ORIGINAL RESEARCH

Symptoms of Post-Traumatic Stress Disorder Among Young Children 2 Years After the Great East Japan Earthquake

Takeo Fujiwara, PhD; Junko Yagi, PhD; Hiroaki Homma, PhD; Hirofumi Mashiko, PhD; Keizo Nagao, MD; Makiko Okuyama, MD; and the Great East Japan Earthquake Follow up for Children Study Team

ABSTRACT

Objective: The aim of this study was to investigate the prevalence of post-traumatic stress disorder (PTSD) and its association with each traumatic experience among 5- to 8-year-old children 2 years after the Great East Japan Earthquake.

Method: Children ages 5-8 years who were in selected preschool classes on March 11, 2011, in 3 prefectures affected by the earthquake and 1 prefecture that was unaffected, participated in the study ($N = 280$). PTSD symptoms were assessed through questionnaires completed by caregivers and interviews by psychiatrists or psychologists conducted between September 2012 and May 2013 (ie, 1.5-2 years after the earthquake).

Results: Among children who experienced the earthquake, 33.8% exhibited PTSD symptoms. Of the different traumatic experiences, experiencing the earthquake and the loss of distant relatives or friends were independently associated with PTSD symptoms; prevalence ratios: 6.88 (95% confidence interval [CI]: 2.06-23.0) and 2.48 (95% CI: 1.21-5.08), respectively.

Conclusion: Approximately 1 in 3 young children in the affected communities exhibited PTSD symptoms, even 2 years after the Great East Japan Earthquake. These data may be useful for preventing PTSD symptoms after natural disasters and suggest the importance of providing appropriate mental health services for children. (*Disaster Med Public Health Preparedness*. 2017;11:207-215)

Key Words: disaster, post-traumatic stress disorder, earthquake, tsunami, child mental health, preschool children

At 2:46 pm (Tokyo time) on March 11, 2011, the Great East Japan Earthquake measuring 9.0 on the Richter scale, striking East Japan and followed by devastating tsunami waves of up to 40.5 meters high. In September 2013, revised numbers of 18 703 deaths, 2674 missing, and 6220 injured in the earthquake were reported.[1] Furthermore, 1706 children lost a parent.[2] The earthquake and following tsunami destroyed almost 272 000 homes and approximately 69 000 people were evacuated. Furthermore, a nuclear power plant exploded.[1]

Previous studies have reported the increase of post-traumatic stress disorder (PTSD) among adolescent populations after earthquakes.[3-7] However, few studies have investigated the prevalence of PTSD symptoms among "preschoolers," children ages 3-6 years, after natural disasters.[8] This is likely because verbal development is limited in preschoolers, which makes it difficult to diagnose PTSD because the DSM-IV requires a verbal description of the child's feelings.[9,10] To that end, Scheeringa et al. suggested alternative criteria that place less emphasis on verbalization and more focus on behavioral observation to diagnose PTSD in preschool children,[9-12] and the DSM-5 PTSD included specific criteria as subtype for preschool children.[13] PTSD symptoms can be expressed symptomatically by nightmares, disturbed sleep patterns, or developmental regression, which can be observed by parents. In fact, the utility of parental observation has been reported.[10] Furthermore, re-experiencing trauma may be expressed as the appearance of threats, such as monsters in a nightmare, or threats to self or others, which can be revealed only through a psychiatric interview.[14] Thus, it is necessary to assess PTSD symptoms in multiple dimensions, that is, using interviews with child psychiatrists or psychologists, and parental reports based on the child's trauma response-related behavior. The relationship between PTSD symptoms measured by both parental reports and psychiatric interviews among young children after natural disasters warrants further exploration.

Studies have yielded inconsistent results on the association between trauma exposure after a natural disaster and PTSD symptoms among children. After

the tsunami and Sumatra earthquake in Thailand, the following were positively and independently associated with PTSD symptoms: experiences of delayed evacuation, an event that threatened the life of a family member, feeling extreme panic or fear, and loss of a close family member or friend. However, seeing tsunami waves, seeing a dead person, or loss of the home or important belongings were not associated with PTSD symptoms in children ages 7-14.[15] However, in adolescent survivors of the Ano Liosia earthquake in Greece, PTSD was positively associated with damage to the home but not with death or injury among family members.[4] Nonetheless, home damage as well as injury to self and family members were positively associated with PTSD in adolescents in the Wenchuan earthquake,[16] yet in a 1-year follow-up study, only parent injury and severe property damage were associated with PTSD symptoms.[6] These findings were based on relatively older children and, to the best of our knowledge, no study has investigated the impact of natural disasters on PTSD symptoms in preschool-aged children. Further studies are needed to elucidate the association between trauma exposure related to natural disaster and PTSD in young children.

