

Research paper

Cumulative incidence of suicidal ideation and associated factors among adults living in temporary housing during the three years after the Great East Japan Earthquake

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ABSTRACT

Background: The effect of disasters on suicidality is not known. We aimed to retrospectively determine the cumulative incidence of suicidal ideation during the 3 years after the Great East Japan Earthquake among residents in temporary housing without prior suicidal ideation, as compared to the general population. Moreover, we aimed to identify the risk factors for the onset of suicidal ideation.

Methods: A cross-sectional survey involving face-to-face interviews was conducted 3 years after the earthquake with adult community residents in disaster-affected areas and a control area using the World Health Organization Composite International Diagnostic Interview version 3.0. We compared the cumulative incidence of suicidal ideation between the two areas using the Cox proportional hazard model and examined risk factors for the onset of suicidal ideation using a multiple logistic regression analysis.

Results: Among 1019 respondents in the disaster-affected areas, the cumulative incidence of suicidal ideation over 1, 2, and 3 years after the earthquake was 1.4%, 2.4%, and 2.8%, respectively, which was significantly higher than that in the control area. Not being married, being injured in the disaster, and poor subjective physical health were associated with the onset of suicidal ideation.

Limitations: We estimated the time of onset of suicidal ideation based on the respondents' current age and self-reported onset age, which limits the accuracy of the onset timing.

Conclusions: We revealed a higher incidence of suicidal ideation in temporary housing residents and identified several risk factors, which suggests the importance of developing countermeasures to prevent suicide after a disaster.

1. Introduction

The Great East Japan Earthquake on March 11, 2011 caused massive damage in a coastal area of the Tohoku region in Japan, especially in three prefectures, namely, Iwate, Miyagi, and Fukushima. A total of

18,440 people died or went missing, among which 99.6% were from these three prefectures (National Police Agency, 2017). In addition, because of the Fukushima Daiichi nuclear power plant accident following the massive earthquake and tsunami, approximately 150,000 residents in Fukushima prefecture were forced to evacuate. The number of indi-

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viduals living in temporary housing 1 year after the earthquake was about 124,000, and was still about 101,000 after 3 years (Reconstruction Agency, 2017).

After the Great East Japan Earthquake, in these three severely damaged prefectures, the suicide rates decreased in the first two years and rose in 2014 (Ohto et al., 2015). Although gender differences were indicated (Hyodo et al., 2010; Nishio et al., 2009; Orui et al., 2014, 2015; Shioiri et al., 1999), similar patterns were also reported after other massive earthquakes occurred in Japan such as the Great Hanshin-Awaji Earthquake and the Niigata-Chuetsu earthquake, where suicide rates decreased during the first 2 or 3 years (Hyodo et al., 2010; Nishio et al., 2009). However, a review of 19 studies on suicide mortality and 23 on non-fatal suicidal behaviors after various natural disasters showed inconsistent patterns (Kölves et al., 2013) and the effect of disasters on suicide rates is unknown.

The prevalence of suicidality, i.e., suicide-related thoughts and non-fatal suicidal behaviors, such as suicidal ideation, suicide plan, or suicide attempt, in adult community residents at 6 months to 3 years after a natural disaster was reported to be 3.8–20% (Chou et al., 2005, 2007; Kessler et al., 2008, 2006; Larrance et al., 2007; Stratta et al., 2012; Suzuki et al., 2011; Wagenaar et al., 2012; Wu et al., 2006). Suzuki et al. (2011) reported in their cross-sectional study of community-dwelling elderly people conducted 3 years after the Niigata-Chuetsu earthquake in Japan that the point prevalence of suicidality was 5.2%, and 6.1% of the respondents had experienced varying levels of suicidality during the 3-year period after the earthquake. A cohort study conducted after the Chi-Chi earthquake in Taiwan in 1999 reported an increase in the prevalence of suicidality from 4.2% at 6 months after the earthquake to 5.6% at 2 years and 6.0% at 3 years following the earthquake (Chou et al., 2007). A study comparing the prevalence of suicidality between a group affected by the L'Aquila earthquake and a non-affected group found that the proportion of people with suicidal intention was 3.54 times higher in the disaster-affected group 1 year after the earthquake (Stratta et al., 2012).

