The course of chronic and delayed onset of mental illness and the risk for suicidal ideation after the Great East Japan Earthquake of 2011: A community-based longitudinal study

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ABSTRACT

This study investigated how the course of a mental illness is distributed and evaluated the risk factors and suicidality of chronic and delayed onset mental illness after the Great East Japan Earthquake. The first, second, and third waves of this study were conducted in 2012, 2013, and 2014, respectively. Psychological distress, suicidal ideation, and socio-demographics were assessed by a self-report questionnaire for affected residents ($N = 1473$; 768 females, 52.1%; average age = 66.3 years, ranged from 20 to 89 years). Prevalence of mental illness was 10.0%, 14.7%, and 11.8% in the first, second, and third waves, respectively. Prevalence of mental illness for three years was found to be 21.4% and of remission, chronic, and delayed-onset course was 5.0% (2.9–7.1%), 3.6% (1.6–5.8%), and 6.2% (4.2–8.4%), respectively. Psychological distress and serious damage to their homes in the first wave predicted chronic course. Psychological distress in the first wave, living at temporary housing, and unemployment in the third wave increased risk for delayed onset. Among the participants, 9.8% reported suicidal ideation. Chronic or delayed onset course showed a higher risk of suicidal ideation. Many residents, who showed high risk of suicidality, still suffer from mental illness requiring housing, occupation, and psychological support.

1. Introduction

The Great East Japan Earthquake on 11 March 2011 wreaked enormous damage with reports of 15,893 lives lost and 2556 people missing (National Police Agency of Japan, Emergency Disaster Countermeasures Headquarters, 2016). Such a large-scale disaster may influence people's mental health in the long term. Prevalence of mental health problems could be about 6%, and suicidality approximately 1 to 6% in victims three to five years after natural disasters (Arnberg et al., 2015; Chou et al., 2007). A larger scale of disaster or higher exposure could lead to a higher prevalence of mental illness and increased suicide rates (Johannesson et al., 2015; Matsubayashi et al., 2013; Paranjothy et al., 2011; Tang et al., 2014). It may depend on the degree of damage and loss caused and the extent of individual exposure. Therefore, understanding the long-term effect of a huge natural disaster on mental health is required for contributing to a long-term care strategy.

Previous longitudinal studies focusing on the populational trend of mental illness have provided conflicting results: improved (Chou et al., 2007; Zhang et al., 2012; Norris et al., 2004), sustained (Pietrzak et al., 2012), or worsening trend (Ye et al., 2014) of depression/depressive symptoms. This might be due to the different scales of the disasters. Although individuals may or may not suffer from mental illness, little is known about the mental illness course distribution, its risk factors, and its associated suicidality. To our knowledge, three studies have reported the prevalence of remission, delayed-onset, and chronic courses of mental illness or depression as 10.7–22.9%, 10.6–16.2%, and 9.9–36.2% (Lowe et al., 2015; Paxson et al., 2012; Tanji et al., 2018), respectively. However, two of these were limited samples of those living at temporary housing (Tanji et al., 2018) and of low-income women (Paxson et al., 2012), which are considered as generating risk

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enrichment (Tang et al., 2014; Xu et al., 2013). Another reported predictive factors only for the 'resilient' course (Lowe et al., 2015). These studies did not evaluate the suicidality of the victims. Further study not confined to residence status and financial condition is needed to promote our understanding of long-term mental problems after a huge natural disaster.

This study aimed to (1) reveal the distribution of the mental illness course in a large community sample one to three years following the Great East Japan Earthquake, (2) identify the risk factors for chronic and delayed onset courses, and (3) estimate the risk of suicidal ideation in each course.

2. Methods

2.1. Participants

Participants comprised 19 years or older individuals who had enrolled for the national health insurance in the city. The national health insurance in Japan is designed for people who are not eligible for any employment-based health insurance program (e.g., self-employed worker, part-time worker), while employees' health insurance is a program for employees who labored more than the certain hours per week. Therefore, the participation rate of the national health insurance is high in the aged people.

The present study was approved by the Ethical Committee, Faculty of Medicine, The University of Tokyo [approval No. 3583-(2)] and the Tokyo Metropolitan Institute of Medical Science [approval No. 14–21]. Written informed consent was waived by the Ethical Committee of the Faculty of Medicine and the University of Tokyo. Instead, we publicized the use of the data for the purpose of the present study, on our research team web page (http://plaza.umin.ac.jp/~youth-mh/). In addition, the use of anonymous data for research was clearly stated on the cover page of a health check questionnaire, so that those who wanted to be excluded from the analysis could claim to do so.

We collaborated with the city of Higashi-Matsushima government and the public health centre, and they provided follow-up support for those residents who have long-term mental health problems and require care.