Moreover, multiple traumatic events occurred over time due to the Great East Japan Earthquake, such as the threat of death due to the earthquake itself, seeing the tsunami, seeing someone swept away by the tsunami, separation from family members, seeing fire, home damage, living in a shelter, living in temporary house, loss of family or friends, and threat of radiation after the nuclear explosion. Thus, it is possible to assess the association between exposure to multiple traumatic events due to a natural disaster and PTSD symptoms (ie, dose-response associations) among young children, an age group that few studies have investigated.

The aim of this study is to investigate the prevalence of PTSD and its association with each traumatic experience and the number of traumatic experiences in young children 2 years after the Great East Japan Earthquake.

METHODS

Sample

Children were recruited through a multistage sampling method in Iwate, Miyagi, and Fukushima prefectures (see details in previous study[17]). First, municipalities severely affected by the tsunami (coastal side) and radiation caused by the nuclear power plant explosion in Fukushima prefecture were selected within each prefecture. Second, preschools were approached in the selected municipalities to request participation. Third, children who were in class and were ages 3-5 in the 2010 fiscal year (ie, children who were 4-6 years old when they experienced the earthquake on March 11, 2011) were approached. Then, from September 2012 to June 2013, caregivers of the targeted children were asked to participate in the study through preschool principals or staff. Parents of 205 children consented, and 178 children completed the questionnaire or interview.

For the unaffected area, Mie prefecture was selected, which was unharmed by the earthquake and tsunami. Similar to the sampling strategy in the affected area, 2 municipalities were selected in Mie prefecture and 1 preschool agreed to participate. The class that included children ages 3-6 years in the 2010 fiscal year was selected, and 30 children participated in the study. Two additional communities were selected in the municipalities, and 52 eligible children were recruited, resulting in a sample of 82 children from unaffected areas.

Measures

Trauma exposure related to the physical environment, such as home damage or the experience of staying at a shelter, was assessed through a questionnaire between September 2012 and June 2013 (around 2 years after the earthquake). Trauma exposure related to the physical environment was defined as follows: lost or completely damaged home, partially damaged home, or undamaged home, the experience of staying at a shelter immediately after the earthquake, living in temporary housing, evacuating to a relative's house, and family members living in different places.

The details of the interview procedure were as follows: Each pair of interviewer, child psychiatrist or clinical psychologist, and the child interviewee met at a separated booth to maintain privacy. The interview composed of 4 parts: behavior during interview, daily life such as appetite or sleep, traumatic experiences related to the Great East Japan Earthquake, and mental health condition in the child including PTSD symptoms (ie, re-experiencing, avoidance, and hyperarousal), depressive symptoms, and developmental disorders. The interview process took 45-60 minutes to complete. We referred to a previous study that assessed children's mental health[15] and the experiences reported in the area affected by the tsunami to define *trauma exposure*. Trauma exposure included separation from parents, loss of a close family member or relative, loss of distant relatives or friends, seeing the tsunami waves, seeing someone swept up by the tsunami, witnessing a fire, seeing a dead person, hearing the nuclear power plant explosion, and lifestyle restrictions due to radiation (eg, unable to play outside, drink tap water, or eat local food).

PTSD symptoms were assessed by interview and questionnaire. During the interview, child psychiatrists and psychologists checked for PTSD symptoms, such as re-experiencing, avoidance, and hyperarousal. Children who exhibited one of those symptoms—especially dissociation due to re-experience (included in DSM-5[13])—as assessed by a trained physiatrist or psychologist from the interview were

https://doi.org/10.1017/dmp.2016.101 Published online by Cambridge University Press

considered to have PTSD symptoms. In addition, to assess PTSD symptoms observed by parents, we used the Japanese short and modified version of the Parent Report of the Child's Reaction to Stress[18] consisting of 28 items. These 28 items include a re-experiencing cluster (posttraumatic play, nightmares, and distress at exposure to reminders of the event), avoidance/numbing of responsiveness cluster (socially more withdrawn, restricted range of affect, and loss of acquired developmental skills measured as regression), hyperarousal cluster (difficulty going to sleep, decreased concentration, hypervigilance, and exaggerated startle response), and new fears and aggression cluster (new aggression, such as feelings of obligation of the onset of disaster, aggression to others or lack of empathy), which are similar to the criteria proposed by Scheeringa et al.[9] There was an additional item on fear of death and having dreams for the future. Alternatively, these 28 items can be compared with DSM-V PTSD subtype for preschool children,[13] that is, intrusion symptoms (play enactment, recurrent distressing dreams, distress at exposure to internal or external cues, and marked physiological reactions to reminders of the traumatic events), persistent avoidance of stimuli and negative alterations in cognition, and alteration in arousal and reactivity (irritable behavior and angry outbursts, hypervigilance, exaggerated startle response, problem with concentration, and sleep disturbance), as well as additional items on fear of death, regression (behaves like a baby), and having dreams for the future. The test was comprised of 6 possible responses (1 = Never; 2 = Rarely; 3 = Sometimes; 4 = Often; 5 = Always; 6 = Do not know) and was administered by parents. Response item scores were calculated, with "Do not know" responses treated as missing. The total score was distributed normally and reliability was high (Cronbach's alpha = 0.86). The cut-off score for having PTSD symptoms (56.3) was calculated from the mean score (39.9) plus two standard deviations (16.4) from children living in the unaffected area. Children who exhibited PTSD symptoms according to the interview or questionnaire were categorized as having PTSD symptoms.

