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Association Between Sleep Disturbance and New-onset Subjective Shoulder Pain in Survivors of the Great East Japan Earthquake: A Prospective Cohort Study in Miyagi Prefecture

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The Great East Japan Earthquake (GEJE) and Tsunami devastated the northeastern coast of Japan on March 11, 2011. This study attempted to determine whether socio-psychological factors such as sleep disturbance and psychological distress influenced new-onset subjective shoulder pain in survivors, during the post disaster phase of the GEJE. From November 2012 to February 2013 (2 years after the GEJE) and November 2014 to January 2015 (4 years after the GEJE), survivors (18 years old or over) answered self-reported questionnaires. In total, 1,454 survivors responded to the questionnaires and were thus included in this study. New-onset subjective shoulder pain was defined as shoulder pain by encircled response absent at 2 years, and present at 4 years after the GEJE. Two years after the GEJE, ≥ 10/24 points on the Kessler Psychological Distress Scale-6, and ≥ 6/24 points on the Athens Insomnia Scale defined the presence of psychological distress and sleep disturbance, respectively. Multiple logistic regression analysis was used to estimate the odds ratio (OR) and 95% confidence interval (CI) of the association between new-onset subjective shoulder pain, and psychological distress or sleep disturbance. Amongst participants, 7.2% (105/1,454) reported new-onset subjective shoulder pain. Sleep disturbance was significantly associated with new-onset subjective shoulder pain (OR = 1.92, 95% CI = 1.24-2.98, P = 0.004); however, psychological distress was not (OR = 0.78, 95% CI = 0.42-1.42, P = 0.41). In conclusion, this is the first study indicating an association between sleep disturbance and new-onset subjective shoulder pain amongst the survivors of the GEJE.

Keywords: Great East Japan Earthquake; prospective cohort study; psychological distress; shoulder pain; sleep disturbance
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Introduction

Six years have passed since the Great East Japan Earthquake (GEJE), with a 9.0 magnitude on the Richter scale, and a devastating Tsunami hit the northeastern coast of Japan on March 11, 2011. Approximately 18,500 people died or went missing as a result of the calamity, and over 3,470 died from related events after the GEJE (Countermeasures for the Great East Japan Earthquake, National Police Agency of Japan 2017). Although this number is now decreasing, more than 119,000 survivors have had to flee from their hometowns because of unfavorable housing and working conditions, as well as owing to the accidents at the Fukushima Daiichi Nuclear Power Station (Situation of the evacuees; Reconstruction Agency 2017). It is widely accepted that natural disasters majorly influence public health, owing to the impact of environmental changes such as a collapse of societal and public hygiene systems (Kako et al. 2014).

Most pain syndromes after earthquakes and other natural disasters are caused by traumatic events in the acute phase (Angeletti et al. 2012). Multiple factors such as psychological disorders, physical inactivity, and functional disabilities affect chronic pain of survivors in the chronic phase. Such factors occur because of life-threatening stress and changes in living conditions, owing to the destruction

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of the home environment and the public healthcare systems of survivors (Angeletti et al. 2012; Tomata et al. 2015; Yabuki et al. 2015). However, the precise mechanism mediating the effects of such factors has remained unsolved. After 1.5 years of the GEJE, the survivors experienced chronic pain most frequently in the knee and its surrounding area, the lower back, and the shoulder, found in a cross-sectional study (Yabuki et al. 2015). New onset subjective lower back pain after the GEJE has been significantly associated with working status (Hagiwara et al. 2016) and subjective economic hardship (Yabe et al. 2017) in prospective cohort studies. Although living status, economic hardship, and sleep disturbance were significantly associated with subjective shoulder pain after the GEJE in a cross-sectional study (Hagiwara et al. 2017), there have been no reports about important factors related to subjective shoulder pain in a prospective cohort study.