2.2. Study design and periods

The present study was a prospective cohort study using data from three waves of annual health checks in Higashi-Matsushima city, Miyagi prefecture. The city is located in the coastal area of northeast Japan, which suffered a serious damage by the Great East Japan Earthquake in 2011. Approximately 65% of the area was flooded by the huge tsunami caused by the earthquake, and more than 1000 of 40,000 residents lost their lives. The first wave was conducted one year after the disaster (between 15th May and 16th June, 2012), and the second and third waves were conducted at around the same dates in 2013 and 2014 (Kanehara et al., 2016).

2.3. Data collection

Data was collected using self-report questionnaires. An investigation letter and self-report questionnaire were delivered to the residents in the city who were eligible for the annual health check conducted by the city. Those who got the health check filled in the questionnaire and brought it to the health check venue.

2.4. Measurements

2.4.1. Psychological distress

Psychological distress was measured in all waves by the Kessler 6 scale (K6), a six-item screening measure of nonspecific psychological distress during the past 30 days (Kessler et al., 2002). It assessed for anxiety disorders, mood disorders, and non-affective psychoses with a Global Assessment of Functioning (GAF) score below 70 on the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV), with area under the curve of 0.879 (GAF in the range 0–50) and 0.950 (GAF in the range of 0–70) in the Receiver Operating Characteristic (ROC) analysis (Kessler et al., 2002). The participants rated the items (e.g., 'During the past 30 days, about how often did you feel so depressed that nothing could cheer you up?') on a 5-point Likert-type scale ranging from 'none of the time' to 'all of the time'. In the present study, 'none of the time' scored 0, and 'all of the time' scored 4, and the score for each question was summed up yielding the total score ranging from 0 to 24. The total K6 score ranging from 8 to 12 was defined as mild-moderate mental illness (MMI), and the score above 13 was defined as serious mental illness (SMI) (Kessler et al., 2003a, 2008). MMI is a residual definition of respondents estimated to meet criteria for a DSM-IV anxiety-mood disorder but not SMI (Kessler et al., 2008), and MMI is considerable because of not only current distress and impairment but also the risk of progression to a more severe disorder (Kessler et al., 2003b). We defined those who have MMI or SMI, as having mental illness. People who scored more than 20 at the first wave were followed-up on at least once by telephone and/or visit by the community health nurses in the public health centre.

2.4.2. Suicidal ideation

In the third wave, suicidal ideation was measured by the question, 'During the past 30 days, about how often did you think you wanted to die?' The response choices were 'none of the time', 'a little of the time', 'some of the time', 'most of the time', and 'all of the time'. In the present study, individuals who opted for other response choices instead of 'a little of the time', were defined as having suicidal ideation.

2.4.3. Socio-demographics

Age, sex, house damage, and whether individuals were seeking counselling for mental health problems were other factors assessed in the first wave. House damage was evaluated by a 5-point Likert scale ('total collapse', 'extensive collapse', 'partial collapse', 'partial damage', and 'no damage') and was treated as a continuous variable in group comparison and multiple analysis. 'Seeking counselling for mental health' was assessed by a dichotomous question: 'Do you want professional support for your mental health?' Participants who responded positively were followed-up on at least once by telephone and/or a visit by the community health nurses in the public health centre. In the second wave, presence of cohabitants and presence of a person to consult about mental health were additionally examined. Presence of a person to consult about mental health was assessed by a dichotomous question: 'Do you have anyone for consulting about your mental health?' In the third wave, residence situation and working status were investigated. The participants chose their residential situation from four categories: 'temporary housing', 'disaster public housing', 'own home' or 'other' . With regard to working status, participants were categorized into 'working 4 days or more in a week', 'working 1–3 days in a week', or 'other'. Unemployment, housewife, and student were options that were classified to 'other' of the working status.

2.5. Statistical analysis

2.5.1. Risk estimation of sampling bias

First, we compared the individuals who participated in all three waves from 2012 to 2014 and those who participated only in the first wave. Socio-demographic characteristics and mental health from the fitst wave were compared by a Student t test for continuous variables or the Pearson's χ^2 test for categorical variables. To examine the effect of age and gender on psychological distress and risk of suicidal ideation at the third wave, univariate linear and logistic regression analyses were conducted.

2.5.2. Classification of mental illness course

The subsequent analyses were conducted using data from the individuals who participated in all three waves. We classified the participants into five mental illness courses (noncase, remission, delayed onset, chronic and other) during the three years, similar to a previous three time point study (Karamustafalioglu et al., 2006), and then we calculated the prevalence of each course of mental illness.

2.5.3. Group comparison for identifying risk factors of chronic and delayed-onset mental illness courses

Next, we conducted group comparisons to evaluate the risk factors of chronic and delayed-onset courses of mental illness by a Student *t* test for continuous variables or the Pearson's χ^2 test (or Fisher's exact test) for categorical variables. When comparing two courses, multiple logistic regression analyses were conducted to examine the factors that predicted the specific course. Age, sex, and factors that had a statistically significant association in the group comparison, were added simultaneously into the adjusted model.