Analysis

First, to assess the overlap among traumatic experiences, a Pearson correlation analysis was conducted on the 15 traumatic experiences. Then, the associations between trauma exposure and PTSD symptoms were analyzed using a bivariate Poisson regression model because of high prevalence.[19,20] Furthermore, a stepwise backward multivariate Poisson regression ($P < 0.05$) (age and sex were force-entered) was used to examine the independent associations between trauma exposure variables and behavior problems. Then, to observe the cumulative effect of traumatic experiences, the number of traumatic experiences was categorized into 4 groups (0, 1-2, 3-5, 6+) and dose-response associations with PTSD symptoms were investigated with bivariate and multivariate Poisson regressions. Stata MP 12 was used to conduct the analyses.

RESULTS

Table 1 shows the demographic characteristics of children and parents who responded to the questionnaire. Mean child age was 7 years, there was an equal sex distribution, and 22.0% of participants had no siblings. Responding parents (mostly mothers, 94.2%) were around 37 years old, 20.9% of whom had graduated from college or had an advanced degree. More than half of the fathers' occupations were manual, other, or unemployed, which was underestimated because 20.8% of parents did not respond to this question.

The distribution of PTSD symptoms is shown in Table 2. Of the children in affected areas, 16.6% showed avoidance, followed by re-experiencing (13.9%) and hyperarousal (9.5%), and 28.7% of symptoms were observed by child psychiatrists or psychologists. No children in the unaffected area exhibited these symptoms. According to the parent-administered questionnaire, 15.2% of children in the affected area and 3% of children in the unaffected area showed positive symptoms of PTSD. According to both child psychiatrist or psychologist interviews and the parent-administered questionnaire, 33.8% of children in affected areas and 3.7% of children in the unaffected area exhibited PTSD symptoms. Thus, 25.0% of the children in this sample displayed symptoms of PTSD.

Table 3 shows the distribution of traumatic experiences. Because sampling was biased toward the affected area, 70.7%

TABLE 1

Demographic Characteristics of Children and Responding Parents (N = 280)

Characteristics	No. or Mean	% or SD
Children		
Child age, mean, y	7.0	1.0
Child age, group		
5 y	45	16.1
6 y	107	38.2
7 y	65	23.2
8+ y	63	22.5
Child's sex		
Male	138	49.3
Female	142	50.7
Number of siblings		
No siblings	61	22.0
1 sibling	127	45.9
2+ siblings	89	32.1
Responding parents		
Age, mean	37.1	5.6
Education		
High school or less	112	40.4
Some college	107	38.6
College+	58	20.9
Father's occupation before earthquake		
Manual/other/unemployed	151	54.1
Non-manual	70	25.1
No response	58	20.8

https://doi.org/10.1017/dmp.2016.101 Published online by Cambridge University Press

TABLE 2

Distribution of PTSD Symptoms[a]

	Total		Children in Affected Areas		Children in Unaffected Area	
	No.	%	No.	%	No.	%
Interview						
Re-experiencing	22	9.2	22	13.9	0	0.0
Avoidance	26	10.9	26	16.6	0	0.0
Hyperarousal	15	6.3	15	9.5	0	0.0
Any of the above (+)	45	18.8	45	28.7	0	0.0
Questionnaire (Parent Report of the Child's Reaction to Stress)						
PTSD (+)	33	11.8	30	15.2	3	3.7
Either interview or questionnaire PTSD (+)	70	25.0	67	33.8	3	3.7

[a]PTSD, post-traumatic stress disorder.