Insomnia is one of frequent occurrence after disasters (Mohsenin and Mohsenin 2014) and has been a great issue amongst the GEJE survivors (Matsumoto et al. 2014). Sleep problems have been associated with an increased risk of chronic pain in the lower back and the neck or shoulders (Mork et al. 2014). Pain during night time is a characteristic of shoulder disorders, which could cause sleep disturbance amongst survivors.

The purpose of this study was to determine whether socio-psychological factors such as sleep disturbance and psychological distress influence new-onset subjective shoulder pain in the chronic phase of the GEJE.

Methods

Study design and participants

A panel study was conducted every 6 months for the GEJE survivors from June 2011, starting three months after the disaster. From November 2012 to February 2013 (2 years after the GEJE) and November 2014 to January 2015 (4 years after the GEJE), survivors (18 years old or over, as of June, 2011) were recruited on the basis of the data from the Basic Resident Registration Network system as well as previous participation in health surveys of survivors (Tsuchiya et al. 2015; Hagiwara et al. 2016). The Basic Resident Registration Network system enables nationwide identity verification through the Basic Resident Registration (official proof of residence) in a network to increase convenience for residents and contributes to rationalized administration of the national and local governments in Japan (Ministry of Internal Affairs and Communications). Because of a high prevalence in the symptoms of shoulder and knee pain, and *katakori* (a Japanese term) (Kitahara and Shibata 2016) found from surveys after the GEJE, these were added to the questionnaire of the "2 years after the GEJE" investigation. "*Katakori,*" different from shoulder pain, is one of the most common subjective symptoms in the Japanese population and is recognized as a collection of symptoms including dull pain, subjective heaviness, and/or muscle tightness in the occipital region, the scapular region, and the shoulder girdle (Kitahara and Shibata 2016). A self-administered questionnaire was mailed to the participants. They had lived in severely damaged coastal regions such as Ishinomaki (Ogatsu and Oshika) and Sendai City (Wakabayashi ward, only living in prefabricated temporary housing) in Miyagi prefecture. All participants who replied to the questionnaire have consented to their participation in this study.

Outcome variables

To record subjective shoulder pain, the Comprehensive Survey of Living Conditions was used. Participants were provided a questionnaire and were instructed to encircle their responses (Comprehensive Survey of Living Conditions; Ministry of Health, Labour and Welfare 2013). The question was "Have you had symptoms within the last few days? If yes, please circle your symptoms (multiple choices were allowed at the time of the questionnaire)". Examples of the possible responses were "dizziness", "irritation", "diarrhea", "palpitation", "headache", "lower back pain", "shoulder pain", "knee pain", and "*katakori*". The outcome of interest was new-onset subjective shoulder pain, which was defined as shoulder pain absent at 2 years and present at 4 years after the GEJE, without quantification.

Main predictors

Athens Insomnia Scale (AIS) and Kessler Psychological Distress Scale-6 (K6) were used to evaluate sleep disturbance and psychological distress, respectively (Soldatos et al. 2000; Kessler et al. 2002). Sleep disturbance was defined as an AIS score greater than or equal to 6/24 at 2 years after the GEJE (Okajima et al. 2013); psychological distress, a K6 score greater than or equal to 10/24 at 2 years after the GEJE (Suzuki et al. 2014).

Covariates

The following were included in the analyses as covariates: gender (male or female), age, body mass index (BMI), living area, smoking habits, alcohol consumption, complications (hypertension (HT), diabetes mellitus (DM), myocardial infarction (MI), and cerebral stroke), working status, walking time/day, living status, economic hardship, and social isolation. To quantify social capital, we used the following statements: "People in your community help each other."; "People in your community can be trusted."; "People in your community greet each other."; "If there is a problem in your community, people work together to solve it." All questions were to be answered by choosing one of the followings: Strongly agree/Somewhat agree/Neither agree nor disagree/Somewhat disagree/Strongly disagree. Each answer could be scored 4 to 0, and the total score thus could range from 16 to 0; a higher score indicated rich social capital (Hagiwara et al. 2016). Social isolation (weak tie) was defined lesser than or equal to 8/16 points, at 2 years after the GEJE (Hagiwara et al. 2016).