2.5.4. Mental illness course and risk of suicidal ideation

Further, we estimated the prevalence of suicidal ideation in each course of mental illness and examined the risk of suicidal ideation in 2014 using logistic regression analyses. When calculating the adjusted odds ratio (OR) and 95% confidence interval (95% CI); the age, sex, house damage, presence of cohabitants, residence situation, working status, and seeking counselling for mental health; were all included simultaneously as covariates.

2.5.5. Significance criteria and software

The significance level for tests were set at $\alpha = 0.05$. Distribution with 95% CI of subjects with mental illness and suicidal ideation in each course were calculated by the R version 3.4.1 (the R Foundation for Statistical Computing, Vienna, Austria). Other statistical analyses were conducted using SPSS version 22.

3. Results

Of the 11,855 residents in the city who were invited in 2012, 3515 residents participated in the health check. Of the 3515 participants, 1473 residents participated in all three waves conducted from 2012 to 2014 (response rate: 41.9%).

Among the participants of the first wave, we compared individuals who participated in all three waves and those who did not. Individuals who participated in all three waves were older (mean age = 66.3 vs. 63.3 years old, standard deviation (SD) = 10.6 vs. 14.8 yrs., $t = 6.8$, $p < 0.001$) and were more likely to be males than those who did not (47.9% vs. 43.1%, $\chi^2 = 7.7$, $df = 1$, $p = 0.005$). Furthermore, the house damage of participants who participated in all three waves was less serious than those who did not (mean score (SD) = 3.6 (1.3) vs. 3.7 (1.3), $t = 2.2$, $p = 0.030$). With regard to mental health, the mean K6 score in the first wave and the prevalence of mental illness was lower in individuals who participated in all three waves than those who did not (mean score (SD) = 2.5 (3.4) vs. 3.2 (4.1), $t = 5.6$, $p < 0.001$; prevalence of mental illness 10.0% vs. 14.1%, $\chi^2 = 12.0$, $df = 1$, $p = 0.001$).

3.1. Demographic characteristics

Demographic characteristics of those who participated in all three waves were summarized in Table 1. Approximately one third of the participants suffered from total house collapse, while only about 12% of the participants' houses were not affected. Prevalence of mental illness showed an increase between 2012 and 2013 and a decrease between 2013 and 2014. During the three years after the disaster, about one in five participants met the criteria for a mental illness at least once. Univariate linear regression and logistic regression analyses did not

Table 1
Demographic characteristics of the study participants in 2012–2014.

Total, *N* (%)	1473	(100)
Age, *mean (SD)*	66.3	(10.6)
Female sex, *N (%)*	768	(52.1)
House damage, *mean (SD)* (range: 1–5)	3.6	(1.3)
House damage category, *N (%)*		
Total collapse	481	(33.4)
Extensive collapse	320	(22.2)
Partial collapse	348	(24.2)
Partial damage	118	(8.2)
No damage	173	(12.0)
Without cohabitants (2013), *N (%)*	127	(9.2)
Residence situation (2014), *N (%)*		
Own home	1215	(86.2)
Temporary housing	159	(11.3)
Disaster public housing	6	(0.4)
Other	29	(2.1)
Working status (2014), *N (%)*		
4 days and above	241	(26.0)
1–3 days	58	(6.3)
Other	628	(67.7)
Seeking counselling for mental health (Yes), *N* (%)	53	(3.8)
Presence of person to consult about mental health (Yes) (2014), *N* (%)	1100	(80.7)
Mental illness, *N* (%)		
2012	134	(10.0)
2013	210	(14.7)
2014	168	(11.8)
At least once during three years	271	(21.4)

Mental Illness, SMI and MMI of K6; K6, Kessler 6 scale; MMI, Mild-Moderate Mental Illness (K6 score ranges from 8 to 12); SMI, Serious Mental Illness (K6 score ranges above 13).

show the effect of age on psychological distress in the third wave ($\beta = 0.01$, 95% CI $= -0.02$–0.02, $p = 0.729$) and risk of suicidal ideation (OR $= 1.00$, 95% CI $= 0.98$–1.01, $p = 0.628$). On the other hand, females were more associated with increased psychological distress ($\beta = 0.12$, 95% CI $= 0.49$–1.26, $p < 0.001$) and risk of suicidal ideation (OR $= 1.66$, 95% CI $= 1.16$–2.37, $p = 0.005$) in the third wave.

3.2. Three-year courses of mental illness

Three-year courses of mental illness are summarized in Table 2. Forty-six participants (3.6%) showed a chronic course of mental illness and 79 participants (6.2%) were classified in the delayed-onset condition of mental illness.

