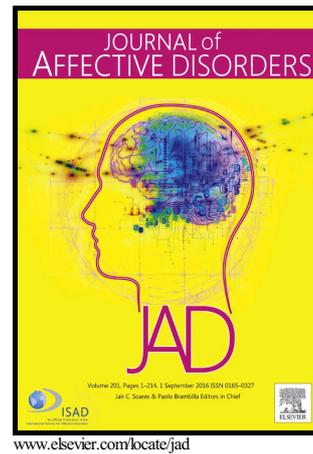


## Author's Accepted Manuscript

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Fumiya Tanji, Yumi Sugawara, Yasutake Tomata, Takashi Watanabe, Kemmyo Sugiyama, Yu Kaiho, Hiroaki Tomita, Ichiro Tsuji



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**Psychological Distress and the Incident Risk of Functional Disability in Elderly  
Survivors after the Great East Japan Earthquake**

Fumiya Tanji<sup>a\*</sup>, Yumi Sugawara<sup>a</sup>, Yasutake Tomata<sup>a</sup>, Takashi Watanabe<sup>a</sup>, Kemmyo  
Sugiyama<sup>a</sup>, Yu Kaiho<sup>a</sup>, Hiroaki Tomita<sup>b</sup>, Ichiro Tsuji<sup>a</sup>

<sup>a</sup>Division of Epidemiology, Department of Health Informatics and Public Health, Tohoku  
University School of Public Health, Graduate School of Medicine, Sendai, Japan.

<sup>b</sup>Department of Disaster Psychiatry, International Research Institute of Disaster Science,  
Tohoku University, Sendai, Japan.

\*Corresponding author: Division of Epidemiology, Tohoku University School of Public  
Health, Graduate School of Medicine, 2-1, Seiryomachi, Aoba-ku, Sendai, Miyagi  
980-8575, Japan. Tel.: +81-22-717-8123; Fax: +81-22-717-8125. ftanji-thk@umin.ac.jp

**Abstract**

Background:

We conducted a prospective cohort study to investigate whether psychological distress  
would have increased the incident risk of functional disability after the 2011 Great East  
Japan Earthquake.

Methods:

First phase data pertaining to psychological distress and other lifestyle factors were

collected from 1,037 subjects aged  $\geq 65$  years, from June to December 2011, in four affected areas of Miyagi prefecture in Japan. Psychological distress was measured by the Kessler 6-item psychological distress scale (K6), and classified into three categories (K6 score  $\leq 9$ , 10-12,  $\geq 13$ ). Outcome data on functional disability were collected from the public Long-term Care Insurance database. Participants were followed up for about 2.6 years. The Cox model was used to calculate the multivariate hazard ratios (HRs) and 95% confidence intervals (CIs).

#### Results:

During the follow-up period, 118 participants were certified as incident disability (43.8 disability events per 1,000 person-years). Compared with the lowest category (K6 score  $\leq 9$ ), participants in the highest category (K6 score  $\geq 13$ ) had a significantly higher risk of functional disability (HR=2.35, 95% CI=1.17-4.70,  $p=0.007$ ). In order to consider reverse causality, we conducted analysis excluding all incidents and deaths that occurred within the first year of follow-up, but our findings remained unchanged.

#### Limitations:

We did not consider all potential confounders and use of appropriate medication.

#### Conclusions:

The present study has demonstrated that psychological distress was associated with an increased risk of functional disability among elderly survivors of a natural disaster.

#### Keywords:

psychological distress; disability; Great East Japan Earthquake; cohort study.

## 1. Introduction

The Great East Japan Earthquake (GEJE) and tsunami on March 11, 2011, not only took the lives of more than 15,000 people (National Police Agency, 2016), but also affected the health and physical function of elderly survivors (Ishiki et al., 2016; Ohira et al., 2015; Sato et al., 2015; Tanisho et al., 2016; Tomata et al., 2014; Tomata et al., 2015). Our previous study had shown that the prevalence of functional disability, defined as having disability certification by the Japanese Long-Term Care Insurance (LTCI) system, among the elderly increased sharply after the GEJE (Tomata et al., 2015). The rate of increase in disability prevalence during the 3 years after the GEJE was higher in coastal (14.7%) and inland (10.0%) disaster areas than in non-disaster areas (6.2%).