Statistical analyses

Continuous variables were presented as medians with an interquartile range (IQR); categorical variables were presented as numbers and percentage (%). To compare the participants' characteristics, we used Mann-Whitney's U test for continuous variables and Pearson's chi-square test for categorical variables. We used multiple logistic regression analysis for analyzing the association of new-onset subjective shoulder pain with psychological distress and sleep disturbance. For calculating the odds ratio (OR) and 95% confidential intervals (CI) for new-onset subjective shoulder pain, two models were used as follows: in model 1, variables included sex (male or female), age (< 65 years old, or ≥ 65 years old), BMI ($18.5 <$, 18.5 to < 25.0, ≥ 25.0, or unknown), living area (Ogatsu, Oshika, or Wakabayashi),

smoking (non-smoker, smoker, or unknown) and drinking habits (non-drinker, < 45.6g of alcohol/day, ≥ 45.6g of alcohol/day, or unknown), complications (HT, present or not present; DM, present or not present; MI, present or not present; cerebral stroke, present or not present), working status (unemployed, employed, or unknown), walking time/day (< 30 min, 30 min to < 1 hr, ≥ 1 hr, or unknown), living status (same house as before the earthquake, small temporary house, apartment house or house of relatives/acquaintance, new house, or unknown), economic hardship (normal, a little bit hard, hard, very hard, or unknown), and social isolation (strong tie: > 8, weak tie: ≤ 8, or unknown). In model 2, all variables in model 1 plus psychological distress and sleep disturbance were included. We divided the participants into two subgroups (≥ 65 years old (n = 734) or < 65 years old (n = 720)) and calculated for OR and 95% CI for new-onset subjective shoulder pain. All statistical analyses were performed with SPSS version 24.0 (SPSS Japan Inc., Tokyo, Japan). All tests were 2-tailed, and $p < 0.05$ was considered statistically significant.

Ethical considerations

This study was approved by the institutional review board of Tohoku University School of Medicine (approved number: 201192).

Results

Amongst study participants (n = 6,283), 38.2% (n = 2,401) responded to the survey of symptoms at 2 years after the GEJE. Of these, 229 of the questionnaire responses with subjective shoulder pain were excluded. The follow-up rate for the questionnaire investigating symptoms 4 years after the GEJE was 73.1% (1,587/2,172). After excluding 55 participants with no consent, and 78 participants with missing data for AIS and K6, 1,454 participants were included in the analysis (Fig. 1).

The median age of the participants was 65.1 years (IQR: 52.8, 73.4) and 55.9% (n = 813) were female. Amongst them, 7.2% (n = 105) reported new-onset subjective shoulder pain. Baseline characteristics according to sleep disturbance are shown in Table 1. Participants who had sleep disturbance were more likely to be female, living in Ogatsu, with little walking time/day, undergoing economic hardship and social isolation, and having psychological distress. In the sleep disturbance group, 10.7% (n = 52) had new-onset subjective shoulder pain, whereas the percentage was 5.5% (n = 53) in the other group with no sleep disturbance. Baseline characteristics according to psychological distress are shown in Table 2. The participants who had psychological distress were likely to be current smokers, having MI, unemployed, with little walking time/day, undergoing economic hardship and social isolation, and having sleep disturbance. In the psychological distress group, 8.4% (n = 17) had new-onset subjective shoulder pain, whereas the percentage was 7% (n = 88) in the other group without psychological distress.

