K, Nishi A, Kondo K, Yanagida K, Kawakami N. Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. Psychiatry Clin Neurosci. 2011; 65:434-441.

19. Weathers FW, Litz BT, Herman DS, Huska JA, Keane TM. The PTSD checklist (OCL): Reliability, Validity, and Diagnostic Utility. Paper presented at the Annual Meeting of the International Society for Traumatic Stress Studies, San Antonio, TX. 1993.

20 Pickering TG. Mental stress as a causal factor in the development of hypertension and cardiovascular disease. Curr Hypertens Rep. 2001; 3: 249-254.

21. Kabutoya T, Kario K. Earthquake and blood pressure. Hypertens Res. 2009; 32:732-734.

22. Kario K. Disaster hypertension- its characteristics, mechanism, and management. Circ J. 2012; 76: 553-552.

23.Yokoyama Y, Otsuka K, Kawakami N, Kobayashi S,Ogawa A, Tannno K, Onoda T, Yaegashi Y, Sakata K. Mental health and related factors after the Great East Japan earthquake and tsunami. PLoS One. 2014; 9: e102497.

24. 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. Predictors and prognostic impact of post-traumatic stress disorder after the great East Japan earthquake in patients with cardiovascular disease. Circ J. 2015; 79: 664-667.

25. Xu J, Mo L, Xu Z. A cross-sectional study on risk factors of depression severity among survivors of the 2008 Sichuan earthquake. Community Ment Health J. 2013; 49: 847-856.

26. Huang Y, Wong H, Tan HT. Associations between economic loss, financial strain and the psychological status of Wenchuan earthquake surivivors. Disasters. 2015; 39:795-810.

27. Dorahy MJ, Rowlands A, Renouf C, Hanna D, Britt E, Carter JD. Impact of average household income and damage exposure on post-earthquake distress and functioning: A community study following the February 2011 Christchurch earthquake. Br J Psychol. 2015; 106: 526-543.

28. Nishi N, Yoshimura E, Ishikawa-Takata K, Tsuboyama-Kasaoka N, Kubota T, Miyachi M, Tokudome S, Yokoyama Y, Sakata K, Kobayashi S, Ogawa A.

Relationship of living conditions with dietary patterns among survivors of the great East Japan earthquake. J Epidemiol. 2013; 5: 376-381.

29. Zhang W, Ohira T, Abe M, Kamiya K, Yamashita S, Yasumura S, Ohtsuru A, Masaharu M, Harigane M, Horikoshi N, Suzuki Y, Yabe H, Yuuki M, Nagai M, Takahashi H, Nakano H; Fukushima Health Management Survey Group. Evacuation after the Great East Japan Earthquake was associated with poor dietary intake: The Fukushima Health Management Survey. J Epidemiol. 2017; 27: 14-23.

30. Shea S, Lima J, Diez-Roux A, Jorgensen NW, McClelland RL Socioeconomic Status and Poor Health Outcome at 10 Years of Follow-Up in the Multi-Ethnic Study of Atherosclerosis. PLoS One. 2016; 11

31. Veronesi G, Tunstall-Pedoe H, Ferrario MM, Kee F, Kuulasmaa K, Chambless LE, Amouyel P, Arveiler D, Bobak M, Ferrieres J, Giampaoli S, Jørgensen T, Peters A, Salomaa V, Soderberg S, Tamosiunas A, Cesana G; MORGAM Project. Combined effect of educational status and cardiovascular risk factors on the incidence of coronary heart disease and stroke in European cohorts: Implications for prevention. Eur J Prev Cardiol. 2016 Nov 11. pii: 2047487316679521. [Epub ahead of print]

32. Kario K, Matsuo T, Ishida T, Shimada K. 'White coat' hypertension and the Hanshin-Awaji Earthquake. Lancet. 1995; 345: 1346.

33. Satoh H, Ohira T, Hosoya M, Sakai A, Watanabe T, Ohtsuru A et al. Evacuation after the Fukushima Daiichi Nuclear Power Plant Accident Is a Cause of Diabetes: Results from the Fukushima Health Management Survey. J Diabetes Res. 2015.