TABLE 3

Distribution of Traumatic Experiences Related to the Great East Japan Earthquake Among Children (N = 280)

Traumatic Experience	No.	%
Experienced earthquake		
Yes	198	70.7
No	82	29.3
Home status		
Lost or completely damaged	45	16.1
Partially damaged	47	16.9
Not damaged	187	67.0
Staying at shelter		
Yes	51	19.3
No	214	80.8
Living in temporary house		
Yes	34	12.7
No	234	87.3
Evacuated to relative's house		
Yes	101	37.3
No	170	62.7
Family members living in different places		
Yes	56	20.7
No	215	79.3
Separated from parents		
Yes	56	23.3
No	184	76.7
Lost close family members or relatives		
Yes	13	5.8
No	211	94.2
Lost distant relatives or friends		
Yes	22	10.0
No	198	90.0
Witnessed tsunami waves		
Yes	65	26.1
No	184	73.9
Witnessed someone being swept up by tsunami waves		
Yes	31	12.6
No	215	87.4
Witnessed a fire		
Yes	11	4.4
No	237	95.6
Saw a dead person		
Yes	4	1.7
No	239	98.4
Heard explosion of nuclear power plant		
Yes	3	1.3
No	225	98.7
Lifestyle restriction due to radiation		
Yes	33	15.2
No	184	84.8
Number of traumatic experiences		
0	79	28.2
1-2	63	22.5
3-5	88	31.4
6+	50	17.9

of children experienced the earthquake, 16.1% lost their homes, and the homes of 16.9% were completely or partially damaged. In terms of evacuation, 37.3% were evacuated to a relative's house, 19.3% stayed in a shelter, and 12.7% lived in temporary housing. In terms of traumatic events revealed by the interview, the greatest percentage of children saw tsunami waves (26.1%), were separated from parents (23.3%), experienced a restricted lifestyle due to radiation (15.2%), witnessed someone being swept up by the tsunami (12.6%), lost distant relatives or friends (10.0%), lost close family or relatives (5.8%), witnessed a fire (4.4%), saw a dead person (1.7%), and heard the nuclear power plant explosion (1.3%). A total of 49.3% of the children were exposed to multiple traumatic experiences (3 or more events).

The correlations (Pearson's r) among these traumatic experiences were calculated (Table 4). As expected, the experience of the earthquake and home status—which include two aspects, that is, damage to home and living away from home—were positively and significantly associated with other traumatic experiences, with the exception of seeing a dead person and hearing the nuclear power plant explosion, as these events were rare. Separation from parents and losing distant relatives or friends were also significantly associated with most of the other traumatic experiences. Family members living in different places (for example, the father having to move to a different place for employment) and lifestyle restrictions due to radiation were significantly associated, suggesting that the head of the household had to move for work while the rest of the family, including children, had to stay in the area affected by radiation.

The associations between demographic information and traumatic experiences with PTSD symptoms are shown in Table 5. Using a bivariate model, we found that children who experienced the earthquake were 9.25 times more likely to have PTSD symptoms (95% CI: 2.91-29.41). Of the traumatic experiences, staying at a shelter, living in different places away from other family members, being separated from parents, losing distant relatives or friends, seeing tsunami waves, witnessing someone being swept up by the tsunami waves, and witnessing a fire were significantly associated with PTSD symptoms. PTSD symptoms were more prevalent in

https://doi.org/10.1017/dmp.2016.101 Published online by Cambridge University Press

TABLE 4

Correlation Matrix of Traumatic Experiences[a]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Experienced earthquake	1.00														
2. Home status	**0.42**	1.00													
3. Staying at shelter	**0.32**	**0.45**	1.00												
4. Living in temporary house	**0.25**	**0.65**	**0.41**	1.00											
5. Evacuated to relative's house	**0.50**	**0.48**	**0.23**	**0.31**	1.00										
6. Family members living in different places	**0.32**	**0.20**	**0.39**	**0.14**	**0.41**	1.00									
7. Separated from parents	**0.38**	**0.22**	**0.15**	0.11	**0.25**	**0.25**	1.00								
8. Lost close family members or relatives	**0.19**	**0.21**	0.05	**0.23**	0.13	−0.02	−0.03	1.00							
9. Lost distant relatives or friends	**0.26**	**0.15**	0.00	0.11	0.10	0.06	**0.32**	**0.20**	1.00						
10. Witnessed tsunami waves	**0.42**	**0.38**	**0.24**	**0.29**	0.20	0.09	**0.32**	0.09	**0.21**	1.00					
11. Witnessed someone being swept up by tsunami	**0.15**	**0.23**	0.00	0.10	0.05	0.00	**0.28**	−0.05	**0.26**	**0.37**	1.00				
12. Witnessed a fire	**0.24**	**0.24**	**0.17**	**0.24**	0.04	0.02	**0.19**	**0.26**	**0.22**	**0.51**	**0.29**	1.00			
13. Saw a dead person	0.09	0.03	−0.05	−0.04	−0.08	−0.05	0.09	**0.14**	**0.24**	**0.15**	**0.15**	0.05	1.00		
14. Heard explosion of nuclear power plant	0.09	0.03	**0.15**	−0.05	0.08	**0.15**	0.07	**0.20**	−0.04	0.05	−0.02	0.12	−0.01	1.00	
15. Lifestyle restriction due to radiation	**0.33**	0.08	**0.14**	−0.02	**0.39**	**0.39**	**0.18**	−0.04	0.04	−0.13	−0.09	**−0.15**	−0.05	−0.04	1.00