The crude and adjusted ORs (95% CI) for new-onset

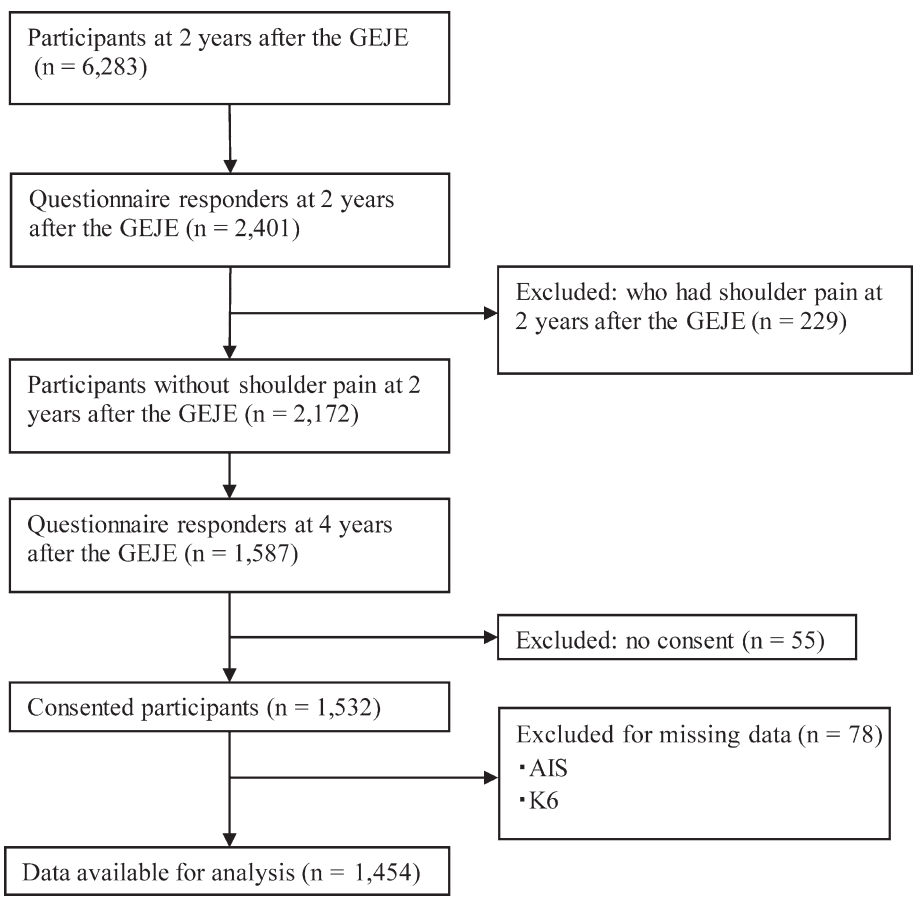

Fig. 1. Selection of study participants.

Table 1. Baseline characteristics of the participants according to sleep disturbance.

