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ORIGINAL PAPER

Risk Factors of Post-traumatic Stress and Depressive Disorders in Longmenshan Adolescents After the 2013 Lushan Earthquake

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Abstract
This study examined the severity of post-traumatic stress and depressive disorders in Longmenshan adolescents after the 2013 Lushan earthquake, as well as relationships among earthquake-related exposure, post-earthquake negative factors, previous exposure to the 2008 Wenchuan earthquake, and level of earthquake impact (city). A cross-sectional survey was conducted among adolescents in Lushan (n = 1416), Baoxing (n = 1102) and Tianquan (n = 1265) at 3 years after the Lushan earthquake. Respondents were evaluated using the Earthquake Experience Scale, the Adolescent Self-rating Life Events Checklist (ASLEC), the Children's Revised Impact of Event Scale (CRIES-13), and the Depression Self-Rating Scale (KADS-6). High levels of post-traumatic stress and depression symptoms were found among adolescents in the most heavily affected cities, and these symptoms were more severe in respondents exposed to the 2008 earthquake. PTSD correlated most strongly with earthquake exposure, whereas depression correlated most strongly with psychosocial stressors following the event.

Keywords Adolescents · Depression · Earthquake · Level of impact · PTSD

Introduction

Earthquakes, one of the most common natural disasters, are usually unpredictable, uncontrollable, and costly in terms of life and property (Zhou et al. 2016; Bal and Jensen 2007). Natural disasters such as earthquakes have been associated with a range of psychopathologies in survivors, such as post-traumatic stress disorders (PTSD) and depression (Association 2013; Okuyama et al. 2017). Indeed, systematic reviews have found PTSD and depressive disorders to be the most common post-disaster psychopathologies (Derivois et al. 2017; Ekşi et al. 2007), and many research studies have focused on the severity of mental health problems in earthquake survivors (Davidson and Mcfarlane 2006; Furr et al. 2010). However, few studies have focused specifically on adolescent survivors who have been exposed to two catastrophic earthquakes within 5 years.

The Longmenshan thrust fault (LMSF) area in Sichuan Province, China, experienced two devastating earthquakes within 5 years: the 2008 Wenchuan earthquake (Ms.8.0, China Earthquake Networks Center) and the 2013 Lushan earthquake (Ms.7.0). The China Earthquake Data Center reported that the catastrophic Wenchuan earthquake was the Chinese second deadliest earthquake in recent history, involving nearly 70,000 deaths, 373,000 people injured and 18,000 people missing. The Lushan earthquake was the strongest earthquake since the 2008 Wenchuan earthquake affecting 12,500 square kilometers and involving more than 10,000 people injured and hundreds of people killed or missing (Fang et al. 2013). The cities of Lushan, Baoxing and Tianquan in the LMSF were affected to

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different degrees by the 2008 Wenchuan and 2013 Lushan earthquakes (Fig. 1).

Previous post-earthquake studies have compared the exposure of children and adolescents at various distances from the epicenter with non-exposed survivors (Giannopoulou et al. 2006; Wang et al. 2000). Many studies have reported conflicting results about the relationship between the severity of post-traumatic stress and the magnitude of the disaster impact (Pynoos et al. 1993; Shaw et al. 1995; Goenjian et al. 2001). For example, one study found that a village with a higher level of initial exposure to the earthquake had a lower PTSD frequency than a village with a lower level of initial exposure (Wang et al. 2000). Conversely, another study found more severe PTSD among victims in cities closer to the epicenter (higher exposure) than victims in more distant locations (Goenjian et al. 1994). Besides proximity to the earthquake, these differences could also reflect exposure to earthquake-related factors during the earthquake such as fear, being injured, or having relatives injured or dying (Goenjian et al. 1995, Hsu et al. 2002), as well as post-earthquake negative life events such as interpersonal factors, learning stress, and loss (Sun et al. 2016; Freedy et al. 1994).