3.3. Risk factors for chronic/delayed-onset courses

First, the chronic and remission courses were compared (Table 3). Compared with the remission course, individuals in the chronic course suffered more serious house damage and had a higher K6 score at the first wave (both $p < 0.01$). Multiple logistic regression analysis including these factors showed that more serious house damage (OR $= 1.6$, 95% CI $= 1.1$–2.5, $p = 0.019$) and a higher K6 score in 2012 (OR $= 1.3$, 95% CI $= 1.1$–1.6, $p = 0.002$) differentiated the chronic course from the remission course.

Second, the delayed-onset course and the noncase course were compared (Table 4). Compared with the noncase course, individuals in the delayed-onset course suffered more serious house damage, and were more likely to have lived alone and sought counselling for mental health, according to the first wave. Additionally, according to the third wave, those in the delayed onset course had a lower likelihood of working full-time, a higher likelihood to live in temporary housing, and a higher baseline for psychological distress than those in the noncase course. Controlling these variables simultaneously, multiple logistic regression analysis showed that living at temporary housing (OR $= 6.4$, 95% CI $= 2.2$–18.6, $p = 0.001$), having no job in 2014 (OR $= 4.0$, 95%

Table 2
Prevalence of the mental illness course.

Course		K6 case 2012	2013	2014	*N (%)*	Prevalence, %	95% CI
Total					1268 (100)		
Noncase		No	No	No	997 (78.6)	78.6	76.6–80.8
Remission						5.0	2.9–7.1
	Combination 1	Yes	No	No	31 (2.4)		
	Combination 2	Yes	Yes	No	32 (2.5)		
Delayed onset						6.2	4.2–8.4
	Combination 1	No	Yes	Yes	31 (2.4)		
	Combination 2	No	No	Yes	48 (3.8)		
Chronic		Yes	Yes	Yes	46 (3.6)	3.6	1.6–5.8
Other					83 (6.5)	6.5	4.5–8.7

Mental Illness, SMI and MMI of K6; K6, Kessler 6 scale; MMI, Mild-Moderate Mental Illness (K6 score ranges from 8 to 12); SMI, Serious Mental Illness (K6 score ranges above 13); 95% CI, 95% Confidence Interval.

CI = 1.2–14.1, p = 0.029), and having a higher K6 score at baseline (OR = 1.6, 95% CI = 1.4–1.9, $p < 0.001$) differentiated the delayed-onset course from the noncase course.

3.4. Suicidal ideation and mental illness course

In the third wave, 144 out of 1473 participants (9.8%) experienced suicidal ideation. In those who had each course of mental illness, prevalence of suicidal ideation ranged from 19.4% to 65.9% (Table 5). Logistic regression analyses examining the risk for suicidal ideation in each mental illness course was shown in Table 5. The adjusted model was controlled for the effects of age, sex, house damage, presence of cohabitants, and working status. In the adjusted model, participants who met any mental illness criteria had higher odds of suicidal ideation than those in the noncase course. Those in the chronic course had very high odds of suicidal ideation. Having no job in 2014 was also associated with an increased risk of suicidal ideation (OR = 3.4, 95% CI = 1.1–10.8, p = 0.037), while no other factors were significant in the adjusted model.

4. Discussion

This is the first study which revealed the mental illness course from one to three years after the Great East Japan Earthquake in 2011 using a large community sample. Approximately one in five participants met the criteria for a mental illness at least once during the three years. Psychological distress at one year after the natural disaster was the risk factor for subsequent chronic and delayed onset of mental illness. House damage increased the risk for the chronic course of mental illness. Living at a temporary housing facility and being unemployed were the risk factors for a delayed-onset course of mental illness. Those who met any mental illness criteria, especially the chronic or delayed-onset course, had higher odds of suicidal ideation three years after the disaster.

4.1. Prevalence of mental illness courses

About 3.6% and 6.2% of the participants suffered from chronic and delayed onset mental illness. Compared to the prevalence of the chronic course of depressive symptoms after a man-made disaster (12.4% at 4 years after a disaster) (van der Velden et al., 2013), we found a lower prevalence for the chronic course of mental illness. This difference may be partly due to the difference in the nature of the disasters. In addition to the findings about the chronic course, it should be noted that as many as 6.2% of the participants experienced a delayed-onset course of mental illness which occurred two to three years after the earthquake. The total prevalence of chronic and delayed-onset course of mental illness in the third year (9.8%) was higher than that of major depression in Taiwan (6.5%) at the same point of time (Chou et al., 2007). In addition, this total prevalence was also higher than that of depressive symptoms in Italy (6.6%) three to five years after an earthquake (Minardi et al., 2016), and that of common mental disorder in Japan (7.6%) reporting as 12-month prevalence in a general population (Ishikawa et al., 2016). This might be due to the magnitude of the Great

Table 3
Group Comparisons for Socio-demographic characteristics and Psychological distress of subjects who showed Chronic or Remission on Mental Illness Course.