		Sleep disturbance		
		AIS < 6 (n = 966)	AIS ≥ 6 (n = 488)	P value
Gender	Male	459 (47.5)	182 (37.3)	<0.001
	Female	507 (52.5)	306 (62.7)	
Age	Total	65.0 (51.6, 73.8)	65.4 (54.8, 73.2)	0.41
	<65 years old	483 (50.0)	237 (48.6)	0.61
	≥65 years old	483 (50.0)	251 (51.4)	
BMI	Total	23.7 (21.8, 26.2)	24.0 (21.8, 26.4)	0.62
BMI*	<18.5	29 (3.0)	12 (2.5)	0.62
	18.5 to <25	542 (56.1)	260 (53.3)	
	≥25	348 (36.0)	192 (39.3)	
Living area	Ogatsu	410 (42.4)	232 (47.5)	0.031
	Oshika	383 (39.6)	159 (32.6)	
	Wakabayashi	173 (17.9)	97 (19.9)	
Smoking habits*	Non-smoker	748 (77.4)	383 (78.5)	0.44
	Smoker	171 (17.7)	76 (15.6)	
Drinking habits*	Non-drinker	582 (60.2)	305 (62.5)	0.25
	<45.6 g of alcohol/day**	195 (20.2)	79 (16.2)	
	≥45.6 g of alcohol/day**	98 (10.1)	49 (10.0)	
Complicatons	HT	381 (39.4)	217 (44.5)	0.066
	DM	78 (8.1)	48 (9.8)	0.26
	MI	60 (6.2)	35 (7.2)	0.48
	Cerebral stroke	14 (1.4)	8 (1.6)	0.78
Working status*	Unemployed	520 (53.8)	274 (56.1)	0.59
	Employed	422 (43.7)	200 (41.0)	
Walking time/day*	<30min	315 (32.6)	202 (41.4)	<0.001
	30min to <1h	369 (38.2)	177 (36.3)	
	≥1h	274 (28.4)	97 (19.9)	
Living status*	Same house as before the GEJE	261 (27.0)	108 (22.1)	0.16
	Small temporary house	443 (45.9)	253 (51.8)	
	Apartment house or house of relatives/acquaintance	207 (21.4)	104 (21.3)	
	New house	36 (3.7)	17(3.5)	
Economic hardship*	Normal	487 (50.4)	151 (30.9)	<0.001
	A little bit hard	265 (27.4)	146 (29.9)	
	Hard	150 (15.5)	128 (26.2)	
	Very hard	56 (5.8)	58 (11.9)	
Social isolation	Total	12.0 (11.0, 13.0)	11.0 (9.0, 13.0)	<0.001
Social isolation*	>8	853 (88.3)	380 (77.9)	<0.001
	≤8	92 (9.5)	94 (19.3)	
K6	Total	2.0 (0.0, 5.0)	7.0 (4.0, 10.0)	<0.001
	<10	914 (94.6)	338 (69.3)	<0.001
	≥10	52 (5.4)	150 (30.7)	

*Because each item has a limited number of respondents, the actual numer is not necessarily in accordance with the total.
**22.8 g of alchol amounts to 1 go or traditional unit of sake (180 ml), which also approximates to two glasses of wine (200 ml), or beer (500 ml) in terms of alchol content.
Continuous variables were presented as medians with interquartile range (IQR); categorical variables were presented as numbers and percentage (%).
Mann-Whitney U test was used for a continuous variable and Pearson's chi-squared test for a categorical variable.
HT, hypertension; DM, diabetes mellitus; MI, myocardial infarction.

Table 2. Baseline characteristics of the participants according to psychological distess.

		Psychological distress		
		K6 < 10 (n = 1,252)	K6 ≥10 (n = 202)	P value
Gender	Male	564 (45.0)	77 (38.1)	0.066
	Female	688 (55.0)	125 (61.9)	
Age	Total	65.2 (52.9, 73.4)	65.0 (52.6, 73.8)	0.53
	<65 years old	619 (49.4)	101 (50.0)	0.88
	≥65 years old	633 (50.6)	101 (50.0)	
BMI	Total	23.8 (21.8, 26.1)	24.2 (21.9, 27.3)	0.25
BMI*	<18.5	32 (2.6)	9 (4.5)	0.055
	18.5 to <25	704 (56.2)	98 (48.5)	
	≥25	460 (36.7)	80 (39.6)	
Living area	Ogatsu	555 (44.3)	87 (43.1)	0.10
	Oshika	475 (37.9)	67 (33.2)	
	Wakabayashi	222 (17.7)	48 (23.8)	
Smoking habits*	Non-smoker	990 (79.1)	141 (69.8)	0.012
	Smoker	199 (15.9)	48 (23.8)	
Drinking habits*	Non-drinker	768 (61.3)	119 (58.9)	0.40
	<45.6 g of alcohol/day**	239 (19.1)	35 (17.3)	
	≥45.6 g of alcohol/day**	120 (9.6)	27 (13.4)	
Complicatons	HT	511 (40.8)	87 (43.1)	0.55
	DM	110 (8.8)	16 (7.9)	0.69
	MI	75 (6.0)	20 (9.9)	0.037
	Cerebral stroke	17 (1.4)	5 (2.5)	0.23
Working status*	Unemployed	664 (53.0)	130 (66.4)	0.010
	Employed	555 (44.3)	67 (33.2)	
Walking time/day*	<30min	416 (33.2)	101 (50.0)	<0.001
	30min to <1h	484 (38.7)	62 (30.7)	
	≥1h	337 (26.9)	34 (16.8)	
Living status*	Same house as before the GEJE	330 (26.4)	39 (19.3)	0.23
	Small temporary house	586 (46.8)	110 (54.5)	
	Apartment house or house of relatives/acquaintance	269 (21.4)	43 (21.3)	
	New house	46 (3.7)	7 (3.5)	
Economic hardship*	Normal	599 (47.8)	39 (19.3)	<0.001
	A little bit hard	352 (28.1)	59 (29.3)	
	Hard	215 (17.2)	63 (31.2)	
	Very hard	77 (6.2)	37 (18.3)	
Social isolation	Total	12.0 (10.3, 13.0)	10.0 (8.0, 12.0)	<0.001
Social isolation*	>8	1098 (87.7)	135 (66.8)	<0.001
	≤8	122 (9.7)	64 (31.7)	
AIS	Total	3.0 (1.0, 6.0)	8.0 (5.0, 11.0)	<0.001
	<6	914 (73.0)	52 (25.7)	<0.001
	≥6	338 (27.0)	150 (74.3)	