Psychological distress was assumed to be one of the risk factors for increased disability prevalence, because previous studies targeting the general elderly population have reported that psychological ill-health is a major risk factor for functional disability (Gallagher et al., 2016; Iwasa et al., 2009; Ohmori-Matsuda et al., 2010; Stuck et al., 1999; Yamazaki et al., 2012). The prevalence of psychological distress among GEJE survivors is reported to be higher than in the general population (Sugimoto et al., 2015; Yokoyama et al., 2014). One suggested mechanism for this association is that people with depression have low levels of physical activity and high levels of sedentary behavior (Schuch et al., 2017). Additionally, it has been reported that physical activity among survivors of the GEJE living in temporary

housing was decreased for a year after the disaster (Murakami et al., 2014). Therefore, increased prevalence of psychological distress may be a cause of increased disability prevalence in disaster areas.

To our knowledge, however, no previous study of a prospective design has examined the association between psychological distress and the incident risk of functional disability among natural disaster survivors. Therefore, we hypothesize that psychological distress increases the incident risk of functional disability in elderly survivors of natural disasters. If this is indeed the case, then this would help to explain the increase in disability prevalence after the GEJE, and facilitate better planning for disability prevention after natural disasters.

The aim of the present study was to examine whether psychological distress would have increased the incident risk of functional disability among elderly survivors after the GEJE, using a prospective cohort data.

## **2. Methods**

### *2.1. Study cohort*

The design of this cohort study has been described in detail elsewhere (Hagiwara et al., 2016; Sone et al., 2016). In brief, we conducted questionnaire surveys of residents aged 18 years or older who were included in the Residential Registry for Ogatsu, Oshika and Ajishima, Ishinomaki City, Miyagi Prefecture, and whose houses were largely or totally destroyed by the earthquake and tsunami in Shichigahama Town, Miyagi Prefecture. We

conducted baseline surveys from June to December, 2011, and then followed up participants for information on the date of incident disability (LTCI certification), death, or emigration (between the baseline and July 1, 2014).

At the baseline survey, 3,467 (41.7%) out of 8,317 eligible subjects participated. Of these subjects, 1,584 were aged 65 years and older. We excluded 384 persons who did not provide written consent for review of their LTCI information, 110 persons who had already been certified as having disability by the LTCI, 2 persons who had moved, and 51 persons who provided incomplete answers about psychological distress measured by the Kessler 6-item psychological distress scale (K6) (Kessler et al., 2002). Thus, a total of 1,037 persons formed the cohort under study.

## 2.2. *Exposure data*

The main exposure was psychological distress, as measured by the K6 (Kessler et al., 2002). The Japanese version of the K6 has been validated previously (Furukawa et al., 2008). The K6 consists of six questions about how often an individual has felt the following in the last month: 1) nervous, 2) hopeless, 3) restless or fidgety, 4) so sad that nothing could cheer you up, 5) everything was an effort, and 6) worthless. The total K6 score ranged from 0 to 24. In previous studies, two cut-off points of 10 and 13 has been commonly used to screen for psychological stress (Fushimi et al., 2012; Sone et al., 2016; Watanabe et al., 2016; Yokoyama et al., 2014). Thus, we classified participants into three groups according to their K6 score (low: 0-9, moderate: 10-12, high: 13-24).

### 2.3. *Covariates*

We regarded the following variables as potential confounders: age (continuous variable), sex, past medical history (cancer, stroke, or myocardial infarction), smoking status (currently smoking, or non-smoking), drinking status (currently drinking, or non-drinking), walking time (<0.5, 0.5-1, or  $\geq 1$ h/day), residence (same house as that before the earthquake, or others including temporary housing, rental housing, house of a family member, relative or friend, and evacuation site), residential area (Ogatsu, Oshika, Ajishima, or Shichigahama), and subjective economic status [normal, slightly severe, or severe (very severe or severe)].