Characteristics		Chronic		Remission		Statistic variables			Adjusted OR (95% CI)[a]		
N		46		63							
Age, *mean (SD)*		65.1	(13.3)	64.2	(12.2)	t	0.4		1.0		(0.9–1.1)
Female sex, *N (%)*		29	(63.0)	40	(63.5)	$\chi2$	0.0		1.0		(0.4–2.6)
House damage, *mean (SD)*		4.4	(0.9)	3.7	(1.4)	t	3.4	**	1.6	*	(1.1–2.5)
Without cohabitants (2013), *N (%)*		6	(14.0)	4	(6.8)	$\chi2$	1.4				
Residence situation (2014), *N (%)*	Own home	34	(73.9)	52	(86.7)	$\chi2$	2.9				
	Temporary housing	11	(23.9)	7	(11.7)						
	Disaster public housing	1	(2.2)	1	(1.7)						
	Other	0	(0.0)	0	(0.0)						
Working status (2014), *N(%)*	4 days and above	6	(22.2)	9	(28.1)	$\chi2$	0.5				
	1–3 days	1	(3.7)	2	(6.3)						
	Other	20	(74.1)	21	(65.6)						
Seeking counselling for mental health, *N(%)*		11	(28.2)	13	(22.8)	$\chi2$	0.4				
Presence of person to consult about mental health (2013), *N (%)*		27	(60.0)	43	(69.4)	$\chi2$	1.0				
Psychological distress at baseline, *mean (SD)*		11.7	(3.0)	9.9	(2.1)	t	3.8	**	1.3	**	(1.1–1.6)

*$p < 0.05$, **$p < 0.01$; Mental Illness, SMI and MMI of K6; K6, Kessler 6 scale; MMI, Mild-Moderate Mental Illness (K6 score ranges from 8 to 12); SMI, Serious Mental Illness (K6 score ranges above 13); House Damage was dealt with numeric (1: no damage ~ 5: total collapse); Psychological distress was measured by K6; OR, Odds Ratio; 95% CI, 95% Confidence Interval.
[a] The multivariate logistic regression analysis adjusting for age, sex, house damage, and psychological distress at baseline.

Table 4

Group Comparisons for Socio-demographic characteristics and Psychological distress of subjects who showed Delayed onset or Noncase on Mental Illness Course.

Characteristics		Delayed onset		Noncase		Statistic variables			Adjusted OR (95% CI)[a]		
N		79		997							
Age, *mean (SD)*		66.4	(12.4)	65.8	(10.7)	*t*	0.5		1.0		(0.9–1.0)
Female sex, *N (%)*		46	(58.2)	487	(48.8)	$\chi2$	2.6		1.3		(0.6–2.9)
House damage, *mean (SD)*		3.9	(1.3)	3.5	(1.3)	*t*	2.8	**	1.0		(0.7–1.5)
Without cohabitants (2013), *N (%)*		13	(20.3)	77	(8.1)	$\chi2$	10.9	**	1.9		(0.7–5.5)
Residence situation (2014), *N (%)*	Own home	54	(74.0)	848	(88.9)	$\chi2$	20.3	**	1.0		
	Temporary housing	17	(23.3)	82	(8.6)				6.4	**	(2.2–18.6)
	Disaster public housing	1	(1.4)	2	(0.2)				0.0		(0.0-)
	Other	1	(1.4)	22	(2.3)				1.8		(0.2–16.9)
Working Status (2014), *N(%)*	4 days and above	6	(11.8)	180	(27.9)	$\chi2$	7.6	*	1.0		
	1–3 days	2	(3.9)	42	(6.5)				2.0		(0.3–11.6)
	Other	43	(84.3)	423	(65.6)				4.0	*	(1.2–14.1)
Seeking Counselling for Mental Health, *N(%)*		6	(8.3)	15	(1.6)	$\chi2$	15.3	**	1.3		(0.2–9.2)
Presence of Person to Consult about Mental Health (2013), *N (%)*		57	(75.0)	730	(78.4)	$\chi2$	0.5				
Psychological distress at baseline, *mean (SD)*		3.5	(2.5)	1.3	(1.9)	*t*	7.9	**	1.6	**	(1.4–1.9)

*$p < 0.05$, **$p < 0.01$; Mental Illness, SMI and MMI of K6; K6, Kessler 6 scale; MMI, Mild-Moderate Mental Illness (K6 score ranges from 8 to 12); SMI, Serious Mental Illness (K6 score ranges above 13); House Damage was dealt with numeric (1: no damage ~ 5: total collapse); Psychological distress was measured by K6; OR, Odds Ratio; 95% CI, 95% Confidence Interval.

[a] The multivariate logistic regression analysis adjusting for age, sex, house damage, without cohabitants, residence situation, working status, seeking counselling for mental health, and psychological distress at baseline.

East Japan Earthquake, referred to as a triple disaster (earthquake, tsunami, and nuclear power plant accident) (Suzuki and Kim, 2012), and the resulting consequences individuals and their environmental resources.