34. Tsai CL, Chou CH, Lee PJ, Yin JH, Chen SY, Lin CC, Sung YF, Yang FC, Chung CH, Chien WC, Tsai CK, Lee JT. The potential impact of primary headache disorders on stroke risk. J Headache Pain. 2016; 17: 108.

35. Hu X, Zhou Y, Zhao H, Peng C. Migraine and the risk of stroke: an updated meta-analysis of prospective cohort studies. Neurol Sci. 2016 Oct 26. [Epub ahead of print]

36. Doijiri R, Uno H, Miyashita K, Ihara M , Nagatsuka K. How Commonly Is Stroke Found in Patients with Isolated Vertigo or Dizziness Attack? J Stroke Cerebrovasc Dis. 2016; 25: 2549-2552.

37. Haasenritter J, Stanze D,Widera G,Wilimzig C,Abu Hani M,Sonnichsen AC, Bosner S, Rochon J,Donner-Banzhoff N. Does the patient with chest pain have a coronary heart disease? Diagnostic value of single symptoms and signs--a meta-analysis. Croat Med J. 2012; 53:432-441.

38. Sun Z. Cardiovascular responses to cold exposure. Front Biosci (Elite Ed). 2010; 2: 495-503.

39. Nakamura M, Tanaka F, Nakajima S, Honma M, Sakai T, Kawakami M, Endo H, Onodera M, Niiyama M, Komatsu T, Sakamaki K, Onoda T, Sakata K, Morino Y, Takahashi T, Makita S. Comparison of the incidence of acute decompensated heart failure before and after the major tsunami in Northeast Japan. Am J Cardiol. 2012; 110:1856-1860.

Table 1. Characteristics of survey participants and correlated incidence of exacerbation of cardiovascular related symptoms.

	Exacerbation of headache	Exacerbation of dizziness	Exacerbation of palpitation	Exacerbation of shortness of breath
	No. (%)	No. (%)	No. (%)	No. (%)
Sex				
Men	466 (1.4)	341 (1.1)	277 (0.9)	257 (0.8)
Women	1,427 (3.5)	888 (2.2)	808 (2.0)	369 (0.9)
Age				
20-49	966 (3.9)	507 (2.0)	407 (1.6)	147 (0.6)
50-64	514 (2.4)	302 (1.4)	323 (1.5)	159 (0.8)
≧65	413 (1.4)	420 (1.6)	355 (1.3)	320 (0.4)
Mental health Status				
K6<13	1,092 (1.7)	695 (1.1)	562 (0.9)	355 (0.6)
K6≧13	801 (8.9)	534 (5.3)	523 (5.2)	271 (2.7)
Post traumatic stress disorder				
No	1,062 (1.7)	653 (1.0)	542 (0.9)	323 (0.5)
Yes	831 (8.0)	576 (5.5)	543 (5.2)	303 (2.9)
Smoking status				
Non-smoker	1,104 (2.7)	715 (1.8)	653 (1.6)	318 (0.8)
Ex-smoker	338 (2.1)	226 (1.4)	214 (1,4)	171 (1.1)
Current smoker	403 (2.8)	258 (1.8)	196 (1.3)	123 (0.8)

Alcohol consumption				
Less than once a month	1,067 (2.9)	674 (1.8)	597 (1.6)	323 (0.9)
Ex-drinker	80 (2.9)	63 (2.3)	61 (2.2)	41 (1.5)
One or more per month	715 (2.3)	463 (1.5)	407 (1.3)	248 (0.8)
Physical activity				
≧ daily	179 (1.7)	131 (1.2)	96 (0.9)	69 (0.7)
2–4 times per week	309 (2.2)	245 (1.7)	195 (1.4)	123 (0.9)
Weekly	234 (2.4)	143 (1.4)	139 (1.4)	97 (1.0)
Never	1144 (3.2)	687 (1.9)	637 (1.8)	325 (0.9)
Hypertension history				
No	1,216 (2.8)	667 (1.6)	584 (1.4)	276 (0.6)
Yes	677 (2.2)	562 (1.8)	501 (1.6)	350 (1.1)
Stroke history				
No	1,799 (2.6)	1,146 (1.7)	1,799 (1.5)	576 (0.8)
Yes	94 (2.4)	83 (2.2)	94 (1.6)	50 (1.3)
Heart disease history				
No	1,691 (2.6)	1,025 (1.6)	1,691 (2.6)	432 (0.7)
Yes	202 (10.7)	204 (2.8)	202 (4.0)	194 (2.7)
Unemployment				
No	1,293 (2.2)	874 (1.5)	790 (1.4)	470 (0.8)
Yes	600 (4.2)	355 (2.5)	295 (2.1)	156 (1.1)
Income decrease				
No	1,432 (2.4)	968 (1.6)	870 (1.4)	506 (0.8)