Potential predictors of trauma-related disorders have been widely studied (Tang et al. 2017), but risk factors of the well studied psychopathology of depression remain unclear. Previous studies have suggested that disaster proximity to the epicenter and disaster magnitude can reliably predict depression in children and adolescents (Goenjian et al. 1995; Groome and Soureti 2011). Several additional adolescent depression predictors have been proposed: fear during trauma, injury, death of relatives, perception of a life threat, interpersonal conflict, academic pressure, and exposure to multiple traumas (Ying et al. 2013; Jackson and Lurie 2006). However, little is known about the contribution of each risk factor to adolescent depressive disorders.

In particular, although there have been many studies of risk factors for post-traumatic stress and depressive disorders, we are unaware of studies of risk factors among adolescent survivors who have lived through two catastrophic earthquakes within 5 years. This is an important question because trauma history can be an important risk factor of

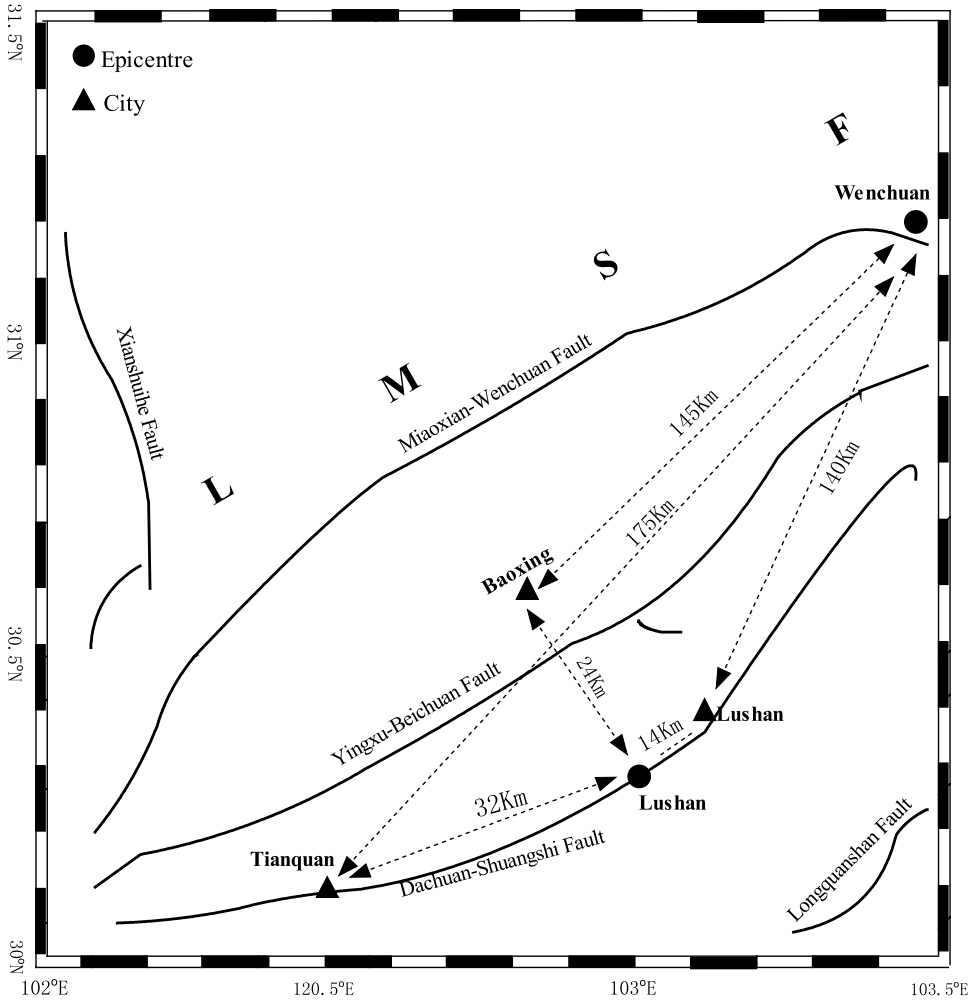

Fig. 1 Map showing the positions of the earthquake epicenters and the Lushan, Baoxing, and Tianquan study sites

PTSD and depression (ODonnell et al. 2004; Breslau and Peterson 2008). The present study, therefore, aimed to determine whether childhood exposure to the 2008 Wenchuan earthquake increased the severity of PTSD and depression among those also exposed to the 2013 Lushan earthquake. At the same time, this study aimed to examine in detail how level of disaster impact (city), earthquake-related exposures and post-earthquake life events influenced the severity of PTSD and depression in this unique population.