4.2. Risk factors for chronic/delayed-onset course

Higher psychological distress at the first wave was a risk factor for chronic and delayed-onset courses of mental illness. This result accords with previous studies that reported that psychological distress or depressive symptoms predicted those symptoms at a subsequent survey, which was conducted more than 12 months after the previous survey (Ye et al., 2014; Beard et al., 2008; van der Velden et al., 2008). The present study added that psychological distress at one-year after a disaster predicted mental illness course in the subsequent two years including a delayed-onset course. Higher psychological distress at the first wave may reflect vulnerability to stress in general. Alternatively, higher psychological distress at the first wave might reflect an unmeasured serious affect by the disaster such as missing close ones.

Among those who had any mental illness at baseline, more serious house damage was the risk factor for the chronic course of mental illness. This was in line with a previous meta-analysis that reported that house damage was associated with depression in adult victims two months to three years after the natural disaster (Tang et al., 2014). However, most studies included in this meta-analysis adopted a cross-sectional design, and no study examined whether house damage lead to the chronic course of depression (Tang et al., 2014). The current results added further evidence that house damage could also be a risk factor for the chronic course of mental illness, for as long as three years after the

natural disaster.

Among those without mental illness at the first wave, living at temporary housing at three years after the disaster increased the risk for the delayed-onset course of mental illness. This was in accordance with a previous cross-sectional study after an earthquake (Xu et al., 2013). The study reported that individuals who were in the prefabricated house had higher depressive symptoms than those in other residences (Xu et al., 2013). Although the study revealed the association between living at a temporary housing facility and increased depressive symptoms, at one year after the earthquake, did not investigate whether the residential situation was related to the long-term course of mental illness. The present study suggests that difficulty in leaving temporary housing and resettling in a new residence may cause the delayed-onset course of mental illness.

In addition, being unemployed three years after the disaster was associated with an increased risk for the delayed onset of mental illness. This result was consistent with the previous findings that unemployment increased the risk of depression or psychological distress at 2–4 months to three years after natural disasters (Oyama et al., 2012; Tang et al., 2014). However, all of these previous studies were of cross-sectional designs, and no studies had investigated whether employment status was related to the longitudinal course of mental health problems. The present study added evidence that even among those without mental illness soon after the disaster, unemployment was associated with the delayed onset of mental illness.

4.3. Suicidal ideation in each course of mental illness

Approximately one in ten residents suffered from suicidal ideation

Table 5

Prevalence and logistic regression analyses for suicidal ideation from mental illness course.

Course	*N*	Suicidal ideation Presence, *N*	% (95% CI)	Crude OR	95% CI			Adjusted OR	95% CI		
Noncase	989	31	3.1 (2.2–4.2)	1.0				1.0			
Remission	62	12	19.4 (11.3–29.6)	7.4	3.6	–	15.3	10.5	3.3	–	33.3
Delayed onset	79	34	43.0 (32.9–54.7)	23.3	13.2	–	41.3	23.3	8.8	–	61.4
Chronic	44	29	65.9 (54.5–81.4)	59.7	29.1	–	122.6	60.2	19.2	–	188.7
Other	82	21	25.6 (17.1–35.3)	10.6	5.8	–	19.6	16.0	6.7	–	38.4

Mental Illness, SMI and MMI of K6; K6, Kessler 6 scale; MMI, Mild-Moderate Mental Illness (K6 score ranges from 8 to 12); SMI, Serious Mental Illness (K6 score ranges above 13); OR, Odds Ratio; 95% CI, 95% Confidence Interval; In the adjusted model, age, sex, house damage, presence of cohabitants, residence situation, working status, seeking counselling for mental health were designated as covariate.

in the third wave of this study. The prevalence of suicidal ideation in the present study was higher than that in the previous studies (6.0% at three years after the Chi-Chi earthquake in Taiwan, and 3.3% at one years after the earthquake of L'Aquila in Italy) (Chou et al., 2007; Stratta et al., 2012). Previous findings suggested that suicide rate in the affected area decreased until two years but increased after three to four years (Matsubayashi et al., 2013; Stratta and Rossi, 2013). The difference in prevalence of suicidal ideation between studies may be due to the difference in study time point after disasters, size of disaster, and/or sample size (Chou et al., 2007; Stratta et al., 2012).

Those who met any mental illness criteria during the three years, had increased risk for suicidal ideation than those who did not. Especially, the risk of suicidal ideation was high in the delayed onset and chronic courses of mental illness. This result was consistent with the previous longitudinal study, which showed that current depression was an important risk for suicidality at three years after the natural disaster (Chou et al., 2007). In addition to the previous finding, the present study suggested that not only current depression but also long-term course of mental illness were associated with highly increased risk of suicidality at three years after the natural disaster.