*Because each item has a limited number of respondents, the actual numer is not necessarily in accordance with the total.

**22.8 g of alchol amounts to 1 go or traditional unit of sake (180 ml), which also approximates to two glasses of wine (200 ml), or beer (500 ml) in terms of alchol content.

Continuous variables were presented as medians with interquartile range (IQR); categorical variables were presented as numbers and percentage (%).

Mann-Whitney U test was used for a continuous variable and Pearson's chi-squared test for a categorical variable.

HT, hypertension; DM, diabetes mellitus; MI, myocardial infarction.

Table 3. Odds ratio (OR) and 95% confidential interval (CI) of new-onset of shoulder pain according to sleep disturbance and psychological distress.

	New onset shoulder pain								
	Crude			Model 1 [a]			Model 2 [b]		
	OR	95%CI	P value	OR	95%CI	P value	OR	95%CI	P value
AIS									
<6	1	Reference		1	Reference		1	Reference	
≥6	2.06	1.38 – 3.06	<0.001	1.83	1.20 – 2.79	0.005	1.92	1.24 – 2.98	0.004
K6									
<10	1	Reference		1	Reference		1	Reference	
≥10	1.22	0.71 – 2.09	0.48	0.99	0.55 – 1.78	0.98	0.78	0.42 – 1.42	0.41

[a]Adjusted for gender, age, BMI, living area, smoking habits, drinking habits, complications, working status, walking time, living status, economic hardship, and social isolation.
[b]Additionally adjusted for sleep disturbance and psychological distress, respectively.
OR, Odds Ratio; CI, Confidence Interval.

Table 4. Stratified analysis for each age group.

	New onset shoulder pain								
	Crude			Model 1 [a]			Model 2 [b]		
	OR	95%CI	P value	OR	95%CI	P value	OR	95%CI	P value
Younger (age <65)									
AIS									
<6	1	Reference		1	Reference		1	Reference	
≥6	1.66	0.96 – 2.88	0.069	1.42	0.78 – 2.58	0.26	1.42	0.76 – 2.65	0.28
K6									
<10	1	Reference		1	Reference		1	Reference	
≥10	1.16	0.55 – 2.45	0.69	1.14	0.50 - 2.62	0.75	1.00	0.42 - 2.36	0.99
Older (age ≥65)									
AIS									
<6	1	Reference		1	Reference		1	Reference	
≥6	2.65	1.47 – 4.79	0.001	2.35	1.22 – 4.52	0.010	2.63	1.33 – 5.17	0.005
K6									
<10	1	Reference		1	Reference		1	Reference	
≥10	1.28	0.58 – 2.81	0.55	0.82	0.33 – 2.03	0.67	0.58	0.22 – 1.48	0.25