Yes	461 (3.6)	261 (2.0)	215 (1.7)	120 (0.9)
Living arrangement				
Evacuation shelter	213 (2.5)	12 (1.6)	5 (0.7)	5 (0.7)
Temporary housing	195 (2.8)	134 (1.9)	89 (1.3)	81 (1.2)
Rental house or apartment	796 (3.5)	489 (2.1)	421 (1.8)	224 (1.0)
Relatives' home	78 (2.8)	53 (1.9)	209 (1.0)	108 (0.5)
Own home	292 (1.4)	199 (0.9)	45 (1.6)	29 (1.0)
Tsunami experience				
No	1,424 (2.4)	908 (1.6)	830 (1.4)	458 (0.8)
Yes	469 (3.2)	321 (2.2)	255 (1.7)	168 (1.1)
Radiation experience				
No	717 (2.1)	426 (1.2)	358 (1.0)	201 (0.6)
Yes	1,176 (3.1)	803 (2.1)	727 (1.9)	425 (1.1)
Damage to house				
None	413 (2.2)	258 (1.4)	233 (1.3)	103 (0.6)
Partial	911 (2.4)	600 (1.6)	559 (1.5)	347 (0.9)
Half	184 (3.5)	129 (2.5)	83 (1.6)	55 (1.1)
More than half	67 (3.4)	48 (2.5)	38 (1.9)	23 (1.2)
Total	126 (3.3)	86 (2.2)	66 (1.7)	43 (1.1)
Loss of family member				
No	552 (3.9)	363 (2.6)	296 (2.1)	199 (1.4)
Yes	1,291 (2.3)	825 (1.5)	759 (1.3)	404 (0.7)
Number of years of education				

4	<12 years (reference)	352 (1.9)	265 (1.4)	223 (1.2)	202 (1.1)
5	≥12 years	1,471 (2.9)	916 (1.8)	822 (1.6)	397 (0.8)

Table 2.Odds ratios (PR) and 95% confidence intervals (CIs) for cardiovascular related symptoms obtained from multiple logistic regression analyses

		Exacerbation of Headache			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) [f]or women [b]
living arrangement	**Own home (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	2.03 (1.58-2.62)	1.58 (1.19-2.09)	1.95 (1.11-2.57)	1.46 (1.06-2.02)
	Rental house or apartment	2.21 (1.93-2.54)	1.54 (1.32-1.80)	1.83 (1.34-2.53)	1.46 (1.22-1.75)
	Evacuation shelter	2.01 (1.24-3.25)	1.80 (1.09-2.96)	2.24 (0.99-5.16)	1.61 (0.85-3.03)
	Temporary housing	2.13 (1.77-2.56)	1.42 (1.15-1.72)	1.69 (1.11-3.43)	1.36 (1.06-1.73)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.70 (1.53-1.88)	1.28 (1.12-1.46)	1.36 (1.04-1.78)	1.26 (1.09-1.47)
Income decrease	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.56 (1.40-1.74)	1.39 (1.22-1.60)	1.39 (1.08-1.78)	1.39 (1.17-1.63)
Number of years of education	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	≧12 years	1.02 (0.89-1.16)	1.04 (0.81-1.63)	1.25 (0.91-1.73)	0.97 (0.80-1.17)

