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Mental Health Problems among Undergraduates in Fukushima, Tokyo, and Kyoto after the March 11 Tohoku Earthquake

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On March 11, 2011, the Great East Japan Earthquake devastated the Tohoku region, which led to a tsunami and a nuclear disaster. While these three disasters caused tremendous physical damage, their psychological impact remains unclear. The present study evaluated traumatic responses, internalizing (i.e., anxiety and depression), and externalizing (i.e., anger) symptoms among Japanese young people in the immediate aftermath and 2.5 years later. A total of 435 undergraduates were recruited from universities in three differentially exposed regions: Fukushima, Tokyo, and Kyoto. They completed a set of questionnaires retrospectively (i.e., September to December 2013) to measure their traumatic responses, anxiety and depressive symptoms, functional impairment, and anger immediately after the disaster and 2.5 years later. Participants in Tokyo had the highest level of traumatic response and internalizing symptoms immediately after the earthquake, whereas those in Fukushima had significantly higher levels of trait anger, anger-in (holding one's anger in), and anger-out (expressing one's anger externally). In Kyoto, the levels of anxiety and depression after 2.5 years were significantly higher than they were immediately after the disasters. In conclusion, anger symptoms were high among young people who lived at or near the center of the disasters, while anxiety and depression were high among those who lived far away from the disasters. These findings suggest the importance of providing mental health services to young people who did not live near the disaster area as well as to those living in the directly affected area.

Keywords: adolescents; earthquake; natural disasters; trauma; tsunami
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Introduction

The Tohoku earthquake, commonly known as the Great East Japan Earthquake, was the fourth most powerful earthquake in the world since recordkeeping began in 1900. It struck the Tohoku region with a magnitude of 9.0 on the Richter scale on March 11, 2011 and caused massive destruction. Approximately 15,883 people were found dead, 6,150 injured, and 2,651 were still missing as of November 8, 2013 (National Police Agency 2013). At the same time, the tsunami that was linked to the earthquake caused approximately 330,000 people being made homeless in the Tohoku region (Reconstruction Agency 2011). These two natural disasters further led to a radioactive disaster in the Fukushima nuclear power plants, resulting in a series of equipment failures, nuclear meltdowns, and releases of radioactive materials at the Fukushima Unit I nuclear power plant. This was the worst nuclear disaster (Level 7 on the Nuclear Event Scale) since the Chernobyl accident in 1986.

Although these unprecedented multiple disasters have caused tremendous damage to properties and physical health among those living in the Tohoku region (National Police Agency 2013), their psychological impact remains unknown. However, according to previous studies, children, adolescents, and young adults (henceforth, "young people") who survived earthquakes and tsunamis have several mental health problems, including symptoms of posttraumatic stress disorder (PTSD), anxiety, depression, and conduct disorder (La Greca 2008; Margolin et al. 2010). For example, 56% of the children and adolescents who survived the Marmara earthquake in Turkey were reported to experience severe PTSD symptoms 3 years after this traumatic event (Bal 2008). Other studies have reported high prevalence of PTSD and major depression

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following exposure to an earthquake. For example, 11.2% and 5.7% of the young people met PTSD criteria 4 and 12 months after the Wen-Chen earthquake in China, respectively (Liu et al. 2010). Ekşi et al. (2007) reported that 60% of children and adolescents met PTSD criteria, and 31% had major depression following the earthquake in Turkey (Ekşi et al. 2007). Several other studies conducted in China (Liu et al. 2011), Armenia (Goenjian et al. 2005), and Greece (Groome and Soureti 2004; Roussos et al. 2005) have similarly reported high anxiety and depression among adolescents who were exposed to earthquakes.

Following the giant 2004 tsunami in Sri Lanka, 14-39% of 8-14-year-old children met the criteria of PTSD (Neuner et al. 2006). High levels of mental health problems (i.e., posttraumatic stress and anxiety symptoms, withdrawal, and acting out) were found among adolescents in India who had been exposed to a tsunami (Bhushan and Kumar 2007). In Thailand, between 11% and 13% and 5% and 11% of children in the tsunami-affected areas had PTSD and depressive symptoms, respectively, while 6% and 8% of children in areas unaffected by the tsunami showed these symptoms (Thienkrua et al. 2006).