[a]Adjusted for gender, age, BMI, living area, smoking habits, drinking habits, complications, working status, walking time, living status, economic hardship, and social isolation.
[b]Additionally adjusted for sleep disturbance and psychological distress, respectively.
OR, Odds Ratio; CI, Confidence Interval.

subjective shoulder pain are shown in Table 3. Sleep disturbance was significantly associated with new-onset subjective shoulder pain; however, psychological distress was not significantly associated in all models.

In the subgroup analyses, there were no significant associations between new-onset subjective shoulder pain and sleep disturbance or psychological distress in the younger age group. However, in the older age group, sleep disturbance was significantly associated with new-onset subjective shoulder pain, and not with psychological distress (Table 4).

Discussion

This study indicates that sleep disturbance has a significant association with new-onset subjective shoulder pain in the GEJE survivors. However, psychological distress had little association with new-onset subjective shoulder pain. Furthermore, we found that sleep disturbance has a significant association with new-onset subjective shoulder pain in the older age group; although little association was found in the younger one.

Chronic musculoskeletal pain in the Japanese general population is at a frequency of 15.4%, and is highest in their 30s to 50s (Nakamura et al. 2011). However, pain was reported to have increased at a frequency of 62% with a mean Numeric Rating Scale of 2.74, in the GEJE survivors (Yabuki et al. 2015). Chronic musculoskeletal pain in the survivors has now been established as a severe problem, which disrupts activity of daily living. To determine the factors causing pain in the survivors, it is necessary to recover details of their normal life before the GEJE.

Symptomatic shoulder disorders are common causes of pain and disability in the general population (Luime et al. 2004). Although there is no consensus about factors

causing shoulder pain after a natural disaster, shoulder pain was the third-most frequent kind of pain, after lower back and knee pain amongst the GEJE survivors (Yabuki et al. 2015). The most suspected causes of shoulder pain are believed to be rotator cuff and biceps tendon lesions, frozen shoulder, osteoarthritis, arthritis with systemic diseases, and fibromyalgia (White 1982). Shoulder motion is a complex movement of four joints (the glenohumeral, acromioclavicular, sternoclavicular, and scapulothoracic joints), and the restriction of motion in one joint could cause shoulder and neck pain because of the change in the normal motion of the other joints (White 1982). Because most of the survivors lived in the coastal areas and their houses were flooded and destroyed by the tsunami, they had to move and live in temporary small houses or apartments. These situations could have easily induced physical inactivity and poor posture, especially in the older participants who were assumed to be unemployed and have thoracic kyphosis. Poor posture is believed to disrupt the kinematic chain of the four joints and increase shoulder pain. Because the data were collected post disaster, physical burden of the survivors, such as clearing up debris or moving to other places, was found to have decreased.

Sleep problems were associated with an increased risk of chronic pain in the lower back, and neck or shoulders (Mork et al. 2014). Insomnia has been a major issue amongst the GEJE survivors (Matsumoto et al. 2014) and was significantly associated with subjective shoulder pain after the GEJE in a cross sectional study (Hagiwara et al. 2017). One possible explanation is that pain at night is a characteristic of shoulder disorders, which could influence sleep habits. On the contrary, sleep disturbance provoked low-level systemic inflammation with more sensitive nociception, which could cause shoulder pain in survivors (Haack et al. 2007; Mork et al. 2014). These complex scenarios could cause both sleep disturbance and shoulder pain in the participants. Insomnia is a prevalent sleep disorder that adversely affects older adults at a rate higher than the overall adult population (Bain 2006). Sleep disturbance was significantly correlated with subjective shoulder pain in the older age group but not in the younger age group. The natural aging process could also cause shoulder pain in the older age group.