While studies reporting post-disaster prevalence of suicidality have accumulated, few studies have focused on the incidence of suicidality after a disaster. Kessler et al. (2008) reported that 1.5 years after Hurricane Katrina, 6.4% and 2.5% of a representative sample of residents had suicidal ideation and suicide plans, respectively; and among those who reported suicidality, 24.1% of the suicidal ideation and 46.6% of the suicide plans occurred after the baseline survey conducted 5–7 months after the hurricane. Chou et al. (2007) reported that among 207 residents without suicidality at 6 months after the Chi-Chi earthquake, 8 (3.9%) reported suicidality at 2 years after the earthquake, and 10 (4.8%) reported it at 3 years. Kessler et al. (2006) compared the proportion of the first onset of suicidality during the past year 2.5–4.5 years before and 5–7 months after Hurricane Katrina among individuals with probable mental illness and found a significantly lower onset rate after the hurricane, suggesting the possibility of suppression of suicidality onset immediately after a disaster. However, since these studies did not use control groups, whether the incidence of suicidality in the affected area differed from that in other areas is unclear. Besides, their sample sizes were relatively small.

Socio-demographic characteristics such as female gender, younger age, and low income have been reported as risk factors for suicidality after a disaster (Chou et al., 2005; Kessler et al., 2008, 2006; Stratta et al., 2012). Post-disaster psychiatric diseases/symptoms (Caldera et al., 2001; Chou et al., 2007; Wagenaar et al., 2012) and previous mental health problems (Caldera et al., 2001) were also found to be strongly associated with suicidality after a disaster. Disaster-related experiences such as destruction of property and injury to relatives (Chen et al., 2001) as well as the overall disaster-related stressors (Kessler et al., 2008) were also found to be associated with post-disaster suicidality.

However, risk factors especially related to the onset of suicidality after a disaster are unknown.

Poor mental health among evacuees living in temporary housing after the Great East Japan Earthquake has been reported (Nagata et al., 2015; Yabuki et al., 2015). Displacement has been shown to be linked with poor mental health after disasters (Abramson et al., 2008; DeSalvo et al., 2007; van Griensven et al., 2006). Moreover, a high prevalence of suicidal ideation was reported among displaced persons in travel trailer parks after Hurricane Katrina (Larrance et al., 2007). Therefore, it is important to determine whether the onset of suicidality increases among residents in temporary housing after a disaster and reveal the associated factors in order to provide necessary support and prevent suicide.

In this study, first we aimed to retrospectively determine the cumulative incidence of suicidal ideation during the 3 years after the Great East Japan Earthquake among residents who lived in temporary housing built in a disaster-affected area and had no prior suicidal ideation, and compare it with that in the general population. Secondly, we aimed to investigate the risk factors for the onset of suicidal ideation, including socio-demographic characteristics, disaster-related experiences, and self-rated physical and mental health.

2. Methods

2.1. Study population

2.1.1. Disaster-affected area

In the present study, the target population consisted of adult community residents, aged 20 years and older, living in temporary housing built in the most severely affected prefectures: Iwate, Miyagi, and Fukushima. In Iwate prefecture, individuals were recruited from two large-scale temporary housing districts located in one municipality, from which 437 adult residents were identified and recruited. In Miyagi prefecture, we targeted all six temporary housing districts in the prefecture located in one municipality, from which 592 adult residents were identified and recruited. In Fukushima prefecture, individuals were recruited from five temporary housing districts located in two municipalities. Since we could not obtain information on the number of residents aged 20 years and older living in these five temporary housing districts, we contacted 446 out of 696 chambers and found 755 residents aged 20 years and older. Therefore, we estimated that 1178 (755* [696/446]) adult residents lived in these five temporary housing districts in Fukushima. To determine the incidence of suicidal ideation after the Great East Japan Earthquake, we excluded the respondents who reported prior suicidal ideation.

2.1.2. Control area

Our control population was selected using a two-stage random sampling method. In the first stage, 37 districts were randomly selected in Eastern Japan (excluding Kanto area, i.e., capital region), and in the second stage, 50 residents aged 20–74 years from each district were randomly sampled based on the population registry. Thus, a total of 1850 individuals were identified.