A meta-analysis by Furr et al. (2010) showed that proximity to the disaster had medium effects on posttraumatic symptoms in youth. In fact, proximity ($_{pooled}$ r = .33) was a more influential predictor than was death toll ($_{pooled}$ r = .22) or personal losses ($_{pooled}$ r = .16) and comparable with general distress ($_{pooled}$ r = .38) or perceived threat ($_{pooled}$ r = .34). Indeed, previous studies of child and adolescent mental health after earthquakes and tsunamis consistently showed that proximity to the disaster also moderated this association (Groome and Soureti 2004; Goenjian et al. 2005; Thienkrua et al. 2006; Şahin et al. 2007).

A study by Korol et al. (1999), however, showed only minimal differences in psychological functioning between children who lived within a 5-mile radius of the nuclear plant (i.e., exposed children) and non-exposed children. Another study found no significant difference in behavior problems of children who lived within 10 miles of the Three Mile Island (TMI) compared to those who lived near another nuclear plant in Pennsylvania, and a fossil-fuel plant (Cornely and Bromet 1986). One reason for the inconsistent findings on the role of proximity as a predictor of mental health may be related to the cause of the incident. Specifically, proximity to the site of a natural disaster has emerged as a significant predictor of mental health problems, whereas human-related disasters such as nuclear spill-outs do not seem to be influenced by the immediate area of residence. This is understandable because a nuclear accident has a broader range of impact compared to natural disasters through air and water leakages, transportation of people, and food supplies. Although proximity could be a moderator, studies that compared the impact of natural and human-related extreme-stress disasters (Catani et al. 2008) on young people's well-being are scarce. Therefore, the extent to which proximity to the disaster site influences young people's mental health when the disaster is a multi-level incident (i.e., both natural and human-related) is unclear.

Another factor that may be responsible for the inconsistent findings is the extent of exposure to media broadcasting. Repeated exposure has a strong impact on the emotional distress level of those who live outside the immediate disaster site, which can lead to secondary trauma. However, at present, there is a dearth of literature examining the impact of media reports after a traumatic disaster on young people. Without indirect exposure through the media, it is conceivable that physical distance can moderate mental health in young people; traumatic responses and psychological impact in the Tohoku region might be persistent after the disaster compared with those who live outside of the Tohoku region.

In order to fill this gap, the main aim of this study was to examine the impact of two natural disasters (i.e., earthquake and tsunami) and a human-related disaster (i.e., nuclear disaster) on young people's mental health immediately after the disasters (T1) and 2.5 years later (T2). It also examined the role of proximity and media exposure in moderating the impact of these three disasters in young people's mental health.

The hypotheses to be tested were as follows: (1) Young people in Fukushima (the most proximal sample) will have the highest levels of traumatic responses as well as functional impairment, anxiety, and depressive symptoms at T1 compared to those who live outside the Tohoku region; (2) Young people outside of Fukushima will have lower levels of mental health problems at T2, while participants in Fukushima will continue to have high levels of mental health problems; and (3) Regardless of proximity, young people who were exposed to media reports of the three disasters will show high levels of mental health problems at T2.

Methods

Participants

Participants in the present study were 435 students (mean age = 19.58, SD = 1.12) from a university in Fukushima (N = 106), a university in Tokyo (N = 176), and a university in Kyoto (N = 153). These universities are located in the Tohoku (Fukushima), Kanto (Tokyo), and Kinki (Kyoto) areas, respectively. Of all participants, 246 were men, 186 were women, and three did not indicate their gender. All of the participants were Japanese, and most were from middle to high socio-economic status families.

Ethical approval to conduct the present study was obtained from Doshisha University and Fukushima Medical University. Data collection was carried out between September and December 2013 (i.e., approximately 2.5 years after the earthquake). All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Measures

Participants completed the same set of questionnaires, which they rated to reflect how they felt immediately after the earthquake (T1: March, 2011) and at present (T2: between September to December, 2013). For T1 assessment, the students were asked to visualize themselves as clearly as they could and retrospectively describe how they felt immediately after the March 11, 2011 Tohoku earthquake.