Social networks were evaluated using the Lubben Social Network Scale-6 (LSNS-6), which consists of 6 questions designed to screen for social isolation among community-dwelling older adult populations (Kurimoto *et al.*, 2011; Lubben *et al.*, 2006). Total point scores ranged from 0 to 30. We classified individuals with scores of  $\leq 11$  as having weak ties and those with scores of  $\geq 12$  as having strong ties (Lubben *et al.*, 2006).

### 2.4. *Follow-up and case details*

The primary endpoint was incident functional disability, which was defined as newly qualifying for LTCI certification, regardless of certification level, up to July 1, 2014. LTCI certification in Japan has used a nationally uniform standard of functional disability. LTCI is a mandatory form of social insurance aimed at assisting activities of daily living (ADL)

in the frail and elderly (Ikegami, 1997; Imai et al., 2008; Ministry of Health; Tsutsui and Muramatsu, 2005). Everyone aged 40 years or older pays premiums, and people aged 65 years or older are eligible for formal caregiving services. When the elderly require assistance with ADL, they apply to the municipal government for benefits, and undergo assessment of their degree of functional disability by care managers using a questionnaire developed by the Ministry of Health, Labor and Welfare. Then, the municipal government calculates the standardized scores for physical and cognitive impairment on the basis of the questionnaire and physician's judgment report. Subsequently, the Municipal Certification Committee assesses whether the applicant is eligible for LTCI benefits. If a person is judged to be thus eligible, the Municipal Certification Committee decides on one of seven levels of support, ranging from Support Level 1, Support Level 2, and Care Level 1 to Care Level 5. In brief, LTCI certification levels are defined as follows. Support Level 1: "limited in instrumental activities of daily living but independent in basic activities of daily living (ADLs)"; Care Level 2: "requiring assistance in at least one basic ADL task"; Care Level 5: "requiring care in all ADL tasks". A community-based study has shown that levels of LTCI certification are well correlated with ability to perform activities of daily living, and with Mini-Mental State Examination scores (Arai et al., 2003). LTCI certification has already been used in many studies as a measure of incident functional disability in the elderly (Chou et al., 2014; Kanamori et al., 2014).

All participants were followed up by reviewing information on the date of LTCI certification, death or emigration from Ishinomaki City and Shichigahama Town

Government. All data were transferred from each government under the agreement related to Epidemiologic Research and Privacy Protection.

### 2.5. Ethical Issues

We received written consent along with the questionnaires from participants for both participation in the study and having their own LTCI certification information reviewed for study. The Ethics Committee of Tohoku University Graduate School of Medicine reviewed and approved the study protocol.

### 2.6. Statistical analysis

The person-years of follow-up were counted from the first date of the baseline survey at each site (Ogatsu: June 24, 2011, Oshika: August 7, 2011, Ajishima: September 10, 2011, Shichigahama: November 18, 2011) until the date of incident functional disability, date of emigration from each area, date of death, or the end of the study period (July 1, 2014), whichever occurred first.

We used the Cox proportional hazards model to calculate the hazard ratios (HRs) and 95% confidence intervals (CIs) for incident functional disability according to each category of K6, treating the lowest category as the reference category, and to adjust for the confounding variables. For cases where values for a confounding variable were missing, we created a separate missing category and included this in the model. We also calculated multivariate HRs and p values for trend by using the K6 category variables.

Additionally, to examine possible reverse causality, we repeated the analyses after excluding all deaths without disability and incident functional disability that occurred within the first year of follow-up. Furthermore, we employed a competing risk model (Berry et al., 2010; Fine and Gray, 1999; Xue et al., 2008) and did not treat deaths preceding incident functional disability as censored, but rather as a competing event.

To assess whether the association between psychological distress and the incident risk of functional disability differed by age, sex, residence, subjective economic status, walking time, pain or social networks, we stratified the subjects according to the following: age (65-74 years vs  $\geq 75$  years), sex (men vs women), residence (same house as that before the earthquake vs others), subjective economic status (severe vs normal), walking time ( $< 1$ h/day vs  $\geq 1$ h/day), pain (presence vs absence), or social networks (weak ties vs strong ties). Pain included low back pain or limb arthralgia. Interactions between three categories of the K6 and the incident risk of functional disability were tested for using the likelihood ratio test, which compared the models with and without cross-product interaction terms.