[a]Bold signifies $P < 0.05$.

older children and girls, but these differences were not statistically significant. PTSD symptoms were less prevalent in children with older parents because parents in the unaffected area were older. In addition, according to the multivariable stepwise Poisson regression, in which child age and sex and other significant covariates were force-entered as explanatory variables, experiencing the earthquake (PR: 6.88, 95% CI: 2.06-23.0) and losing distant relatives or friends (PR: 2.48, 95% CI: 1.21-5.08) remained significantly associated with PTSD symptoms, suggesting that these experiences were significant, independent, traumatic events that induced PTSD symptoms among children ages 5-8 years old 2 years after the Great East Japan Earthquake.

Finally, a dose-response association was observed between the number of traumatic experiences and PTSD symptoms. Compared to children without traumatic experiences, children with 1-2, 3-5, and 6 + traumatic experiences showed 8.15, 14.8, and 17.4 times higher prevalence of PTSD symptoms, respectively, and the trend was significant ($P < 0.001$). This association remained significant in a multivariate model adjusted for child age, sex, and other covariates.

DISCUSSION

This is the first study to assess the prevalence of PTSD symptoms among children 5-8 years old 2 years after the Great East Japan Earthquake. Of children living in affected areas, 33.8% exhibited PTSD symptoms, as assessed by either child psychiatrists or psychologists, or parents. Furthermore, as the Great East Japan Earthquake led to multiple traumatic events—including the earthquake itself, tsunami, fire, and nuclear power plant explosion—we were able to show that exposure to multiple traumatic experiences was associated with a higher prevalence of PTSD symptoms, suggesting a dose-response association between traumatic experiences and PTSD symptoms.

The prevalence of PTSD symptoms among children and adolescents after traumatic events varies between 3% and 95%, depending on sex, age, the nature of the event, and the population studied.[21-23] In Japan, it was reported that 25% of preschool children showed PTSD symptoms, (as defined by the DSM-IV alternative criteria) 6 months after a gas explosion.[24] In addition, 50% of preschool children showed PTSD symptoms when assessed using the same alternative criteria 6 months after Hurricane Katrina.[8] Although the PTSD symptom criteria differed from our study, the prevalence of PTSD symptoms was relatively similar to what we found here (33.8%), suggesting that our PTSD criteria is plausible.

We also found a dose-response association between the number of traumatic experiences and PTSD symptoms. It was also reported that the severity of home damage was associated with PTSD symptoms among young children after the Hanshin-Awaji earthquake in Japan.[25] The importance of polyvictimization resulting from traumatic events after natural disasters has not been well described compared to complex trauma, such as child maltreatment.[26] To lessen the impact of traumatic events for children, disaster preparedness needs to consider how administration for relief activities prevents exposure to multiple traumatic events.

Further, we observed that experiencing the earthquake was a significant independent risk factor for PTSD symptoms among young children. This implies that the earthquake was a "life-threatening" experience for children. In other words,

https://doi.org/10.1017/dmp.2016.101 Published online by Cambridge University Press

https://doi.org/10.1017/dmp.2016.101 Published online by Cambridge University Press

TABLE 5

Bivariate and Multivariate Analyses of Prevalence Ratios of PTSD Symptoms Induced by Great East Japan Earthquake by Traumatic Experiences[a]