2.2. Data collection

We conducted cross-sectional face-to-face interview surveys in each area about 3 years after the Great East Japan Earthquake, which occurred in March 2011. In Iwate and Miyagi prefectures, we conducted the surveys between June and August 2014, and in Fukushima prefecture, between October 2013 and February 2014. In the control area, we conducted the survey from August to November 2014. Computer-assisted individual interviews were conducted by trained lay interviewers.

2.3. Study variables

Suicidal ideation was assessed using the Japanese version of the World Health Organization Composite International Diagnostic Interview (WHO-CIDI) version 3.0 (Kessler and Üstün, 2004). The WHO-CIDI is a structured psychiatric diagnostic interview that can be administered by trained lay interviewers. Suicidal ideation was determined based on a single-item question about the lifetime experience of suicidal ideation ("Have you ever seriously thought about committing suicide?"). During the survey, a separate booklet was provided to the participant to read before responding to the questions and experiences were referred to by letters of the alphabet (e.g., Experience A). When lifetime suicidal ideation was endorsed, age of onset and experience of suicidal ideation within the past 12 months were asked. The time of onset was roughly estimated by comparing the age of onset with the current age of the respondent, and we classified it into four periods: before the disaster, within 1 year after the disaster, within 2 years after the disaster, and until the survey was conducted about 3 years after the disaster.

The socio-demographic characteristics included in this study were current age (20–59, 60–69, 70+), gender, marital status (married; separated, divorced, or bereaved; never married), and educational attainment (less than high school; high school or higher).

As for history of mental disorder, the DSM-IV diagnoses of six selected common mental disorders were determined using the WHO-CIDI: major depressive episode, manic or hypomanic episode, generalized anxiety disorder, panic disorder, post-traumatic stress disorder, and alcohol use disorder, where alcohol use disorder included alcohol abuse and alcohol dependence. All diagnoses were assessed for the respondent's lifetime, and then, the age of the first onset was asked. By comparing the age of onset with the current age of the respondent and the time of the survey, we identified mental disorders that existed before the Great East Japan Earthquake. If the respondents had at least one of these six mental disorders before the earthquake, we designated them as having history of mental disorder.

As for disaster-related damage experienced by individuals, we considered five experiences: own harm, harm to family members, death of family members or friends, house damage, and loss of job.

Subjective physical health and mental health were assessed on a 5-point scale and dichotomized into "good" and "fair or poor." Please note that the interviewer asked about current physical and mental health at the time of the survey.

2.4. Statistical analysis

First, we calculated descriptive statistics for socio-demographic characteristics of the study participants and compared them between the disaster-affected and control areas using chi-square tests. We also calculated the 12-month prevalence of suicidal ideation in the whole sample for comparison purposes. Second, we calculated cumulative incidences of suicidal ideation in each area and compared them controlling for socio-demographic characteristics and history of mental disorder using Cox proportional hazard model.

Subsequently, we examined factors related to suicidal ideation among the residents in the disaster-affected area. We first compared socio-demographic characteristics, history of mental disorder, disaster-related experiences, and self-rated health between the participants with and without suicidal ideation using chi-square tests, and then examined the association of these variables with suicidal ideation using multivariate logistic regression analysis. The first model contained socio-demographic characteristics, history of mental disorder and disaster-related experiences (Model 1) and self-rated health was added subsequently (Model 2).

All statistical analyses were performed using SPSS version 19 for Windows (IBM, Chicago, USA) and STATA version 15.0 for Windows (StataCorp LP, College Station, TX). Statistical significance was set at 0.05 and all tests were two-tailed.

2.5. Ethical considerations

All procedures followed were in accordance with the Helsinki Declaration and its later amendments. Written informed consent was obtained from each participant. Participation in this study was completely voluntary, and anonymity and confidentiality were assured. The study protocol was reviewed and approved by the Research Ethics Committee of The University of Tokyo Graduate School of Medicine and Faculty of Medicine.