The *Impact of Event Scale-Revised* (IES-R; Asukai et al. 2002; Weiss 2004) was used to measure subjective distress caused by a specific traumatic event. It has 22 items across three subscales: intrusion, avoidance, and hyperarousal. The total score was obtained by summing the items, with higher scores indicating higher levels of traumatic response. Cronbach's alpha for T1 and T2 assessments was .96 and .95, respectively.

The *Spence-Essau Anxiety Questionnaire* (SEA; Spence and Essau 2004) was used to measure anxiety symptoms. It contains 33 items rated on a 4-point scale in terms of frequency from "never" (0) to "always" (3). The Cronbach's alpha of the SEA in this study was .94 for T1 data and .91 for T2 data.

The *Center for Epidemiologic Studies Depression Scale* (CES-D; Radloff 1977; Shima et al. 1985) was used to measure depressive symptoms. It contains 20 items rated on a 4-point Likert scale, ranging from "rarely or none of the time (less than 1 day a week)" to "most or all of the time (5-7 days of the week)". The total score is obtained by summing up all the items, with higher scores indicating higher depressive symptoms. The Cronbach's alpha in this study was .89 for T1 data and .87 for T2 data.

The *Sheehan Disability Scale* (SDS; Sheehan 1986; Yoshida et al. 2004) was used to assess functional impairment in work/school, social, and family life. It consists of three items, and participants responded to each on a visual analogue scale (VAS) ranging from 0 (no impairment) to 10 (extreme). The items were summed to yield a total score, with higher scores reflecting higher levels of global functional impairment. Cronbach's alpha was .89 and .84 for T1 and T2, respectively.

The *State-Trait Anger Expression Inventory* (STAXI; Spielberger 1988; Suzuki and Haruki 1994) was used to measure subjective levels of anger and its expression. It contains 44 items rated on a 4-point Likert scale ranging from "almost never" to "almost always." The items can be divided into five subscales: state anger, trait anger, anger-in, anger-out, and anger-control. State and trait anger represent the subjective experience of anger, with the former measuring the intensity of the emotional state and the latter measuring the disposition to experiencing angry feelings as a personality trait. Anger-in, anger-out, and anger-control represent the way in which anger is expressed. Anger-in measures the suppression of anger, anger-out assesses the negative expression of anger to others, and anger-control measures the effort to maintain emotional control when experiencing anger. Cronbach's alpha at T1 for state anger, trait anger, anger-in, anger-out, and anger-control was .96, .94, .87, .89, and .89, respectively. At T2, Cronbach's alpha for state anger, trait anger, anger-in, anger-out, and anger-control was .92, .90, .78, .84, and .84, respectively.

Statistical analyses

Generalized linear models for repeated measures were used to examine the between-group effect of area of residence (i.e., Tohoku, Kanto, and Kinki regions) and the within-group effect of time (T1 and T2). The area × time interaction was also tested. Comparisons between the main effects and examinations of simple effects in interactions were conducted using Bonferroni post-hoc tests. All data were missing at random, and missing data were excluded from the analysis using pairwise deletion. Significance level was set at 0.05. All analyses were carried out with IBM SPSS version 22.0.

Results

Demographic variables

At the time of the earthquake, two participants were in Hokkaido, 11 in Tohoku (outside the immediate Fukushima area), 70 in Fukushima, 22 in northern Kanto (which was also heavily hit by the earthquake), 169 in southern Kanto (Tokyo area), 35 in Chubu (Nagoya area), 110 in Kinki (Kyoto area), 11 in Chugoku (Hiroshima area), two in Kyushu (Fukuoka area), two lived outside the country at the time of the earthquake, and one did not indicate their place of residence (Table 1). Four (0.9%) participants directly experienced the tsunami; of these, one was hospitalized for less than 1 month and the other three were not hospitalized. Three (0.7%) had parents or relatives who were injured or died. Seventy participants experienced partial damage to their houses, 10 experienced half-collapse, and two experienced total demolition.