Methods

Participants

A cross-sectional survey was conducted in Lushan, Baoxing and Tianquan in the LMSF area 3 years after the 2013 Lushan earthquake. A total of 3783 students from 11 schools in the three cities completed the survey, comprising four schools in Lushan (n = 1416), four schools in Tianquan (n = 1265) and three schools in Baoxing (n = 1102). Participants were aged 13–18 years, and 2343 (61.93%) had experienced both the 2008 Wenchuan and 2013 Lushan earthquakes.

The exclusion criteria were an unfinished PTSD and depression assessment, severe communication problems such as dementia or psychotic disorders, those too young to have experienced the Wenchuan earthquake, or those who were older than adolescents at the time of the Lushan earthquake.

Procedures

A temporary survey team made up of psychology teachers and psychology graduate students was established. The survey team underwent a week of training at the West China School of Public Health, Sichuan University, and then visited earthquake-struck areas on April 25–29, 2016, approximately 3 years after the Lushan earthquake. The survey team was divided into three sub teams, with one team each visiting Lushan, Baoxing, and Tianquan, where they administered the questionnaires, which were in Mandarin. Prior to the local distribution of the questionnaires, potentially confusing items were indentified and rewritten in the local Sichuan dialect. If respondents had difficulties with the survey, team members helped them to record their responses and complete the survey.

In accordance with Chinese law, consent for this study was obtained from the subjects themselves, their parents, the local education authority and school administrators. Before each data collection session, participants were informed that their participation was voluntary and they had the right to with draw from the study at any time without penalty. Participants were encouraged to complete the questionnaires in private.

Measures

There were two parts to the assessment questionnaires. The first part gathered basic demographic information: age, gender, home, school, grades, and only-child status. The second part included the Earthquake Experience Scale, the Adolescent Self-Rating Life Events Checklist (ASLEC), the PTSD assessment from the Children's Revised Impact of Event Scale (CRIES-13), and the Depression Self-Rating Scale (KADS-6).

Earthquake Exposure

The degree of exposure to the Lushan earthquake was assessed using the Earthquake Experience Scale, which uses a self-report binary scale (yes/no) to assess whether the respondent had (a) felt scared he or she would die; (b) was trapped in the earthquake and had to be rescued; (c) was injured in the earthquake; (d) witnessed parents, relatives or good friends being injured;(e) experienced both the Wenchuan and Lushan earthquakes; (f) witnessed someone trapped; (g) witnessed someone injured; (h) had relatives who died in the earthquake; or (i) witnessed someone die during the earthquake.

Post-earthquake Negative Life Factors

The frequency and intensity of daily stress experienced by participants were evaluated using the ASLEC (Xin et al. 2015; Zhang et al. 2015), which features 27 items involving interpersonal conflicts, family conflicts, academic pressure, punishment by guardians or teachers, health problems, humiliation, monetary loss and the death or illness of family members. These items are grouped under six factors: interpersonal, learning stress, punishment, loss, health adaptation, and "other" (Liu et al. 1997). Each item is rated on a 5-point Likert scale. Participants were required to indicate whether the life events had occurred over the preceding 12 months. If participants answered "no", the score was 0; if subjects answered "yes", they were required to assess the influence of the life event from 1 (not at all) to 5 (very much). This instrument has been shown to have good reliability and validity (Xin et al. 2015). In our study, the Cronbach's alpha was 0.84.