The traditional biomedical model of illnesses assumes a direct correspondence between nociception (the pathophysiology of tissue damage) and pain (the experience of discomfort). However, biomedical treatments (surgery, injection, medication, and exercises) are only one aspect of care for disabling musculoskeletal pain (Vranceanu et al. 2009). On the contrary, the biopsychosocial model emphasizes complex influences of biological, psychological, cultural, and social variables on the experience of pain (Vranceanu et al. 2009). Certain events could alter the perception of pain and discomfort (Bener et al. 2013). Feeling of helplessness and hopelessness are important predictors for the onset as well as the persistence of psychosomatic disorders (Schmale 1972). In terms of the biopsychosocial model, new onset subjective lower back pain after the GEJE was significantly associated with working status (Hagiwara et al. 2016) and subjective economic hardship (Yabe et al. 2017) in prospective cohort studies. Furthermore, living status, economic hardship, and sleep disturbance were significantly associated with subjective shoulder pain after the GEJE in a cross sectional study (Hagiwara et al. 2017). Pain in the GEJE survivors has been influenced by various factors. Numerous survivors have felt severe economic hardship and difficulties in ascertaining positivity towards their future lives, which is assumed to add to their discomfort. Psychological interventions such as cognitive behavioral therapy, relaxation, and biofeedback have been, on an average, more effective than standard biomedical treatments for decreasing pain intensity, pain-related disability, depression, and for improving the health-related quality of life of patients with lower back pain (Hoffman et al. 2007). Considering the shortage of medical practitioners in their living areas, such interventions depending on the biopsychosocial model should be a helpful method for reducing shoulder pain as well as lower back pain in survivors.

As chronic diseases exacerbate, depression is the strongest predictor of health, as it relates to the psychopathology of the patient (Moussavi et al. 2007). Patients with depressive disorders often have multiple complaints, including an overlapping constellation of emotional and physical symptoms. Amongst physical symptoms, fatigue, insomnia, and pain are common, and they are frequently nonspecific (Härmä et al. 2002). It is not surprising that survivors of the GEJE have a higher prevalence of distress and depression owing to their loss of homes, vehicles, and jobs, and the lack of access to psychiatric care is significantly associated with the exacerbation of these symptoms even 3 years after the GEJE (Tsuboya et al. 2016). However, psychological distress had no influence on subjective shoulder pain in this study. One possible explanation is that pain hinders the diagnosis and treatment of depression (Bair et al. 2004). Furthermore, sleep disturbance has a stronger effect on shoulder pain than does psychological distress. The survivors' living conditions have changed so dramatically that even building new communities around these new temporary housing areas has not majorly contributed to alleviating this stress. Because municipal offices have prepared new permanent public housing, the temporary houses have been demolished and survivors have to settle in new housing. Such situations may increase social isolation and psychological stress. Further careful study is needed to observe the influence of these circumstances on the mental status of survivors.

This study has several limitations. First, the follow-up rate was not high. We checked the symptoms of shoulder pain using self-reported questionnaires. Shoulder pain was inquired about in the self-reported questionnaire from 2012, although only allowed one question was asked regarding this symptom. Thus, in order to raise the collection rate of

data, underlying pathology, degree, duration, and acuteness or chronicity of the pain could not be assessed. Because the devastating tsunami after the GEJE destroyed all of the public facilities in surrounding living areas, it was difficult to follow through all the medical records of survivors. Furthermore, because survivors have had to settle in the short term to all areas of Japan owing to their social circumstances, it was difficult for us to trace them. Finally, it was difficult to set normal controls because the GEJE and Tsunami had hit such a vast area of Japan.

In conclusion, psychological distress has little effect, although, sleep disturbance has a significant correlation with subjective shoulder pain amongst the survivors of the GEJE. Furthermore, these trends are more prominent in the older age group than in the younger group. Further observational studies and continuous support are needed for the survivors of the GEJE.

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Conflict of Interest

The authors declare no conflict of interest.

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