Almost all the participants (98.6%) were regularly exposed to TV/internet news images of these disasters, of which 292 (68.1%) responded that they saw these visual cues daily. Seventy-one participants (16.4%) volunteered in various activities after the earthquake. Thus, while the percentages of participants who had directly experienced these two natural disasters were low, most of them indirectly experienced the events through mass media or volunteer activities.

Changes from T1 to T2 in different areas of residence

Traumatic response: All questionnaire measures were subjected to a 2 (time: T1 and T2) × 3 (area: Fukushima, Tokyo, and Kyoto) repeated measures ANOVA. To simplify comparisons, the subjects were divided into three groups based on their areas of residence during the events: Fukushima (i.e., 81 from the Tohoku area), Tokyo (169 from southern Kanto), and Kyoto (110 from Kinki). All others were excluded from further analysis, leaving 360 participants for the analyses (Table 2).

The first step of the analysis was to examine the traumatic response as measured by the IES-R. There was a significant interaction between area and time on the total IES-R (F (2, 338) = 6.15, $p < .01$) and its subscales: intrusion (F (2, 344) = 5.66, $p < .01$) and hyperarousal (F (2, 348) = 10.16, $p < .001$). Further analysis showed that for the total IES-R score, the Tokyo group scored higher than did the Kyoto group at T1 ($p < .001$); this significant difference, however, disappeared at T2. Significant differences were also found in the T1 and T2 data in both Fukushima ($p < .001$) and Tokyo ($p < .001$), but not in Kyoto. The same held true for the intrusion and

Table 1. Characteristics of participants.

Characteristics	Fukushima (N = 106)	Tokyo (N = 176)	Kyoto (N = 153)
Gender			
Male	66 (62.26%)	65 (36.93%)	115 (75.16%)
Female	39 (36.79%)	110 (62.50%)	37 (24.18%)
Unknown	1 (0.91%)	1 (0.57%)	1 (0.65%)
Mean age (SD)	20.40 (1.16)	19.46 (0.93)	19.15 (0.99)
Direct experience			
Yes	2 (1.89%)	2 (1.14%)	0
No	102 (96.23%)	174 (98.86%)	150 (98.04%)
Indirect experience through media			
Yes	103 (97.17%)	174 (98.86%)	151 (98.69%)
No	1 (0.94%)	2 (1.14%)	1 (0.65%)
Injury			
Yes	2 (1.89%)	2 (1.14%)	1 (0.65%)
No	103 (97.17%)	174 (98.86%)	151 (98.69%)
Injury to family			
Yes	1 (0.94%)	2 (1.14%)	0
No	104 (98.11%)	174 (98.86%)	152 (99.35%)
Damage to house			
Never	59 (55.66%)	144 (81.82%)	146 (95.42%)
Partly	36 (33.96%)	32 (18.18%)	2 (1.31%)
Half collapse	9 (8.49%)	0	1 (0.65%)
Total demolition	1 (0.94%)	0	1 (0.65%)
Volunteer activity			
Never	76 (71.70%)	144 (81.82%)	142 (92.81%)
A few times	19 (17.92%)	26 (14.77%)	8 (5.23%)
Moderate	10 (9.43%)	5 (2.84%)	1 (0.65%)
Frequently	0	1 (0.57%)	1 (0.65%)

Participants were recruited from first-year classes of the three participating universities. The numbers of participants slightly varied due to differences in class size, number of students who volunteered to participate in the study, and number of completed questionnaires.

hyperarousal subscales. On the intrusion subscale, a significant difference was found between T1 and T2 data in Kyoto data ($p < .05$). On the hyperarousal scale, Fukushima scored higher than Kyoto at T1 ($p < .05$), but the difference disappeared at T2.