All statistical analyses were performed using the SAS software package (version 9.4; SAS Institute, Inc., Cary, North Carolina, USA). All statistical tests were 2-sided, and differences at  $P < 0.05$  were accepted as significant.

### 3. Results

Among the 2.6 years of follow-up (2,692 person-years), 118 incidents of new disability were certified (43.8 disability events per 1,000 person-years), 39 participants died without

any certification of disability, and 30 subjects (2.9%) were lost to follow-up because they moved away from the study area.

Baseline characteristics according to each category of the K6 are shown in Table 1.

Among the 1,037 participants, the mean age (S.D) was 73.8 (5.8) years, and 45.8% of them were men. Participants with a higher K6 category were more likely to be self-assessed as having severe economic status, and to suffer from insomnia. Compared with the “low” category (K6 score  $\leq 9$ ), participants in the “high” category (K6 score  $\geq 13$ ) were less likely to walk  $\geq 1$  h/day (29.8% vs 16.7%) and to go out every day (43.9% vs 28.8%).

Table 2 shows the association between psychological distress and the incident risk of functional disability as assessed by multivariate Cox proportional hazards regression analysis. We found a significantly higher risk in the “high” category (multivariate HR<sub>2</sub>=2.65, 95% CI=1.35-5.18), than in the “low” category. The HRs for the “moderate” category (K6 score 10-12) were also increased, but only slightly and not to a significant degree (multivariate HR<sub>2</sub>=1.70, 95% CI=0.98-2.95). To examine possible reverse causality, we repeated the analysis after excluding incident functional disability (39 participants) and all deaths (6 participants) that occurred within the first year of follow-up. Among the remaining 992 participants, 79 incidents of new disability and 33 disability-free deaths (death without any certification of functional disability as a competing event) were certified. The results remained unchanged after this analysis: the multivariate HR<sub>3</sub> for “moderate” and “high” was increased significantly (moderate: multivariate HR=2.03, 95% CI=1.06-3.88; high: multivariate HR=2.77, 95% CI=1.19-6.44,  $p=0.003$ ), in comparison

with the “low” category. In addition, using a competing risk model, we conducted analysis by treating deaths preceding incident functional disability as a competing event, but our findings remained unchanged (moderate: multivariate HR=1.91, 95% CI=1.03-3.57; high: multivariate HR=2.80, 95% CI=1.19-6.62,  $p=0.005$ ).

Table 3 shows stratified analyses of the associations between psychological distress and incident functional disability. Analyses stratified by age revealed significant interaction ( $p$ -interaction=0.047). Among subjects aged 65-74 years, the “moderate” and “high” categories were associated with a higher risk of incident functional disability, with HRs (95% CIs) of 3.02 (1.04-8.78) and 6.44 (1.91-21.72), respectively. The association was not significant among those aged 75 years and over (moderate: multivariate HR=1.37, 95% CI=0.71-2.63; high: multivariate HR=1.36, 95% CI=0.56-3.30). A significant association between psychological distress and disability risk was observed only among subjects who continued to live at the same house as that before the earthquake (moderate: multivariate HR=2.19, 95% CI=1.04-4.61; high: multivariate HR=4.31, 95% CI=1.71-10.96), although the interaction was only slightly significant ( $p$ -interaction=0.056). Additionally, a significant association between psychological distress and disability risk was observed only among subjects who walked <1h/day (moderate: multivariate HR=2.02, 95% CI=1.15-3.56; high: multivariate HR=2.57, 95% CI=1.26-5.23), although interaction was not observed ( $p$ -interaction=0.458). After stratifications by other variables, the associations did not differ substantially (sex:  $p=0.302$ ; subjective economic status:  $p=0.796$ ; social networks:  $p=0.491$ ).

#### 4. Discussion

We investigated the association between psychological distress and the incident risk of functional disability in elderly Japanese survivors of the GEJE using prospective cohort data. We found that psychological distress was associated with a risk of incident functional disability. The present study is the first to have investigated this association among survivors of a major natural disaster. Because the prevalence of psychological distress usually increases after a natural disaster, it has a substantial impact upon incident functional disability.