		Exacerbation of Dizziness			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) [f]or women [b]
living arrangement	**Own home (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.98 (1.46-2.69)	1.42 (1.02-1.98)	0.96 (0.49-1.91)	1.66 (1.13-2.43)
	Rental house or apartment	2.27 (1.91-2.69)	1.45 (1.20-1.75)	1.28 (0.92-1.79)	1.55 (1.23-1.96)
	Evacuation shelter	1.84 (1.02-3.32)	1.39 (0.74-2.59)	0.85 (0.26-2.77	1.83 (0.87-3.84)
	Temporary housing	2.09 (1.68-2.61)	1.40 (1.09-1.79)	1.51 (1.00-2.28)	1.36 (1.00-1.85)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.65 (1.45-1.87)	1.26 (1.07-1.48)	1.27 (0.94-1.73)	1.20 (0.98-1.45)
Income decrease	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.37 (1.19-1.57)	1.18 (0.99-1.40)	1.12 (0.83-1.51)	1.22 (0.98-1.51)
Number of years of education	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	≧12 years	1.17 (1.01-1.37)	1.13 (0.94-1.36)	1.08 (0.80-1.47)	1.14 (0.90-1.44)

		Exacerbation of Palpitation			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) for women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.70 (1.23-2.34)	1.23 (0.87-1.74)	1.25 (0.57-2.71)	1.21 (0.82-1.78)
	Rental house or apartment	1.90 (1.60-2.25)	1.25 (1.03-1.51)	1.73 (1.17-2.53)	1.11 (0.89-1.39)
	Evacuation shelter	0.74 (0.30-1.80)	0.51 (0.19-1.39)	0.93 (0.22-3.92)	0.35 (0.09-1.45)
	Temporary housing	1.32 (1.03-1.69)	0.82 (0.62-1.10)	1.19 (0.69-2.04)	0.72 (0.51-1.01)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.46 (1.27-1.68)	1.21 (1.01-1.45)	1.29 (0.91-1.83)	1.20 (0.97-1.48)
Income decrease	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.24 (1.07-1.44)	1.14 (0.94-1.38)	1.46 (1.05-2.03)	1.00 (0.80-1.28)
Number of years of education	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	≧12 years	1.28 (1.09-1.50)	1.14 (0.93-1.39)	1.15 (0.79-1.67)	1.00 (0.81-1.23)

		Exacerbation of Shortness of Breath			
		OR(95%CI) [a]	OR(95%CI) [b]	OR(95%CI) for men [b]	OR(95%CI) for women [b]
living arrangement	**Own home (Reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Relatives' home	1.60 (1.02-2.52)	1.16 (0.71-1.90)	0.95 (0.42-2.16)	1.33 (0.72-2.63)
	Rental house or apartment	2.34 (1.85-2.96)	1.76 (1.35-2.28)	1.50 (1.01-2.22)	1.98 (1.39-2.81)
	Evacuation shelter	1.33 (0.54-3.27)	1.20 (0.48-3.00)	1.73 (0.60-4.95)	0.52 (0.07-3.79)
	Temporary housing	2.29 (1.72-3.06)	1.49 (1.07-2.08)	1.25 (0.75-2.09)	1.72 (1.10-2.68)
Unemployment	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.55 (1.29-1.87)	1.13 (0.89-1.44)	1.06 (0.73-1.55)	1.17 (0.85-1.60)
Income decrease	**No (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	Yes	1.24 (1.01-1.52)	1.14 (0.89-1.47)	1.18 (0.83-1.69)	1.10 (0.77-1.57)
Number of years of education	**<12 years (reference)**	1.00(reference)	1.00(reference)	1.00(reference)	1.00(reference)
	≧12 years	0.94 (0.78-1.13)	0.84 (0.67-1.06)	0.76 (0.54-1.07)	0.90 (0.66-1.23)

a. Adjusted for age and sex.

b. Further adjusted for drinking status (once or more per month, ex-drinker, less than once per month), smoking status (non-smoker, ex-smoker, current smoker), mental health distress (K6<3, K6>=13), hypertension history (yes or no), stroke history (yes or no), heart disease history (yes or no), physical activities (≧ daily, 2–4 times per week, weekly, never), tsunami experience (yes or no), radiation experience (yes or no), damage to house (none, partial, half, more than half, total), loss of family member (yes or no).