No significant interaction effect was found for the avoidance subscale (F (2, 344) = 1.93, n.s.). However, there was a within-subject effect of time (F (1, 344) = 28.22, $p < .001$) and a between-group effect of area (F (2, 344) = 5.54, $p < .01$). Specifically, avoidance scores were significantly higher at T1 than they were at T2 across all sites. When these scores were compared across sites, Tokyo had significantly higher avoidance scores at both T1 and T2 than did Kyoto ($p < .01$).

Anxiety symptoms: Although the interaction effect was not significant for the total anxiety symptoms (F (2, 330) = 2.89, $p < .10$), there were significant main effects of time (F (1, 330) = 33.09, $p < .001$) and area (F (2, 330) = 16.39, $p < .001$). Across all sites, total anxiety was higher at T2 than T1. Tokyo scored higher than did both Kyoto ($p < .01$) and Fukushima ($p < .001$).

Depressive symptoms: A significant interaction effect of time and area was found for depressive symptoms (F (2, 335) = 9.53, $p < .001$). Post-hoc analyses showed that at T1, students from Kyoto had significantly lower depressive symptoms than did students from Fukushima ($p < .05$) and Tokyo ($p < .01$). At T2, students from Fukushima scored lower than did students from Tokyo ($p < .05$), but no significant differences emerged between Tokyo and Kyoto. When comparing the depressive scores across time, results revealed a significant decrease from T1 and T2 in Fukushima ($p < .001$). The difference between T1 and T2 showed a marginal decrease in Tokyo ($p < .10$), but a marginal increase in Kyoto ($p < .10$), suggesting that while Tokyo had the highest score at T1, depression increased in Kyoto from T1 to T2. As with anxiety levels, Fukushima had the lowest depressive symptoms at T2.

Global functional impairment: The interaction effect

Table 2. Means (standard deviations) of traumatic responses and internalizing and externalizing symptoms.

	Fukushima		Tokyo		Kyoto	
	T1	T2	T1	T2	T1	T2
IES-R						
Intrusion	N = 79		N = 162		N = 106	
	5.39	2.47	6.75	3.30	3.44	2.34
	(7.66)	(4.66)	(7.25)	(4.67)	(5.29)	(4.41)
Avoidance	N = 79		N = 162		N = 106	
	4.51	2.67	5.98	4.33	3.31	2.65
	(7.06)	(5.05)	(7.08)	(5.62)	(5.59)	(4.35)
Hyperarousal	N = 79		N = 165		N = 107	
	4.04	1.72	5.02	2.55	1.98	1.65
	(5.40)	(3.49)	(5.16)	(3.63)	(3.22)	(3.23)
Total score	N = 79		N = 157		N = 105	
	13.94	6.86	17.68	9.98	8.68	6.48
	(19.17)	(12.35)	(18.56)	(12.56)	(12.88)	(11.01)
SEA						
Total score	N = 79		N = 165		N = 99	
	15.46	18.29	27.17	29.68	19.10	25.01
	(15.27)	(12.71)	(20.90)	(16.02)	(13.66)	(12.40)
CES-D						
Total score	N = 78		N = 157		N = 103	
	19.26	14.73	19.99	18.44	14.84	16.76
	(12.67)	(8.73)	(10.91)	(10.18)	(8.49)	(10.62)
SDS						
Total score	N = 79		N = 163		N = 107	
	6.70	4.67	8.67	8.16	4.01	5.48
	(8.04)	(5.86)	(7.49)	(6.85)	(5.32)	(6.26)
STAXI						
State angry	N = 79		N = 165		N = 105	
	36.25	37.41	36.35	36.58	37.35	37.52
	(6.70)	(4.82)	(6.38)	(4.86)	(4.86)	(4.18)
Trait angry	N = 80		N = 162		N = 105	
	34.76	33.25	31.07	28.43	31.56	29.27
	(6.90)	(6.32)	(8.23)	(6.78)	(7.80)	(6.59)
Anger-in	N = 76		N = 160		N = 101	
	23.05	21.47	20.71	18.48	21.28	19.21
	(5.84)	(4.70)	(6.37)	(4.64)	(5.67)	(4.68)
Anger-out	N = 80		N = 160		N = 105	
	29.49	29.15	27.78	25.46	27.83	26.65
	(5.82)	(5.07)	(6.18)	(5.28)	(5.56)	(4.86)
Anger-control	N = 80		N = 159		N = 104	
	17.83	17.36	17.35	16.77	17.63	16.63
	(5.70)	(4.98)	(5.79)	(4.71)	(4.96)	(4.29)

CES-D, Center for Epidemiologic Studies Depression Scale; IES-R, Impact of Event Scale-Revised; SDS, Sheehan Disability Scale; SEA, Spence-Essau Anxiety Questionnaire; STAXI, State-Trait Anger Expression Inventory.