3. Results

3.1. Sample characteristics

In the disaster-affected area, 242 out of 437 initial individuals in Iwate prefecture (response rate 55.4%), and 329 out of 592 initial individuals in Miyagi prefecture (55.6%) completed the interview. In Fukushima prefecture, from the estimated 1178 initial individuals, a total of 518 (44.0%) completed the interview. Among the total 1089 respondents, 1070 (48.5%) answered the question on suicidality. From them, we excluded 51 participants with prior suicidal ideation, making a final sample of 1019 study participants from the affected area. In the control area, of the 1850 initial individuals, 4 died, 72 moved, 37 had long-term absences, and 11 whose residences were unknown were excluded. From the remaining 1726 individuals, 852 (49.4%) completed the interview, and 813 (47.1%) answered the question on suicidality, from which we included 756 as the control participants after excluding 57 with prior suicidal ideation. Missing information on all variables except for suicidal ideation was assumed to be in the low-risk category; 5 respondents in the disaster-affected area and 2 in the control area who did not answer educational attainment were included in the category of high school or higher, 22 respondents without information on disaster-related experiences were assumed not to have such an experience, and 1 respondent without an answer on mental health was categorized into the group of good mental health.

Table 1 displays descriptive statistics for socio-demographic characteristics of the study population. When compared to the general population in the control area, the participants in the disaster-affected area were more likely to be old, women, separated, divorced or bereaved, and have lower educational attainment. There were fewer respondents in the disaster-affected area who reported a history of mental disorder compared to the control area.

Among 1070 and 813 initial respondents in the affected area and the control area who answered the question on suicidality (including participants with prior suicidal ideation), 20 (1.9%) and 6 (0.7%) experienced suicidal ideation in the past 12 months, respectively (not shown).

3.2. Cumulative incidence of suicidal ideation after the Great East Japan Earthquake

Fig. 1 shows the cumulative incidence of suicidal ideation after the Great East Japan Earthquake in the disaster-affected and control areas. In the disaster-affected area, 14 participants experienced suicidal ideation for the first time in their lives within the 1st year after the earthquake. The number of participants who experienced suicidal ideation increased to 24 when 2 years had passed, and to 29 (2.8%) until the time of the survey. On the other hand, in the control area, 3 participants experienced suicidal ideation within the 1st year after the

Table 1
Socio-demographic characteristics of our study participants and their comparisons between in the disaster-affected area and in the control area.

	Disaster-affected area (n = 1019)		Control area (n = 756)		chi2	df	p
	n	%	n	%			
Age							
20–59	315	30.9	499	66.0	293.3	2	< 0.001
60–69	227	22.3	174	23.0			
70 +	477	46.8	83	11.0			
Sex							
Men	404	39.7	365	48.3	13.2	1	< 0.001
Women	615	60.4	391	51.7			
Marital status							
Married	592	58.1	555	73.4	122.6	2	< 0.001
Separated, divorced, bereaved	317	31.1	71	9.4			
unmarried	110	10.8	130	17.2			
Educational attainment							
Less than high school	409	40.1	51	6.8	253.2	1	< 0.001
High school or higher	610	59.9	705	93.3			
History of mental disorder							
Yes	74	7.3	133	17.6	45.0	1	< 0.001
No	945	92.7	623	82.4			

df, degree of freedom.

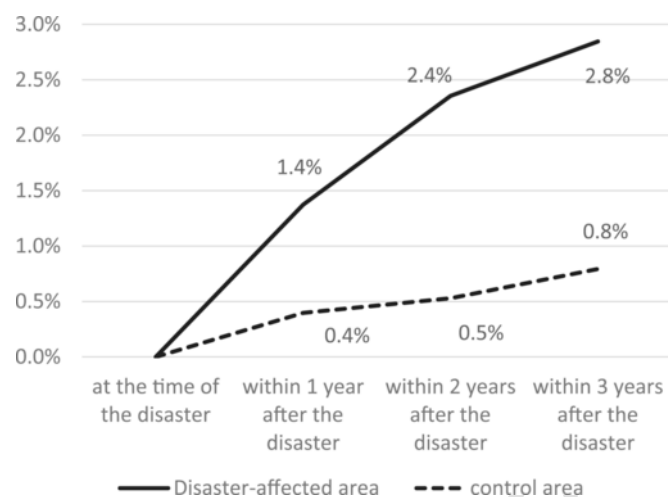


Fig. 1. Cumulative incidence of suicidal ideation in the disaster-affected area and in the control area.

earthquake, 4 within 2 years, and 6 (0.8%) until the time of the survey. The cumulative incidence was 3.5 times higher in the disaster-affected area than in the control area within the 1st year after the earthquake, and 4.5 and 3.6 times higher within 2 years and 3 years after the earthquake, respectively. Comparison of the cumulative incidence of suicidal ideation over 3 years after the earthquake between the two areas using Cox proportional hazard model controlling for socio-demographic characteristics (i.e., age, gender, marital status, and educational attainment) and history of mental disorder revealed that the cumulative incidence in the disaster-affected area was significantly higher (Hazard ratio = 3.15; 95% confidence interval = 1.20–8.25).