			Bivariate			Model 1[b]			Model 2		
	No.	%	PR	95% CI	*P*-Value	PR	95% CI	*P*-Value	PR	95% CI	*P*-Value
Demographics											
Child age, group, y											
5-6	30	19.9	1.00			1.00			1.00		
7-8	40	31.3	1.57	0.98-2.53	0.061	1.34	0.71-2.52	0.37	1.42	0.88-2.30	0.15
Child's sex											
Male	27	19.6	1.00			1.00			1.00		
Female	43	30.3	1.55	0.96-2.50	0.075	1.62	0.88-2.97	0.12	1.55	0.96-2.51	0.075
Number of siblings											
No siblings	18	29.5	1.00								
1 sibling	36	28.4	0.96	0.55-1.69	0.89						
2+ sibling	15	16.9	0.57	0.29-1.13	0.11						
Parent age, group, y											
36 or less	45	34.9	1.00			1.00			1.00		
37+	25	16.7	**0.48**	**0.29-0.78**	**0.003**	0.79	0.43-1.47	0.46	0.68	0.41-1.12	0.13
Education											
High school or less	30	26.8	1.00								
Some college+	39	23.6	0.88	0.55-1.42	0.61						
Father's occupation before earthquake											
Manual/other/unemployment	35	23.2	1.00								
Non-manual	15	21.4	0.92	0.50-1.69	0.80						
No response	20	34.5	1.49	0.86-2.58	0.16						
Traumatic Experience											
Experienced earthquake											
Yes	67	33.8	**9.25**	**2.91-29.41**	**<0.001**	**6.88**	**2.06-23.0**	**0.002**			
No	3	3.7	1.00			1.00					
Lost family member											
Yes	3	50.0	2.06	0.65-6.56	0.22						
No	65	24.3	1.00								
Home status											
Lost or completely damaged	16	35.6	1.70	0.95-3.05	0.072						
Partially damaged	15	31.9	1.53	0.84-2.78	0.16						
Not damaged	39	20.9	1.00								
Staying at shelter											
Yes	22	43.1	**2.10**	**1.26-3.50**	**0.005**	NA					
No	44	20.6	1.00								
Living in temporary house											
Yes	9	26.5	1.07	0.53-2.16	0.85						
No	58	24.8	1.00								
Evacuated to relative's house											
Yes	30	29.7	1.36	0.84-2.21	0.21						
No	37	21.8	1.00								
Family members living in different places											
Yes	22	39.3	**1.88**	**1.13-3.13**	**0.016**						
No	45	20.9	1.00								

Separated from parents												
Yes	27	48.2	**2.77**	**1.66-4.63**	**< 0.001**	NA						
No	32	17.4	1.00									
Lost close family members or relatives												
Yes	5	38.5	1.80	0.72-4.54	0.21							
No	45	21.3	1.00									
Lost distant relatives or friends												
Yes	14	63.6	**3.50**	**1.89-6.49**	**< 0.001**	**2.48**	**1.21-5.08**	**0.013**				
No	36	18.2	1.00			1.00						
Witnessed tsunami waves												
Yes	31	47.7	**2.83**	**1.72-4.66**	**< 0.001**	NA						
No	31	16.9	1.00									
Witnessed someone swept up by tsunami												
Yes	9	81.8	**3.66**	**1.80-7.42**	**< 0.001**	NA						
No	53	22.4	1.00									
Witnessed a fire												
Yes	14	45.2	**2.06**	**1.14-3.75**	**0.017**	NA						
No	47	21.9	1.00									
Saw a dead person												
Yes	3	75.0	3.14	0.98-10.04	0.053							
No	57	23.9	1.00									
Heard explosion of nuclear power plant												
Yes	1	33.3	1.50	0.21-10.9	0.69							
No	50	22.2	1.00									
Lifestyle restriction due to radiation												
Yes	12	36.4	1.63	0.86-3.11	0.14							
No	41	22.3	1.00									
Number of traumatic experiences												
0	2	2.5	1.00						1.00			
1-2	13	20.6	**8.15**	**1.84-36.1**	**0.006**				**7.27**	**1.62-32.6**	**0.010**	
3-5	33	37.5	**14.8**	**3.55-61.7**	**< 0.001**				**12.5**	**2.93-53.0**	**0.001**	
6+	22	44.0	**17.4**	**4.09-73.9**	**< 0.001**				**14.1**	**3.26-66.8**	**< 0.001**	
P for trend			**< 0.001**						**< 0.001**			
pseudo R2							0.152			0.135		

[a]Bold signifies $P < 0.05$.

[b]Stepwise Poisson regression model was used with backward elimination ($P < 0.05$), but demographic variables were forced-entered. Independent variables that showed significant associations ($P < 0.1$) with *P*TSD symptoms according to the bivariate model.

traumatic experiences after the earthquake, such as home damage, staying at a shelter, or living in a temporary house were not independently associated with PTSD symptoms, suggesting that psychiatric treatment is needed to deal with the experience of a life-threatening earthquake to avoid further PTSD symptoms. Moreover, we found that loss of distant relatives or friends was a significant independent risk factor for PTSD symptoms. This is consistent with a study conducted after the Sumatra tsunami in Thailand, revealing that losing a close family member or friend was independently associated with PTSD symptoms in children ages 7-14.[15] The mechanism underlying these results is unclear; however, it is plausible that losing a friend may lead to fear of death. The lack of independent association between loss of family members in our study and PTSD symptoms might be due to a lack of statistical power.