We also considered the effects of reverse causality. Even after excluding individuals who experienced incident functional disability within the first year of follow-up, the association between psychological distress and incident functional disability persisted.

Previous studies have suggested some mechanisms to explain the association between psychological distress and the risk of functional disability in the general population. It has been reported that a homebound state (i.e., being less likely to go outside and seek social integration) might mediate the relationship between depression and functional decline (Iwasa et al., 2009). Individuals with depressive symptoms are less likely to actively go out, even though they can go out into the neighborhood unassisted (Shinkai et al., 2005).

Depression is a risk factor for development of a sedentary lifestyle and a decreased level of physical exercise (Roshanaei-Moghaddam et al., 2009). Sedentary time has a significant positive association with risk of functional loss (Semanik et al., 2015). In our study, participants with a higher K6 category walked a shorter time and went out less often than

those who had the lowest level of psychological distress. In fact, a significant association between psychological distress and the incident risk of functional disability was observed among subjects who walked for less than 1 hour a day, but was not evident among those who walked for 1 hour or more a day. Therefore, it is suggested that the increased risk of incident functional disability among the elderly survivors of the GEJE would be partly attributable to a sedentary lifestyle among those with psychological distress. The proportion of individuals with psychological distress increases markedly after a large-scale natural disaster. These findings highlight the importance of interventions for supporting mental health and promoting physical activity, in order to prevent the development of functional disability among subjects with psychological distress after a natural disaster.

A significant association between psychological distress and the incident risk of functional disability was also observed among subjects aged 65-74 years and those lived at the same house as before the earthquake. Our findings suggest that lack of physical activity, belonging to the 65-74 year age group, and living at the same house as before the earthquake would be high-risk factors for the association between psychological distress and the incident risk of functional disability.

Our study had some methodological strengths. This was the first study to have examined the association between psychological distress and the incident risk of functional disability among survivors of a major natural disaster, using prospective data. Second, many confounding factors were taken into account. Third, we reinforced our findings by sensitivity analyses, including the competing risk model.

This study also had several limitations. First, we did not consider all potential confounders, such as a history of psychiatric disorders including depression, and use of appropriate medication. Second, we did not consider changes in the lifestyle characteristics and psychological status of our study participants during the follow-up period. Thus, these limitations might have led to some possible residual confounding and misclassification. Third, we did not investigate the causes of functional disability in participants who received LTCI certification. Thus, we were unable to identify the mechanism of the observed association.

## **5. Conclusions**

The present study has demonstrated a first attempt to examine that psychological distress was associated with an increased risk of functional disability among elderly survivors of a major natural disaster. We suggest that the increased risk of incident functional disability among elderly survivors of the GEJE would have been partly attributable to a sedentary lifestyle among those with psychological distress. Our findings highlight the importance of interventions for supporting mental health and promoting physical activity, in order to prevent the development of functional disability among subjects with psychological distress after a natural disaster.

## **Conflict of Interest**

All authors declare that they have no conflicts of interest.

## Author Disclosure

### Contributors

All the authors have made a substantial contribution to the manuscript and have approved this submission. FT performed the data analyses and wrote the manuscript. YS, YT, and IT supervised the data analyses and the manuscript. TW, KS, YK and HT helped to supervise the manuscript.

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**Table 1.** Characteristics of participants divided to three categories of K6 score.

	K6 score			p values
	≤9	10≤K6≤12	≥13	
Number of subjects	880	91	66	
Age (%)				
Mean age years (S.D)	73.9 (5.8)	74.1 (5.7)	72.6 (5.1)	0.196
65-74	56.8	56.0	62.1	0.688
≥75	43.2	44.0	37.9	
Sex (%)				