The number of participants who developed suicidal ideation in the 1st year was 14, in the 2nd year was 10, and in the 3rd year was 5 in the disaster-affected area, while in the control area, these numbers were 3, 1, and 2, respectively. When comparing the incidence of suicidal ideation between the areas in each year, the incidence in the disaster-affected area was significantly higher in the 1st year (1.37% in the disaster-affected area and 0.40% in the control area; Fisher's exact test, $p = .047$) and in the 2nd year (1.00% and 0.13%; $p = .029$) but not in the 3rd year (0.55% and 0.27%; $p = .706$).

3.3. Determinants of the onset of suicidal ideation in the disaster-affected area

Within 3 years since the disaster occurred, a total of 29 participants (2.8%) experienced onset of suicidal ideation in the disaster-affected area. Table 2 displays descriptive statistics for socio-demographic characteristics, history of mental disorder, disaster-related experiences, and self-rated health of the participants in the disaster-affected area and those who developed suicidal ideation among them. The participants who developed suicidal ideation were less likely to be married and more likely to have been injured in the disaster and to rate their physical and mental health as fair or poor.

Table 3 presents the results of the multivariate logistic regression analysis, which revealed that the onset of suicidal ideation during the 3 years after the disaster was significantly associated with marital status and personal injury in the disaster (Model 1). When self-rated physical and mental health were added, self-rated physical health was associated with suicidal ideation while self-rated mental health was not, and the associations of marital status and own injury with suicidal ideation were maintained (Model 2).

4. Discussion

The cumulative incidence of suicidal ideation among the residents in temporary housing in disaster-affected areas over 1, 2, and 3 years after the Great East Japan Earthquake was 1.4%, 2.4%, and 2.8%, respectively, which was significantly higher than that in the control area. Not being married, personal injury in the disaster, and poor subjective physical health were related to the onset of suicidal ideation after the earthquake among the residents in temporary housing.

The cumulative incidence of suicidal ideation during the 3 years after the earthquake was higher in the disaster-affected area compared to the control area, controlling for socio-demographic characteristics and prior mental disorder. On the other hand, when we compared the incidences of suicidal ideation in each year, the higher incidence in the disaster-affected area was observed only in the 1st and 2nd year, although we did not control for socio-demographic characteristics and prior mental disorder because of the limited number of respondents who developed suicidal ideation. Therefore, it is possible that the impact of the disaster on the onset of suicidal ideation might have subsided after 2 years.

Table 2

Socio-demographic characteristics, disaster-related experiences and self-rated health of our study participants in the disaster-affected area and their relationships with the onset of suicidal ideation. (n = 1019).

	Total (n = 1019)		Participants with suicidal ideation (n = 29)		chi2	df	p
	n	%	n	%	?	?	?
Area							
Iwate	226	22.2	6	20.7	0.2	2	0.911
Miyagi	306	30.0	8	27.6			
Fukushima	487	47.8	15	51.7			
Socio-demographic characteristics							
Age							
20–59	315	30.9	7	24.1	0.8	2	0.659
60–69	227	22.3	8	27.6			
70 +	477	46.8	14	48.3			
Sex							
Men	404	39.7	9	31.0	0.9	1	0.336
Women	615	60.4	20	69.0			
Marital status							
Married	592	58.1	9	31.0	9.0	2	0.011
Separated, divorced, bereaved	317	31.1	15	51.7			
unmarried	110	10.8	5	17.2			
Educational attainment							
Less than high school	409	40.1	15	51.7	1.7	1	0.197
High school or higher	610	59.9	14	48.3			
History of mental disorder							
Yes	74	7.3	4	13.8	1.9	1	0.169
No	945	92.7	25	86.2			
Disaster-related experiences							
Harm of oneself							
Yes	50	4.9	6	20.7	15.9	1	<0.001
No	969	95.1	23	79.3			
Harm of family members							
Yes	143	14.0	2	6.9	1.3	1	0.262
No	876	86.0	27	93.1			
Death of family members or friends							
Yes	596	58.5	19	65.5	0.6	1	0.436
No	423	41.5	10	34.5			
House damage							
Yes	819	80.4	23	79.3	0.0	1	0.884
No	200	19.6	6	20.7			
Loss of job							
Yes	394	38.7	12	41.4	0.1	1	0.761
No	625	61.3	17	58.6			
Self-rated health							
Self-rated physical health							
Good	444	43.6	1	3.5	19.5	1	<0.001
Fair or poor	575	56.4	28	96.6			
Self-rated mental health							
Good	493	48.4	4	13.8	14.3	1	<0.001
Fair or poor	526	51.6	25	86.2			