Several limitations need to be addressed: First, the participants were not a representative sample of children affected by the earthquake. Furthermore, among the target population, children with severe mental disorders may be less likely to participate because they may already receive care through psychiatric or psychological counseling services. Alternatively, parents with concerns about their children's mental health may have been more likely to join this study. Second, PTSD symptoms were not assessed by structured interviews using the DSM-5, and the Japanese short and modified version of the Parent Report of the Child's Reaction to Stress was not validated. However, the prevalence of PTSD symptoms among young children was similar to that reported in other studies.[8,24] The combination of interviews by child psychiatrists or psychologists and parental questionnaires is unique because we were able to detect PTSD symptoms in preschool children. Third, exposure to traumatic experience was assessed through interviews, but some of the children may not have voiced their true experience to the interviewer. We double-checked the reported experiences during interviews with parents and preschool teachers, but we assumed that traumatic experiences described by the children reflected meaningful traumatic experiences. Fourth, although the sample size was sufficient to detect the association between traumatic experiences and PTSD symptoms, it was relatively small for detecting significant associations with specific traumatic experiences and PTSD symptoms.

In conclusion, the prevalence of PTSD symptoms among young children in a community sample 2 years after the Great East Japan Earthquake was 33.8%, which is consistent with previous studies. Children who experienced the Great Earthquake and lost distant relatives or friends showed a significantly higher prevalence of PTSD symptoms, even 2 years after the earthquake. The dose-response association between number of traumatic exposures and PTSD symptoms was confirmed, suggesting that more serious exposure is correlated with PTSD symptoms 2 years later, whereas less severe exposures are not. Further, we found that some specific traumatic experiences were significantly associated with PTSD symptoms, despite the small sample size. These findings suggest possible ways to prevent PTSD after natural disasters. These data may be useful for preventing PTSD symptoms after natural disasters and providing appropriate mental health services that target children.

About the Authors

Department of Social Medicine, National Research Institute for Child Health and Development, and Department of Global Health Promotion, Tokyo Medical and Dental University, Tokyo, Japan (Dr Fujiwara), Department of Psychiatry, Iwate Medical University, Iwate, Japan (Dr Yagi), Miyagi Prefectural Comprehensive Children's Center, Miyagi, Japan (Dr Homma), Fukushima Rehabilitation Center for Children, Fukushima, Japan (Dr Mashiko), Nagao Mental Clinic, Mie, Japan (Dr Nagao), and Department of Psychosocial Medicine, National Center for Child Health and Development, Tokyo, Japan (Dr Okuyama).

Correspondence and reprint requests to Dr Takeo Fujiwara, Department of Global Health Promotion, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo-ku, Tokyo 113-8519, Japan (e-mail: fujiwara.hlth@tmd.ac.jp).

Acknowledgments

We thank the participants who contributed to this study. We also thank the child psychiatrists and psychologists who provided extra mental health support to participants when requested during interviews. In addition, we thank the research coordinators who coordinated the logistics for this study, and Ms Emma Barber for her editorial assistance. The Great East Japan Earthquake Follow-up for Children Study Team is comprised of Dr Takehito Yambe and Ms Mitsuko Miura (Iwate Medical University), Dr Hirokazu Yoshida (Miyagi Prefectural Comprehensive Children's Center), Dr Yoshiko Yamamoto (Iwaki Meisei University), Ms Noriko Ohshima (Fukushima Gakuin University), Dr Keiichi Funahashi and Ms Mai Kuroda (Saitama Children's Hospital), Dr Takahiro Hoshino (Musashino Gakuin School), Ms Rie Mizuki, Dr Lena Akai, and Dr Yoshiyuki Tachibana (National Center for Child Health and Development), led by Dr Makiko Okuyama (okuyama-m@ncchd.go.jp).

Funding

Supported by a grant from the Ministry of Health, Labour and Welfare (H24-jisedai-shitei-007).

Published online: July 1, 2016.