Note the difference in the numbers of responders for each subscale.

of time and area was significant on functional impairment (F (2, 346) = 7.69, $p < .01$), indicating that at T1, Kyoto had significantly lower impairment levels than did Tokyo ($p < .001$) and Fukushima ($p < .05$). However, at T2, Tokyo had higher levels of impairment than did Kyoto ($p < .01$) and Fukushima ($p < .001$). Over time, impairment significantly decreased in Fukushima ($p < .01$), while a significant increase was found in Kyoto ($p < .05$). No significant changes were found in Tokyo.

Anger expression: No significant interaction between time and area emerged for state anger scores (F (2, 346) = 0.94, n.s.). The main effect of time and area were also not significant (F (1, 346) = 2.88, $p < .10$ and F (2, 346) = 1.40, n.s., respectively). Trait anger and anger-in showed significant main effects of time (F (1, 344) = 44.95, $p < .001$ and F (1, 344) = 47.15, $p < .001$, respectively) and region (F (2, 344) = 11.44, $p < .001$ and F (2, 344) = 8.08, $p < .001$, respectively). These findings suggest that trait anger and anger-in scores were significantly higher at T1 than they were at T2, and that participants in Fukushima had higher scores than did those in Tokyo (both $p < .001$) and Kyoto ($p < .001$; $p < .05$). For anger-control, only a main effect of time (F (1, 340) = 7.85, $p < .05$) was found.

As for anger-out, there was a significant interaction between time and area (F (2, 342) = 6.09, $p < .01$). Post-hoc tests showed no significant differences in anger-out scores between the three areas at T1; however, at T2, Fukushima scored significantly higher than did Tokyo ($p < .001$) and Kyoto ($p < .01$). At T2, anger-out scores decreased significantly in Tokyo ($p < .001$) and Kyoto ($p < .01$), whereas no such change was found in Fukushima.

Gender differences in mental health problems at T1 and T2: A three way (area × time × sex) ANOVA was also conducted for all the variables. There were significant time × sex interactions for the total IES-R (F (1, 333) = 6.08, $p < .05$), intrusion (F (1, 339) = 6.60, $p < .05$), avoidance (F (1, 339) = 4.72, $p < .05$), and anger-out of the STAXI (F (2, 338) = 6.22, $p < .05$). Post-hoc analyses of simple main effect indicated that women showed higher traumatic responses at T1, whereas from T1 to T2, a significant decrease was found among both men and women ($p < .001$). On anger-out, men showed higher scores at T1 than did women ($p < .01$), whereas anger-out scores decreased at T2 for both men and women. Although significant three-way interactions were found for the total CES-D (F (2, 331) = 3.622, $p < .05$), anger-in (F (2, 330) = 3.16, $p < .05$), and anger-out (F (2, 338) = 4.12, $p < .05$), there were no significant simple interactions for these at each time.

Discussion

The main aim of this study was to retrospectively examine the impact of the Tohoku Earthquake on young people's mental health at the time of the disaster and 2.5 years later. A total of 435 young people participated in the present study, of which 360 were selected for comparison between the three regions in Japan (Fukushima, Tokyo, Kyoto).

In contrast to our hypothesis, students from Tokyo had the highest levels of trauma response and internalizing symptoms (i.e., anxiety and depression) at T1 (i.e., immediately after the earthquake) than did those at the other two sites. In analyzing this result, it is important to understand the situation in Tokyo after the disasters. In addition to the nuclear power plant accident that resulted in a shortage of electricity and planned outages, Tokyo experienced a shortage of water and food because of road destruction, causing major disruption in public transportation (Fire and Disaster Management Agency 2014). Therefore, a temporary paralysis in urban function could have had a psychological impact on the mental health of young people who lived in the Kanto area, including Tokyo.