4.4. Implications

We can take several clinical implications from the present study. More than 20% of people suffered from a form of mental illness during the three years after the natural disaster. Long-term support for mental health was needed as a result. Housing, occupational and mental health support may be required to prevent mental illness in people in the affected area. In order to prevent mental illness with delayed onset, more attention should be paid to people at temporary housing facilities, long after a disaster. A substantial proportion of people living at temporary housing facilities also suffered from a chronic course of mental illness. Assessment of employment and/or financial status on the residents may be required for estimating the risk of delayed onset of mental illness. In terms of suicide prevention, special attention would be required for those with chronic and delayed-onset mental illness.

4.5. Limitations

This study has several methodological limitations. First, residents who did not participate in all three waves were more likely to have mental illness at the first wave, suggesting that individuals with serious psychological distress might not participate in this study. Due to a substantial attrition rate, the prevalence of mental illness might be underestimated in the community. Second, it is unclear whether the present findings can be applicable for a younger population. However, according to the national registry of Japanese citizens, the Basic Resident Register, approximately half (48.1%) the number of adult residents in the Higashi-Matsushima city were 55 years or older. It indicates that this study sample may represent the population in the affected area. Third, a causal relationship is unclear between the courses of mental illness and several factors such as the residence situation and working status assessed in the third wave of data collection. Fourth, this study did not investigate some factors that could affect the mental illness courses including pre-disaster mental health, receiving medical treatment, and injury/loss of relatives (Ye et al., 2014; Bread et al., 2008; Lowe et al., 2015).

4.6. Conclusions

This is the first cohort study to investigate long-term mental illness courses and their risk factors, and the association with risk for suicidal ideation in a large community sample after a huge natural disaster. Approximately one in five participants suffered a mental illness at least once during the three years after the Great East Japan Earthquake. A substantial proportion of residents experienced a chronic and delayed-

onset course of mental illness. Higher psychological distress at the baseline, house damage, living at temporary housing facilities and unemployment long after the disaster, were risk factors for chronic and delayed-onset courses. Since, those who met the criteria for chronic or delayed-onset courses comprised a higher risk population of suicidality; housing, occupational, as well as psychological support may be essential for suicide prevention after a huge natural disaster.

4.7. Future research

Following issues should be addressed in future studies. First, our findings have not been applied on a young population. To investigate the long-term course of mental illness in youth may promote our understanding of long-term mental problems on all age ranges after a natural disaster. Second, there is a need to examine the causal relationship between unemployment or living at temporary housing and delayed-onset course of mental illness. Last, we also need to know if pre-disaster mental health, receiving medical treatment, and injury/loss of relatives can predict long-term mental problems. To address these issues in future work, this study may prove beneficial for developing a long-term mental health care strategy.

Conflicts of interest

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2018.12.151.

References

Arnberg, F.K., Gudmundsdóttir, R., Butwicka, A., Fang, F., Lichtenstein, P., Hultman, C.M., et al., 2015. Psychiatric disorders and suicide attempts in Swedish survivors of the 2004 southeast Asia tsunami: a 5 year matched cohort study. Lancet Psychiatry 2, 817–824.

Beard, J.R., Tracy, M., Vlahov, D., Galea, S., 2008. Trajectory and socioeconomic predictors of depression in a prospective study of residents of New York City. Ann. Epidemiol. 18, 235–243.

Chou, F.H., Wu, H.C., Chou, P., Su, C.Y., Tsai, K.Y., Chao, S.S., et al., 2007. Epidemiologic psychiatric studies on post-disaster impact among Chi-Chi earthquake survivors in Yu-Chi, Taiwan. Psychiatry Clin. Neurosci. 61, 370–378.

Ishikawa, H., Kawakami, N., Kessler, R.C., World Mental Health Japan Survey Collaborators, 2016. Lifetime and 12-month prevalence, severity and unmet need for treatment of common mental disorders in Japan: results from the final dataset of World Mental Health Japan Survey. Epidemiol. Psychiatr. Sci. 25, 217–229.

Johannesson, K.B., Arinell, H., Arnberg, F.K., 2015. Six years after the wave. Trajectories of posttraumatic stress following a natural disaster. J. Anxiety Disord. 36, 15–24.

Kanehara, A., Ando, S., Araki, T., Usami, S., Kuwabara, H., Kano, Y., et al., 2016. Trends in psychological distress and alcoholism after The Great East Japan Earthquake of 2011. SSM Popul. Health 2, 807–812.

Karamustafalioglu, O.K., Zohar, J., Güveli, M., Gal, G., Bakim, B., Fostick, L., et al., 2006. Natural course of posttraumatic stress disorder: a 20-month prospective study of Turkish earthquake survivors. J. Clin. Psychiatry 67, 882–889.

Kessler, R.C., Andrews, G., Colpe, L.J., Hiripi, E., Mroczek, D.K., Normand, S.L., et al., 2002. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. Psychol. Med. 32, 959–976.

Kessler, R.C., Barker, P.R., Colpe, L.J., Epstein, J.F., Gfroerer, J.C., Hiripi, E., et al., 2003a. Screening for serious mental illness in the general population. Arch. Gen. Psychiatry

60, 184–189.