df, degree of freedom.

In the study, in the disaster-affected areas, during the 1st year after the earthquake, 1.4% of residents newly developed suicidal ideation. A previous study conducted by Kessler et al. (2008) 1.5 years after Hurricane Katrina reported a suicidal ideation prevalence of 6.4%, 24.1% of which had developed since the baseline survey conducted 5–7 months after the hurricane. Based on this information, the incidence of suicidal ideation during a period of 1 year from 5–7 months after the hurricane was about 1.5%, which was similar to our result. On the other hand, Chou et al. (2007) reported in their cohort study conducted after the Chi-Chi earthquake in Taiwan that among respondents without suicidality at 6 months after the earthquake, 3.9% participants reported suicidality at 2 years after the earthquake, and 4.8% at 3 years. Compared to their results, our results of cumulative incidence during the 2 and 3 years after the earthquake of 2.4% and 2.8%, respectively, were slightly lower. Although rigorous comparison was limited by differences in methodology between our study and these two studies (which did not exclude prior suicidal ideation and focused on the incidence of suicidality from 6 months after the disaster), the cu-

mulative incidence in our study was not as high. When compared to the control area, the cumulative incidence of suicidal ideation in the disaster-affected area was significantly higher. Kessler et al. (2006) indicated the possibility that the incidence of suicidality may be suppressed among individuals with mental illness immediately after a disaster; however, although our study did not explore the conditional prevalence of suicidality, the suppression of the incidence of suicidality in the disaster-affected area was not suggested by our results. Studies focusing on the incidence of suicidality after a disaster are limited and further research in this area is needed.

The 12-month prevalence of suicidal ideation in the affected area at the time of the survey was 1.9% in our study. A previous study conducted by Suzuki et al. (2011) reported that 6.1% of community-dwelling elderly people had experienced varying levels of suicidality during a 3-year period after the Niigata-Chuetsu earthquake and the 2-week prevalence of suicidality at 3 years after the earthquake was 5.2%. Chou et al. (2007) reported the 1-month suicidality prevalence was 4.2% at 6 months after the Chi-Chi earthquake, 5.6% at 2

Table 3

Factors associated with the onset of post-disaster suicidal ideation in the disaster-affected area. (n = 1019).

	Model 1			Model 2		
	OR	95%CI		OR	95%CI	
Area						
Iwate	1.00			1.00		
Miyagi	1.07	0.34	3.35	1.38	0.42	4.49
Fukushima	1.15	0.38	3.51	1.16	0.37	3.67
Socio-demographic characteristics						
Age						
20–59	1.00			1.00		
60–69	1.95	0.62	6.18	1.84	0.57	5.96
70+	1.23	0.38	4.01	1.04	0.32	3.37
Sex						
Men	1.00			1.00		
Women	1.97	0.78	4.98	1.71	0.65	4.48
Marital status						
Married	1.00			1.00		
Separated, divorced, bereaved	3.18	1.30	7.78	3.31	1.32	8.30
unmarried	5.07	1.44	17.86	4.78	1.34	17.05
Educational attainment						
Less than high school	1.51	0.65	3.49	1.29	0.54	3.04
High school or higher	1.00			1.00		
History of mental disorder						
Yes	2.26	0.68	7.46	1.85	0.54	6.27
No	1.00			1.00		
Disaster-related experiences						
Harm of oneself						
Yes	5.67	2.02	15.93	5.27	1.79	15.52
No	1.00			1.00		
Harm of family members						
Yes	0.47	0.11	2.12	0.56	0.12	2.61
No	1.00			1.00		
Death of family members or friends						
Yes	1.42	0.60	3.37	1.35	0.56	3.23
No	1.00			1.00		
House damage						
Yes	0.90	0.31	2.59	0.73	0.24	2.22
No	1.00			1.00		
Loss of job						
Yes	1.44	0.62	3.35	1.23	0.52	2.88
No	1.00			1.00		
Self-rated health						
Self-rated physical health						
Good				1.00		
Fair or poor				13.81	1.74	109.49
Self-rated mental health						
Good				1.00		
Fair or poor				2.51	0.80	7.83

OR, odds ratio; CI, confidence interval.