Participants in the Fukushima area did not show significantly higher levels of traumatic reactions as compared to participants at the other two sites. This is a surprising finding, given that a recent study by Fukudo et al. (2012) showed that the PTSD incidence rate among adults in Tohoku was estimated at 12.7% 2-5 months after the earthquake (Fukudo et al. 2012). Compared to studies conducted in Western countries (Cohen et al. 1998; Ekşi et al. 2007; Bal 2008), the prevalence of PTSD in Japan was very low, and was consistent with a previous study conducted in China (Liu et al. 2010).

Anxiety and depression scores were strikingly low in Fukushima, which is in line with the low mental health service utilization that has been reported in the Tohoku region (Hori 2013). There is no clear explanation for this finding; thus, further research is needed to identify factors that contribute to the low levels of traumatic response and internalizing symptoms. It could be that internalizing problems appear with time. As reported by Nishimoto et al. (2000), young people's mental health problems became apparent 4 years after the Hanshin-Awaji Earthquake (Nishimoto et al. 2000). More recently, a prospective survey at Tohoku University indicated that responses to a yes/no single-item question about disaster-related mental distress were slightly increased immediately at the 2-year follow-up relative to baseline. This effect was maintained at the 3-year follow-up (Arata et al. 2015). Based on these findings, it could be speculated that the negative impact of the Tohoku earthquake may become apparent a few years later.

Trait anger, anger-in, and anger-out were significantly more common in Fukushima than they were in the other two regions. This finding is in line with that of a nationwide survey, which showed that anger among people living in Tohoku was exacerbated after the earthquake due to life restrictions, harmful rumors, and lagging reconstruction because of the nuclear disaster (Watanabe et al. 2013). In addition, the present results may reflect the resentment of the people in Fukushima, who were burdened by one of the worst nuclear disasters in history, to support the vast electric demand in Tokyo. Overall, the present findings

suggest that Japanese people who lived close to the center of natural and human-related disasters show high externalizing symptoms, as opposed to symptoms of PTSD, anxiety, and depression.

In Kyoto, a different trend was observed in that anxiety and depressive symptoms increased from T1 to T2. At T1, residents in Kyoto were not directly affected, as their location was the farthest from the earthquake site. However, following the release of radioactive materials at the Fukushima Unit I power plant, anxiety regarding vegetables, seafood, and dairy products spread nationwide through mass media. This result is in line with the findings of a previous study (Nakajima and Tatsuno 2002), in which the impact of the Tokaimura accident (another nuclear accident in Japan) had a more negative impact among children located in distant schools. Specifically, students from a distant school (100 km or more from the accident site) reported the worst levels of mental health as compared to those from nearby areas (i.e., located within 10 km) (Minoshita et al. 2002). Another factor may be related to the fact that the disasters were widely broadcasted through mass media. It could be that media-based exposure influences the mental health of people distant from the center of natural and human-related disasters. However, it is difficult to conclude that young people who were exposed to media had high levels of mental health problems, as almost all participants (98.4%) were regularly exposed to TV or internet news.

Our study is not without limitations, which include a small sample size, the use of university students, and self-reports using a retrospective design. In addition to this methodological limitation, the occurrence of these three disasters that took place within a short time interval made it difficult to specify which of these disasters and/or their consequences (e.g., direct damage or injury, voluntary or mandatory evacuations, and loss of significant others due to the earthquake, tsunami, or nuclear accident) had a direct impact on the young people's mental health. Notwithstanding these limitations, our findings suggest that earthquakes, tsunamis, and nuclear disasters not only have a negative effect on young people who lived at the center of the disasters, but also on those who lived far away from the disasters. Thus, it is important to provide mental health services to young people across different regions and not only to those living in the affected area.

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Conflict of Interest

The authors declare no conflict of interest.

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