PTSD

PTSD symptoms were assessed using the CRIES-13, adapted from the IES-8 (Perrin et al. 2005). Each question was answered on a four-point scale (0, not at all; 1, rarely;

3, sometimes; 5, often) with no reversed items. Total scores indicated the severity of post-traumatic stress reactions and ranged from 0 to 65. The scale has been found to have satisfactory internal consistency, good convergent validity, and good reliability (Lau et al. 2013). In our study, the Cronbach's alpha was 0.88. The CRIES has been used with children who experienced the 1999 Athens earthquake (Giannopoulou et al. 2006), and the Chinese CRIES-13 proved to be valid and reliable in assessing the PTSD symptoms in Chinese adolescents following the 2008 Wenchuan earthquake (Lau et al. 2013).

Depression

Depression severity was measured using the 6-item Kutcher Adolescent Depression Scale (KADS-6) (Messer et al. 1995), which largely focuses on selected or clinical samples of children or adolescents (Cheng et al. 2009). The total score ranges from 0 to 18, with a cutoff score of 6. This instrument has been found to have sensitivity of 0.92 and specificity of 0.71 (LeBlanc et al. 2002). In this study, the Cronbach's alpha was 0.92. The six-item KADS has been found to be an efficient and effective means of identifying major depressive episodes in adolescents (LeBlanc et al. 2002).

Statistical Analysis

All statistical procedures were carried out using the SPSS 17.0 (IBM, Chicago, IL, USA). Simple descriptive statistics such as frequencies, numbers, and proportions were used when appropriate. Kendall's tau-b was used to assess the differences in the earthquake-related exposure frequencies across the cities for the earthquake-related items. One-way ANOVA was used to examine differences among the three cities. A t test was used to compare differences in mean scores for PTSD and depression between respondents who were exposed or not to the 2008 Wenchuan earthquake. Multiple hierarchical linear regression was conducted to examine the contributions of earthquake-related exposure, post-earthquake negative life factors, exposure to the 2008 Wenchuan earthquake, and level of earthquake impact on the severity of PTSD (measured by CRIES-13 scores) and depression (measured by KADS-6 scores) after the Lushan earthquake. A p value < 0.05 was considered significant.

Results

Descriptive statistics for the overall sample are shown in Table 1. A total of 1416 participants were surveyed in Lushan, 1102 in Baoxing, and 1265 in Tianquan, and 61.93% of all participants had been exposed to the 2008 Wenchuan earthquake. Participants ranged in age from 13 to 18 years (mean = 15.22, SD = 1.54), and 55.93% were female.

Table 1 Characteristics of the total sample

Variable	Mean	N	SD	%
Age	15.22		1.54	
Gender				
Male		1667		44.07
Female		2116		55.93
Only child		1726		45.6
Level of impact (city)				
Lushan		1416		37.43
Baoxing		1102		29.13
Tianquan		1265		33.44
Exposure to 2008 earthquake		2343		61.93
Earthquake-related variables				
Feeling scared he/she would die		1440		38.07
Trapped in the earthquake		153		4.04
Injured in the earthquake		611		16.15
Had parents or relatives injured		1503		39.73
Had relatives who died in the earthquake		254		6.71
Witnessing someone trapped		1547		40.89
Witnessing someone injured		1985		52.47
Witnessing death		1244		32.88
Post-earthquake negative life event variables				
Interpersonal factor	8.44		4.82	
Learning stress factor	9.55		5.04	
Punishment factor	6.82		6.16	
Loss factor	3.02		3.33	
Health adaptation factor	2.96		2.56	
Other factors	4.28		3.67	

Table 2 shows the different frequencies for the earthquake-related exposure items and the post-earthquake negative life factor mean scores in the three cities. The highest percentages were found in Lushan, the most affected region, followed by Baoxing and Tianquan. Lushan also reported the highest injury rates (20.34%), the most people with relatives who died (9.39%), and the most people who had witnessed someone trapped (56.27%). Exposure to the 2008 earthquake was higher in Lushan (71.89%) than in Baoxing (60.8%) and Tianquan (51.78%). Frequencies of the following earthquake-related items differed significantly among Lushan, Baoxing and Tianquan: being injured (Kendall's tau-b = 0.19, $p < 0.05$), having relatives who died in the earthquake (Kendall'stau-b = 0.32, $p < 0.01$), and witnessing others trapped (Kendall's tau-b = 0.55, $p < 0.01$). Of the various post-earthquake negative life event factors that were analyzed in our study, only loss factors showed significant differences among the three cities ($F = 5.74$, $p < 0.05$).