Kessler, R.C., Galea, S., Gruber, M.J., Sampson, N.A., Ursano, R.J., Wessely, S., 2008. Trends in mental illness and suicidality after Hurricane Katrina. Mol. Psychiatry 13, 374–384.

Kessler, R.C., Merikangas, K.R., Berglund, P., Eaton, W.W., Koretz, D.S., Walters, E.E., 2003b. Mild disorders should not be eliminated from the DSM-V. Arch. Gen. Psychiatry 60, 1117–1122.

Lowe, S.R., Joshi, S., Pietrzak, R.H., Galea, S., Cerdá, M., 2015. Mental health and general wellness in the aftermath of Hurricane Ike. Soc. Sci. Med. 124, 162–170.

Matsubayashi, T., Sawada, Y., Ueda, M., 2013. Natural disasters and suicide: evidence from Japan. Soc. Sci. Med. 82, 126–133.

Minardi, V., Gigantesco, A., Mancini, C., Quarchioni, E., D'Argenio, P., Cofini, V., 2016. Behavioural risk factors in L'Aquila (Central Italy) 3-5 years after the 2009 earthquake. Epidemiol. Prev. 40 (2 Suppl 1), 34–41.

National Police Agency of Japan, Emergency Disaster Countermeasures Headquarters., 2016. Damage Situation and Police Countermeasures associated with 2011 Tohoku district - off the Pacific Ocean Earthquake. http://www.npa.go.jp/archive/keibi/biki/higaijokyo_e.pdf accessed 11 Jan 2017.

Norris, F.H., Murphy, A.D., Baker, C.K., Perilla, J.L., 2004. Postdisaster PTSD over four waves of a panel study of Mexico's 1999 flood. J. Trauma Stress 17, 283–292.

Oyama, M., Nakamura, K., Suda, Y., Someya, T., 2012. Social network disruption as a major factor associated with psychological distress 3 years after the 2004 Niigata-Chuetsu earthquake in Japan. Environ. Health Prev. Med. 17, 118–123.

Paranjothy, S., Gallacher, J., Amlôt, R., Rubin, G.J., Page, L., Baxter, T., et al., 2011. Psychosocial impact of the summer 2007 floods in England. BMC Public Health 11, 145.

Paxson, C., Fussell, E., Rhodes, J., Waters, M., 2012. Five years later: recovery from post traumatic stress and psychological distress among low-income mothers affected by Hurricane Katrina. Soc. Sci. Med. 74, 150–157.

Pietrzak, R.H., Tracy, M., Galea, S., Kilpatrick, D.G., Ruggiero, K.J., Hamblen, J.L., et al.,

2012. Resilience in the face of disaster: prevalence and longitudinal course of mental disorders following Hurricane Ike. PLoS One 7, e38964.

Stratta, P., Capanna, C., Riccardi, I., Carmassi, C., Piccinni, A., Dell'Osso, L., et al., 2012. Suicidal intention and negative spiritual coping one year after the earthquake of L'Aquila (Italy). J. Affect. Disord. 136, 1227–1231.

Stratta, P., Rossi, A., 2013. Suicide in the aftermath of the L'Aquila (Italy) earthquake. Crisis 34, 142–144.

Suzuki, Y., Kim, Y., 2012. The great east Japan earthquake in 2011; toward sustainable mental health care system. Epidemiol. Psychiatr. Sci 21, 7–11.

Tang, B., Liu, X., Liu, Y., Xue, C., Zhang, L., 2014. A meta-analysis of risk factors for depression in adults and children after natural disasters. BMC Public Health 14, 623.

Tanji, F., Tomata, Y., Sekiguchi, T., Tsuji, I., 2018. Period of residence in prefabricated temporary housing and psychological distress after the Great East Japan Earthquake: a longitudinal study. BMJ Open 8, e018211.

van der Velden, P.G., Kleber, R.J., Koenen, K.C., 2008. Smoking predicts posttraumatic stress symptoms among rescue workers: a prospective study of ambulance personnel involved in the Enschede Fireworks Disaster. Drug Alcohol Depend. 94, 267–271.

van der Velden, P.G., Wong, A., Boshuizen, H.C., Grievink, L., 2013. Persistent mental health disturbances during the 10 years after a disaster: four-wave longitudinal comparative study. Psychiatry Clin. Neurosci. 67, 110–118.

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

Ye, Y., Fan, F., Li, L., Han, Q., 2014. Trajectory and predictors of depressive symptoms among adolescent survivors following the Wenchuan earthquake in China: a cohort study. Soc. Psychiatry Psychiatr. Epidemiol. 49, 943–952.

Zhang, Z., Ran, M.S., Li, Y.H., Ou, G.J., Gong, R.R., Li, R.H., et al., 2012. Prevalence of post-traumatic stress disorder among adolescents after the Wenchuan earthquake in China. Psychol. Med. 42, 1687–1693.