Among 1019 study population, 29 developed post-disaster suicidal ideation.

years, and 6.0% at 3 years. Compared to the results of these previous studies, the prevalence of suicidal ideation in our study was lower. Combined with these results, it seems that although the incidence of suicidality increases in the disaster-affected area, the first onset of suicidality after a disaster accounts for less than half of the suicidality manifested after a disaster.

In our study, marital status was related to the onset of suicidal ideation, while age, gender, educational attainment, and history of mental disorder were not. Being unmarried has been repeatedly reported as a risk factor for suicidality in non-disaster times (Dutta et al., 2017; Handley et al., 2012; Inder et al., 2014; Song and Lee, 2016; Wang et al., 2013), although previous studies conducted after a natural disaster reported an insignificant effect (Wagenaar et al., 2012; Kessler et al., 2006). Death of spouse and recent divorce are major stressful life events and being unmarried is also stressful, increasing the risk of developing depression (Kessing et al., 2003); moreover, being unmarried has been found to be a predictor of depression after a natural disaster (Tang et al., 2014). Although in our study we could not ascertain

whether the divorce or bereavement of spouse occurred before the onset of suicidal ideation, being separated, divorced, bereaved, or never married may have an effect on mental health in the aftermath of the disaster and contribute to the onset of suicidal ideation. Concerning the other socio-demographic characteristics, such as age, gender, educational attainment, which we used as an indicator of socio-economic status, and history of mental disorder, their relationship with suicidality has been inconsistent in studies conducted in non-disaster times (Dutta et al., 2017; Goldney et al., 2000; Handley et al., 2012; Inder et al., 2014; Jang et al., 2014; Song and Lee, 2016; Wang et al., 2013) and also after a disaster (Caldera et al., 2001; Chen et al., 2001; Chou et al., 2005, 2007; Kessler et al., 2008; Stratta et al., 2012; Suzuki et al., 2011; Wagenaar et al., 2012). The effects of socio-demographic characteristics and history of mental disorder on suicidality after a disaster might depend on the circumstances of each disaster. It is also possible that the risk factors of the onset of suicidal ideation after a disaster are different from those of its prevalence.

Among the disaster-related experiences, in our study, own injury in the disaster was the only variable significantly associated with an increased risk of onset of suicidal ideation. Physical injury has been previously reported to have a significant effect on post-disaster mental health (Dyster-Aas et al., 2012; Norris et al., 2010). Physical activity (Vancampfort et al., 2017) and restriction of daily life and social activities due to chronic diseases (Jang et al., 2014) have been associated with suicidal ideation in non-disaster times. Injury in the disaster may restrict physical and social activity in the aftermath of the disaster and deteriorate mental health or trigger suicidal ideation. On the other hand, other damages by the disaster such as injury of family members, death of family members or friends, house damage, or loss of job were not significantly associated with suicidal ideation in our study despite being well-known risk factors of depression after natural disasters (Tang et al., 2014). Chen et al. (2001) reported the association of property damage and relatives' injury with suicidal ideation after the Chi-Chi earthquake among psychiatric service users. Kessler et al. (2008) found a significant correlation between overall disaster-related stressfulness and suicidality after Hurricane Katrina, while Fergusson et al. (2014) showed that the overall measure of earthquake impact was not associated with suicidal ideation/attempt after the Canterbury earthquakes sequence in the cohort aged 35 years. The effects of the level of exposure to a disaster and each specific damage might depend on the circumstances of each disaster, recovery processes, or study population. Particularly, since our study population consisted of residents in temporary housing and 80% of respondents had suffered house damage and nearly 60% bereavement, almost all of our study population was assumed to have been highly exposed to the disaster, which might have weakened the effect of each disaster-related experience. In addition, we assessed the effects of the presence or absence of these disaster-related experiences and did not assess their severity, such as the seriousness of the injury or the number and closeness of the people who died. Combining respondents with less severe damage with those with more severe damage might have obscured the effects of these disaster-related experiences.