REFERENCES

1. Fire and Disaster Management Agency. Higai-hou. 2015. http://www.fdma.go.jp/bn/higaihou/pdf/jishin/151.pdf. Accessed June 15, 2015.
2. Japan Child and Family Research Institute. *Almanac of Data on Japanese Children 2013*. Tokyo: KTC Chuoh Publishing; 2013.
3. Goenjian AK, Walling D, Steinberg AM, et al. A prospective study of posttraumatic stress and depressive reactions among treated and untreated adolescents 5 years after a catastrophic disaster. *Am J Psychiatry*. 2005;162(12):2302-2308.
4. Roussos A, Goenjian AK, Steinberg AM, et al. Posttraumatic stress and depressive reactions among children and adolescents after the 1999 earthquake in Ano Liosia, Greece. *Am J Psychiatry*. 2005;162(3):530-537.
5. Wu CH, Chen SH, Weng LJ, et al. Social relations and PTSD symptoms: a prospective study on earthquake-impacted adolescents in Taiwan. *J Trauma Stress*. 2009;22(5):451-459.
6. Liu ZY, Yang YF, Ye YL, et al. One-year follow-up study of post-traumatic stress disorder among adolescents following the Wen-Chuan earthquake in China. *Biosci Trends*. 2010;4(3):96-102.

https://doi.org/10.1017/dmp.2016.101 Published online by Cambridge University Press

7. Fan F, Long K, Zhou Y, et al. Longitudinal trajectories of post-traumatic stress disorder symptoms among adolescents after the Wenchuan earthquake in China. *Psychol Med*. 2015;45(13):2885-2896.
8. Scheeringa MS, Zeanah CH. Reconsideration of harm's way: onsets and comorbidity patterns of disorders in preschool children and their caregivers following Hurricane Katrina. *J Clin Child Adolesc Psychol*. 2008;37(3):508-518.
9. Scheeringa MS, Zeanah CH, Drell MJ, et al. Two approaches to the diagnosis of posttraumatic stress disorder in infancy and early childhood. *J Am Acad Child Adolesc Psychiatry*. 1995;34(2):191-200.
10. Scheeringa MS, Peebles CD, Cook CA, et al. Toward establishing procedural, criterion, and discriminant validity for PTSD in early childhood. *J Am Acad Child Adolesc Psychiatry*. 2001;40(1):52-60.
11. Scheeringa MS, Zeanah CH, Myers L, et al. New findings on alternative criteria for PTSD in preschool children. *J Am Acad Child Adolesc Psychiatry*. 2003;42(5):561-570.
12. Scheeringa MS, Myers L, Putnam FW, et al. Diagnosing PTSD in early childhood: an empirical assessment of four approaches. *J Trauma Stress*. 2012;25(4):359-367.
13. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*, 5th ed. Arlington, VA: American Psychiatric Publishing; 2013.
14. Yule W. Posttraumatic stress disorder in the general population and in children. *J Clin Psychiatry*. 2001;62(suppl 17):23-28.
15. Thienkrua W, Cardozo BL, Chakkraband ML, et al. Symptoms of posttraumatic stress disorder and depression among children in tsunami-affected areas in southern Thailand. *JAMA*. 2006;296(5):549-559.
16. Ma X, Liu X, Hu X, et al. Risk indicators for post-traumatic stress disorder in adolescents exposed to the 5.12 Wenchuan earthquake in China. *Psychiatry Res*. 2011;189(3):385-391.
17. Fujiwara T, Yagi J, Homma H, et al. Clinically significant behavior problems among young children 2 years after the Great East Japan Earthquake. *PLoS One*. 2014;9(10):e109342.
18. Fletcher K. Psychometric review of the Parent Report of Child's Reaction to Stress. In: Stamm BH, ed. *Measurement of Stress, Trauma, and Adaptation*. Lutherville, MD: Sidran Press; 1996:225-227.
19. Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. *JAMA*. 1998; 280(19):1690-1691.
20. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res Methodol*. 2003;3:21.
21. Salcioglu E, Basoglu M. Psychological effects of earthquakes in children: prospects for brief behavioral treatment. *World J Pediatr*. 2008; 4(3):165-172.
22. La Greca A, Silverman WK, Vernberg EM, et al. Symptoms of posttraumatic stress in children after Hurricane Andrew: a prospective study. *J Consult Clin Psychol*. 1996;64(4):712-723.
23. Davis L, Siegel LJ. Posttraumatic stress disorder in children and adolescents: a review and analysis. *Clin Child Fam Psychol Rev*. 2000; 3(3):135-154.
24. Ohmi H, Kojima S, Awai Y, et al. Post-traumatic stress disorder in pre-school aged children after a gas explosion. *Eur J Pediatr*. 2002; 161(12):643-648.
25. Takada S. Post-traumatic stress disorders and mental health care (lessons learned from the Hanshin-Awaji Earthquake, Kobe, 1995). *Brain Dev*. 2013;35(3):214-219.
26. Finkelhor D, Ormrod RK, Turner HA. Poly-victimization: a neglected component in child victimization. *Child Abuse Negl*. 2007;31(1): 7-26.

https://doi.org/10.1017/dmp.2016.101 Published online by Cambridge University Press