Table 2 Comparison of the three cities in terms of frequencies of earthquake-related exposure and mean scores for negative life factors

Variable	Lushan (1416)		Baoxing (1102)		Tianquan (1265)		Kendall's tau-b
	N	%	N	%	N	%	
Earthquake-related variables							
Feeling scared he/she would die	523	36.94	444	40.29	473	37.39	0.025
Trapped in the earthquake	65	4.61	42	3.81	46	3.63	0.00
Injured in the earthquake	288	20.34	168	15.25	155	12.25	0.19*
Had parents or relatives injured	562	39.69	473	42.92	468	37	0.09
Had relatives who died in the earthquake	133	9.39	57	5.17	64	5.06	0.32**
Witnessing someone trapped	797	56.27	360	32.67	390	30.83	0.55**
Witnessing someone injured	741	52.33	608	55.17	636	50.28	0.03
Witnessing death	454	32.06	372	33.76	418	33.04	0.00
Exposure to the 2008 earthquake	1018	71.89	670	60.8	655	51.78	0.102*
	Mean	SD	Mean	SD	Mean	SD	F-value
Post-earthquake negative life event variables							
Interpersonal factor	8.78	4.82	8.04	4.12	8.14	4.22	0.72
Learning stress factor	9.85	5.17	9.57	4.93	9.44	5.04	0.5
Punishment factor	6.98	6.36	6.82	6.12	6.83	6.16	0.38
Loss factor	4.92	3.6	3.03	3.31	2.96	3.07	5.74*
Health adaptation factor	3.18	2.96	2.96	2.32	2.91	2.54	1.08
Other factors	4.98	3.34	4.87	3.47	4.82	3.29	0.27

*p < 0.05; **p < 0.01

Table 3 shows mean PTSD scores for Lushan (16.64), Baoxing (14.07), and Tianquan (12.13). The one-way ANOVA indicated significant PTSD differences among the three cities (F = 72.361, p < 0.001). Survivors who had been exposed to the 2008 Wenchuan earthquake showed higher mean scores than those without previous exposure, and this was observed in all three cities: Lushan, No = 16.14, Yes = 18.84 (t = 15.720, p < 0.001); Baoxing, No = 13.97, Yes = 15.53 (t = 4.195, p < 0.05); and Tianquan, No = 11.27, Yes = 13.38 (t = 9.174, p < 0.01). Mean scores for depression were 6.08 in Lushan, 4.02 in Baoxing, and 3.37 in Tianquan; one-way ANOVA showed significant differences among the three cities (F = 5.327, p < 0.05). Participants who were exposed to the 2008 earthquake showed higher mean scores for both PTSD and depression than those exposed only to the 2013 earthquake, and this was observed in all three cities: Lushan, No = 5.28, Yes = 7.47 (t = 10.572, p < 0.01); Baoxing, No = 3.24, Yes = 5.82 (t = 8.327, p < 0.01), and Tianquan, No = 3.02, Yes = 3.72 (t = 1.569, p = 0.21).

Hierarchical regression in which the dependent variables were total PTSD scores and depression scores is presented in Table 4. Survivors who were older and had a sibling had lower PTSD scores, and those who were older also had lower depression scores. Demographic characteristics were found to contribute 1.4% to variance in PTSD ($\Delta R^2 = 0.014$, $p < 0.05$) and 2.3% to variance in depression ($\Delta R^2 = 0.023$, $p < 0.01$). Earthquake-related exposure accounted for 14.2% of variance in R^2 in the PTSD model

Table 3 Comparison among cities in terms of mean scores for PTSD and depression, stratified by previous earthquake exposure