In our study, subjective physical health was associated with suicidality. Self-reported poor physical health (Wang et al., 2013) and chronic diseases (Kye and Park, 2017) were found to be related to suicidal ideation in non-disaster times, which may be applicable to the onset of suicidal ideation after a disaster. It is possible that suicidal ideation caused poor subjective physical health since we assessed current subjective health at the time of the survey. On the other hand, subjective mental health was not associated with the onset of suicidal ideation in our study, while previous studies have reported a strong relationship between psychiatric diseases, including posttraumatic stress disorder, major depression, and drug dependence/abuse, and depressive symptoms, and suicidality after a disaster (Caldera et al., 2001; Chou et al., 2007; Wagenaar et al., 2012). While psychiatric diseases or symptoms are strongly related with suicidality, their relationship with the first onset of suicidal ideation after a disaster might be different.

4.1. Limitations

Our study has some limitations. First, response rates were not high (48.5% in the disaster affected areas and 47.1% in the control area), which might produce a selection bias. For instance, if subjects with suicidal ideation were more likely to decline participation in the study because of the shame or stigma they felt about suicidality, the incidence of suicidal ideation observed in our study may be an underestimation. Furthermore, we compared the cumulative incidence of suicidal ideation among residents in temporary housing in the disaster-affected area with those in the general population. Although significant dif-

ferences in socio-demographic characteristics between these two groups (shown in Table 1) were controlled, it is possible that residents in temporary housing found it easier to talk about their suicidal ideation than the general population, because of the services intensely provided by mental health professionals in the temporary housing after the disaster. This might have produced the overestimation of the difference of the incidence of suicidal ideation between the groups. Second, our study population consisted of community residents; however, individuals with strong suicidal ideation might be hospitalized or institutionalized, which may also produce an underestimation of the incidence of suicidal ideation. Third, our data was obtained in a cross-sectional survey conducted about 3 years after the Great East Japan Earthquake and we estimated the time of onset of suicidal ideation based on the current age of the respondent and the self-reported onset age. This calculation method limits the accuracy of the estimated time of the onset being combined with the probable inaccuracy of respondents' recall. In addition, since we did not ask whether the onset of suicidal ideation was before or after the earthquake, but used respondent's self-reported age when he/she first had suicidal ideation to determine the timing; there may be errors in the estimate of the suicidal ideation incidence after the earthquake. This may lead to an underestimated association between the disaster and the incidence of suicidal ideation. Fourth, since the number of individuals who developed suicidal ideation was small, our study may fail to show a significant association between important factors and suicidal ideation. Furthermore, we combined data from respondents from the three prefectures in the disaster-affected areas. Though the cumulative incidences of suicidal ideation were not significantly different among the respondents from each prefecture, there were some differences in terms of socio-demographic characteristics, disaster-related experiences, and self-rated health (not shown) in addition to response rates. The respondents from Fukushima might have differed from those in the other two prefectures because they were forced to evacuate after the nuclear power plant accident. In contrast, those in Iwate and Miyagi moved to temporary housing because of direct damage caused by the earthquake and/or tsunami. Stratified analyses suggested the possibility that being unmarried was a risk factor for suicidal ideation only in Fukushima and one's own injury was a risk factor only in the other two prefectures (not shown). To estimate the incidence of suicidality after a disaster more accurately and identify its risk factors, a large-scale cohort study needs to be conducted in the future.

5. Conclusion

The cumulative incidence of suicidal ideation among residents in temporary housing in the three years after the Great East Japan Earthquake was significantly higher than that in the general population in a non-affected area. Among the residents in temporary housing without prior suicidal ideation, those who did not have a spouse, were injured in the disaster, and had poor subjective physical health were more likely to develop suicidal ideation after the earthquake. When assessing suicidality after a disaster in highly exposed populations, these risk factors need to be considered for those without suicidal ideation before the disaster. Further studies are warranted to understand the long-term consequences of massive disasters on suicidality among affected individuals and identify its risk factors in order to design effective countermeasures to improve mental health and prevent suicide.

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