Men	46.9	36.3	43.9	0.144
Residence (%)				
Same house as that before the earthquake	48.9	41.8	31.8	0.061
Others <sup>a</sup>	49.3	57.1	66.7	
Residential area (%)				
Ogatsu	26.1	22.0	25.8	0.106
Oshika	29.3	31.9	36.4	
Ajishima	14.0	11.0	1.5	
Shichigahama	30.6	35.1	36.3	
Subjective economic status (%)				
Very severe or severe	19.0	33.0	62.1	<0.001***
Slightly severe	29.0	35.2	24.2	
Normal	51.9	31.9	13.6	
Past medical history <sup>b</sup> (%)	13.1	17.6	22.7	0.057
Smoking status (%)				
Non-smoking	84.7	89.0	86.4	0.577
Currently smoking	10.0	7.7	6.1	
Drinking status (%)				
Non-drinking	66.6	73.6	62.1	0.535
Currently drinking	28.5	20.9	31.8	
Walking time (%)				
≥1h/day	29.8	18.7	16.7	0.021*
0.5-1h/day	35.6	31.9	42.4	
<0.5h/day	34.1	49.5	40.9	
Frequency of going out				
Every day	43.9	35.2	28.8	0.033*
3 days/week	25.2	26.4	21.2	
<1day/week	30.6	38.5	50.0	
Social networks (%)				
Strong ties	78.9	70.3	68.2	0.137
Weak ties	17.7	25.3	27.3	
Insomnia (%)				
Absence	68.2	38.5	12.1	<0.001***
Presence	27.8	57.1	84.9	

<sup>a</sup> Temporary housing, rental housing, house of a family member, relative or friend, or evacuation site.

<sup>b</sup> Cancer, stroke, or myocardial infarction.

\* p<0.05; \*\* p<0.01; \*\*\* p<0.001.

**Table 2.** Association between the K6 and the incident functional disability.

	K6 score levels			p trend <sup>a</sup>
	≤9	10≤K6≤12	≥13	
<b>All subjects</b>				
Number of subjects	880	91	66	
Person-years	2,296	227	169	
Number of events of incident disability	91	16	11	
Sex-age adjusted HR (95% CI)	1.00 (ref)	1.69 (0.99-2.89)	2.21 (1.18-4.16)	0.003**
Multivariate HR1 <sup>b</sup> (95% CI)	1.00 (ref)	1.63 (0.94-2.82)	2.38 (1.25-4.55)	0.003**
Multivariate HR2 <sup>c</sup> (95% CI)	1.00 (ref)	1.70 (0.98-2.95)	2.65 (1.35-5.18)	0.002**
<b>Subjects after excluding incident functional disability and all deaths within the first year of follow up</b>				
Number of subjects	843	87	62	
Person-years	2,276	225	166	
Number of events of incident disability	60	12	7	
Disability-free deaths as a competing event	26	6	1	
Multivariate HR3 <sup>d</sup> (95% CI)	1.00 (ref)	2.03 (1.06-3.88)	2.77 (1.19-6.44)	0.003*
Multivariate HR4 <sup>e</sup> (95% CI)	1.00 (ref)	1.91 (1.03-3.57)	2.80 (1.19-6.62)	0.005*

<sup>a</sup> Linear trend tests were calculated by treating K6 scores as categorical variables.

<sup>b</sup> HR1 was adjusted for sex, age, past medical history of cancer, stroke, or myocardial infarction (presence or absence), smoking status (currently smoking, or non-smoking), drinking status (currently drinking, or non-drinking), walking time (<0.5, 0.5-1, or ≥1 h/day), residence (same house as before the earthquake, or others) and residential area (Ogatsu, Oshika, Ajishima, or Shichigahama).

<sup>c</sup> HR2 was adjusted for HR1 + subjective economic status (very severe/severe, slightly severe, or normal) and social networks (strong or weak ties).

<sup>d</sup> HR3 denotes the HR2 with incident functional disability and all deaths within the first year of follow-up excluded from the analysis.

<sup>e</sup> HR4 denotes the HR3 by treating death preceding functional disability as a competing event.

\*p<0.05; \*\*p<0.01; \*\*\*p<0.001.