City	Lushan (14 km from epicenter)			Baoxing (24 km from epicenter)			Tianquan (32 km from epicenter)			F-value
Exposure to 2008 earthquake	No	Yes	T-value	No	Yes	T-value	No	Yes	T-value	
PTSD	16.64			14.07			12.13			72.361***
	16.14	18.84	15.720***	13.97	15.53	4.195*	11.27	13.38	9.174**	
Depression	6.08			4.42			3.37			5.327*
	5.28	7.47	10.572**	3.24	5.82	8.327*	3.02	3.72	1.569	

*p < 0.05; **p < 0.01; ***p < 0.001

Table 4 Risk factors and interaction effect analysis for total PTSD and depression score

Variable	PTSD			Depression		
	Beta	ΔR^2	R^2	Beta	ΔR^2	R^2
Step 1: Demographic statistics		0.014*	0.014*		0.023**	0.023**
Gender	2.704**			2.109**		
Age	−0.304			−0.043		
Only child	−0.463			0.015		
Step 2: During the earthquake		0.142***	0.156***		0.095***	0.118***
Feeling scared he/she would die	5.052***			3.199***		
Trapped in the earthquake	0.163*			1.002*		
Injured in the earthquake	3.027***			2.084**		
Had parents or relatives injured	2.416**			2.096**		
Had relatives who died	2.979***			2.017**		
Witnessed someone trapped	1.433*			1.053*		
Witnessed someone injured	0.962*			1.039*		
Witnessed death	1.459*			1.056*		
Step 3: Post-earthquake negative life factors		0.113***	0.269***		0.174***	0.292***
Interpersonal factor	1.983**			2.091**		
Learning stress factor	2.128**			2.078**		
Punishment factor	1.231*			1.079*		
Loss factor	2.042**			1.083*		
Health adaptation factor	1.958**			0.782*		
Other factors	1.762**			1.067*		
Step 4		0.051**	0.32**		0.067***	0.359***
Exposure to 2008 earthquake	2.602**			1.103*		
Step 5		0.063***	0.383***		0.048**	0.407***
Level of impact (city)	1.88**			0.924*		

Beta standardized coefficients derived from the final step, R^2 explanation rate, ΔR^2 change in explanation rate in each step

*p < 0.05; **p < 0.01; ***p < 0.001

($\Delta R^2 = 0.142$, $p < 0.001$) and for 9.5% of variance in R^2 in the depression model ($\Delta R^2 = 0.095$, $p < 0.001$). Post-earthquake negative life events contributed 11.3% to variance in PTSD ($\Delta R^2 = 0.113$, $p < 0.001$) and 17.4% to variance in depression ($\Delta R^2 = 0.174$, $p < 0.001$). Exposure to the 2008 earthquake contributed positively to variance in both PTSD ($\Delta R^2 = 0.051$, $p < 0.01$) and depression ($\Delta R^2 = 0.067$, $p < 0.001$), as did impact level (city) (PTSD, $\Delta R^2 = 0.063$, $p < 0.001$; depression, $\Delta R^2 = 0.048$, $p < 0.01$). These results indicate that in our study sample, earthquake-related exposure was the strongest explanatory variable for PTSD, while post-earthquake negative life events were the strongest explanatory variables for depression.

Discussion

Level of Earthquake Impact

In the present study, PTSD and depression severity were related to higher impact level (city). Of the three cities in this study, Lushan was the most severely affected in the 2013 Lushan earthquake, and Lushan and Baoxing were struck hardest in the 2008 Wenchuan earthquake. This may help explain why the most severe PTSD and depression symptoms were found in Lushan city, while the least severe symptoms were found in Tianquan city. These findings are in agreement with previous post-disaster studies that found a dose-of-exposure relationship between disaster impact magnitude on one hand and PTSD and depression severity on the other (Pynoos et al. 1993; Shaw et al. 1995). As in the present study, previous work found severe levels of PTSD and depression in children and adolescents in the most heavily affected cities (Goenjian et al. 2001; Giannopoulouet al., 2006). One explanation for this is that more people are exposed to the earthquake in high-impact areas (Roussos et al. 2005).