**Table 3.** Stratified analyses: Association between K6 and the incident of functional disability.

	K6 score levels			p trend <sup>a</sup>	p interaction <sup>b</sup>
	≤9	10≤K6≤12	≥13		
<b>Age</b>					
<b>65-74 years</b>					
Number of events of incident disability /subjects	16/500	5/51	5/41		
Multivariate HR (95% CI)	1.00 (ref)	3.02 (1.04-8.78)	6.44 (1.91-21.72)	0.001**	0.047*
<b>≥75 years</b>					
Number of events of incident disability /subjects	75/380	11/40	6/25		
Multivariate HR (95% CI)	1.00 (ref)	1.37 (0.71-2.63)	1.36 (0.56-3.30)	0.316	
<b>Sex</b>					
<b>Men</b>					
Number of events of incident disability /subjects	33/413	6/33	5/29		
Multivariate HR (95% CI)	1.00 (ref)	2.17 (0.87-5.38)	2.82 (0.97-8.21)	0.023*	0.302
<b>Women</b>					
Number of events of incident disability /subjects	58/467	10/58	6/37		
Multivariate HR (95% CI)	1.00 (ref)	1.49 (0.73-3.03)	2.38 (0.96-5.90)	0.043*	
<b>Residence</b>					
<b>Same house as that before the earthquake</b>					
Number of events of incident disability /subjects	50/430	9/38	7/21		
Multivariate HR (95% CI)	1.00 (ref)	2.19 (1.04-4.61)	4.31 (1.71-10.96)	<0.001***	0.056
<b>Others</b>					
Number of events of incident disability /subjects	38/434	6/52	4/44		
Multivariate HR (95% CI)	1.00 (ref)	1.14 (0.46-2.83)	1.88 (0.64-5.54)	0.290	
<b>Subjective economic status</b>					
<b>Severe</b>					
Number of events of incident disability /subjects	12/167	1/30	5/41		
Multivariate HR (95% CI)	1.00 (ref)	0.32 (0.03-3.55)	4.45 (1.18-16.80)	0.074	0.796
<b>Normal</b>					
Number of events of incident disability /subjects	79/712	15/61	6/25		
Multivariate HR (95% CI)	1.00 (ref)	2.10 (1.20-3.70)	2.17 (0.91-5.18)	0.006*	
<b>Walking time</b>					
<b>&lt;1h/day</b>					
Number of events of incident disability /subjects	75/613	16/74	10/55		
Multivariate HR (95% CI)	1.00 (ref)	2.02 (1.15-3.56)	2.57 (1.26-5.23)	0.001**	0.458
<b>≥1h/day</b>					
Number of events of incident disability /subjects	16/262	0/17	1/11		
Multivariate HR (95% CI)	1.00 (ref)	-	1.18 (0.07-20.11)	0.816	
<b>Pain<sup>c</sup></b>					

<b>Presence</b>					
Number of events of incident disability /subjects	30/216	9/37	5/30		
Multivariate HR (95% CI)	1.00 (ref)	1.25 (0.56-2.76)	2.66 (0.90-7.89)	0.103	-
<b>Absence</b>					
Number of events of incident disability /subjects	61/664	7/54	6/36		
Multivariate HR (95% CI)	1.00 (ref)	1.53 (0.67-3.50)	3.00 (1.21-7.44)	0.016*	
<b>Social networks</b>					
<b>Weak ties</b>					
Number of events of incident disability /subjects	17/156	5/23	5/18		
Multivariate HR (95% CI)	1.00 (ref)	2.01 (0.68-5.93)	3.07 (0.96-9.89)	0.035*	0.491
<b>Strong ties</b>					
Number of events of incident disability /subjects	69/694	10/64	4/45		
Multivariate HR (95% CI)	1.00 (ref)	1.50 (0.74-3.03)	1.66 (0.57-4.87)	0.181	

<sup>a</sup> Linear trend tests were calculated by treating K6 scores as categorical variables.

<sup>b</sup> Interactions were tested for using the likelihood ratio test, which compared the models with and without cross-product interaction terms.

<sup>c</sup> Pain includes low back pain and limb arthralgia.

\*p<0.05; \*\*p<0.01; \*\*\*p<0.001.

## Highlights

- The Great East Japan Earthquake increased psychological distress (PD) of survivors.
- The prevalence of disability among the elderly increased after the earthquake.
- No study examined the association between PD and incident disability after disaster.
- PD was significantly associated with incident disability.
- This study suggests chronic effects of PD after disaster.