Lushan city showed the highest frequencies for earthquake-related exposure and highest mean scores for negative life factors (Table 2), echoing previous earthquake surveys that found an association of higher earthquake exposure and frequent negative life events with more serious psychological

problems (Giannopoulou et al. 2006; Smith et al. 1990). In our study, the number of children and adolescents who had been injured, had had parents or relatives injured, or had witnessed someone trapped in the earthquake were much higher in Lushan city than in Baoxing or Tianquan city. Furthermore, a significantly higher ratio of respondents in Lushan city had experienced both the Lushan and Wenchuan earthquakes than in Baoxing or Tianquan city. Multiple traumas have been found to increase the incidence of mental disorders (Cougle et al. 2009), which may help explain why the severity of the PTSD and depression symptoms was greater in Lushan. Another explanation is the much higher incidence of the loss factor (one of the post-earthquake negative life factors in our analysis) in Lushan than in the other two cities. Many studies have found that loss of property, money, relatives, friends, and pets is an important contributor to mental disorders (Tang et al. 2014; Jia et al. 2013; Wu et al. 2006). Indeed, this is supported by the hierarchical regression analyses in the present study.

Exposure to the 2008 Wenchuan Earthquake

Survivors with prior trauma exposure from the 2008 Wenchuan earthquake, i.e. those who experienced two earthquakes in five years, were found to have more severe PTSD and depression symptoms than those who had experienced only the 2013 earthquake. This suggests that the 2008 earthquake experience left negative feelings that were reawakened by the subsequent 2013 earthquake; in other words, the 2013 event aroused the tragedy of the previous one, potentially facilitating psychological distress (Goenjian et al. 2009). Traumatic visual memory has been found to be an important factor in the development of many psychological disorders in children and adolescents (Ying et al. 2014).

Participants who had been exposed to the 2008 earthquake showed a higher propensity for PTSD and depression. Similarly, children and adolescents who have experienced multiple traumas report more severe emotional and behavioral problems than children who have experienced no or only one trauma experience (Carlson 1991; Neuneret al. 2006). Trauma event frequency is an important risk factor for PTSD and depression (Breslau and Peterson 2008; Goenjian et al. 2011). Multiple traumas can cause not only psychological problems but also economic loss: the survivors in our study who experienced both earthquakes suffered significantly greater economic losses than those who experienced only the 2013 earthquake. These losses can cause poverty (Dongling et al. 2017) and exacerbate the negative effects of earthquake exposure. Even on its own, poverty is an important contributing factor to PTSD (Xu and Song 2011) and depression (Xu et al. 2013). Our results are consistent with the idea that exposure to the 2008 earthquake was a risk factor for poor mental health following the 2013 Lushan earthquake.

Earthquake-Related Exposure and Post-earthquake Negative Life Events

Earthquake-related exposure was found to be a major contributing factor to PTSD and depression prevalence (Ekşi et al. 2007). In our study, hierarchical regression showed that earthquake-related experiences contributed 14.2% to PTSD severity and 9.5% to depression severity, consistent with the idea that earthquake-related exposures are significant predictors of psychological distress (Tang et al. 2017). In the present study, feelings that one would die, be injured, or see relatives die or be injured were the most significant earthquake exposure factors contributing to PTSD and depression. Among these factors, the feeling that one would die contributed the greatest extent to risk of PTSD and depression. Previous work also reported subjective experiences of fear and horror to be important predictors of PTSD and depression severity (Başoglu et al. 2004), and indicated that adolescents were likely to experience greater levels of fear for their own safety in an earthquake (Zhang et al. 2010). Again similar to our study, previous work has shown that being physically injured or experiencing the death of a close family member were significant risk factors of PTSD and depression in children and adolescent victims (Mercuri and Angelique 2004; Neuner et al. 2006; Hodes and Diaz Caneja 2007). The present study found that witnessing people die or be injured predicted risk of PTSD and depression, and such experiences have also been linked to the development of many psychological symptoms in adolescents (Goenjian et al. 2009; Ying et al. 2014).

Post-earthquake negative life events are also important risk factors for the prediction of PTSD and depression (Giannopoulouet al. 2006; Tang et al. 2017). Hierarchical regression in the present study found that post-earthquake negative factors contributed 11.3% to PTSD and 17.4% to depression. Negative life events can cause enormous pressure, which can make people very depressed. Although this pressure is not as strong as catastrophic stress, it is frequent and persistent (Freedy et al. 1994; Sun et al. 2016). In addition, earthquakes change the way of life for local populations, with many of these changes triggering additional negative life events (Cénat and Derivois 2014). Previous studies have found that people who have been exposed to several negative life events within the previous 12 months are more likely to have serious negative emotions and behavior (Freedy et al. 1994; Sun et al. 2016). Negative life events may adversely affect the post-earthquake stress reactions in adolescents, with many daily problems negatively impacting their mental health (Zhou et al. 2016). In the present study, post-earthquake negative life events emerged as key risk factors for more severe PTSD and depression symptoms, which is in line with several previous studies (Ceyhan and Ceyhan 2007; Chou et al. 2004; Goenjian et al. 2011).

In our study, earthquake-related exposure was the strongest explanatory variable in the PTSD model, while post-earthquake negative life events were the strongest explanatory variable in the depression model. These results differ from prior studies. For example, in the 2010 Haiti earthquake, exposure to trauma was found to be the strongest predictor of depression, while life events had a predictive effect only on depression symptoms (Cénat and Derivois 2014). In a study of survivors of the Parnitha earthquake, exposure to earthquake trauma was found to be the strongest predictor of PTSD, while adverse life events strongly affected depression symptoms (Goenjian et al. 2011). The different risk profiles between PTSD and depression may be attributable in part to respondent characteristics, research methodology, degree of earthquake exposure and the time interval between the earthquake and data collection. Future studies should explore this issue further, especially since several studies suggest that PTSD and depression symptoms are highly inter-correlated (Tural et al. 2012; Kilpatrick et al. 2003; Goenjian et al. 1995): variables strongly associated with one disorder are often strongly associated with the other as well (Goenjian et al. 2001; Roussos et al. 2005). Nevertheless, although depression and PTSD may overlap in many respects, their causal factors are likely to differ. Indeed, our results showed that PTSD was highly correlated with geographical exposure (earthquake-related exposure) to the earthquake, whereas depression was most related to psychosocial stressors (negative life events) following the trauma event.

Conclusions

To the best of our knowledge, this study is the first to explore relationships of PTSD and depression severity in adolescent survivors of a major earthquake with the level of earthquake impact, exposure to another major earthquake within the preceding 5 years, earthquake-related exposure, and post-earthquake negative life events. Higher earthquake impact (nearer to the epicenter) contributed to more severe PTSD and depression symptoms, as did previous exposure to a major earthquake. Our findings suggest that post-disaster reconstruction efforts should pay more attention to badly affected areas and to survivors who have experienced two catastrophic earthquakes. Earthquake-related items and post-earthquake negative life events were also clearly identified as important risk factors for both PTSD and depression. Earthquake-related exposure was the strongest predictor of PTSD, while post-earthquake negative life events were the strongest predictors of depression. In other words, post-earthquake adversity was the second most important predictor of PTSD severity in adolescents directly exposed to the event, and such adversity was the most important predictor of depression, regardless of whether the child was directly exposed to the earthquake or not. These results highlight the need for swift government relief efforts.

The present study had several limitations. First, we cannot compare our data at 3 years after the Lushan earthquake with data collected in the immediate aftermath or with data collected after the 2008 Wenchuan earthquake. Second, although our sample was larger than previous samples and all information was complete, it may not have accurately represented all adolescent populations in the severely affected cities. Third, the earthquake-related items and post-earthquake negative life events in this study were not analyzed in detail. Further research is required to explain the extent to which each risk factor affects the physical and mental health of adolescent earthquake survivors.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no competing interests.

Ethical Approval This project was approved by the Research Ethics Committee of Sichuan University, the Research Ethics Committee of the West China Hospital of Sichuan University, and the Education Bureau of Lushan, Tianquan, and Baoxing Counties. The study was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

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