Psychiatry Research 275 (2019) 253–260

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Influence of earthquake exposure and left-behind status on severity of post-traumatic stress disorder and depression in Chinese adolescents

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ARTICLE INFO

Keywords:
Depression
Earthquake
Left-behind children
PTSD

ABSTRACT

In the Longmenshan seismic fault zone in the Sichuan province of China, many children and adolescents have been exposed to the 2008 Wenchuan earthquake and/or the 2013 Lushan earthquake, and many are left alone for extended periods by parents who migrate to larger cities for work. We wished to examine how these two kinds of trauma—earthquake exposure and left-behind status—influence severity of post-traumatic stress disorder (PTSD) and depressive reactions. A cross-sectional survey of 2447 adolescents aged 13–18 at 11 schools in three cities in the Longmenshan fault zone was conducted in 2016. Potential relationships of scores on the Children's Revised Impact of Event Scale (CRIES-13) and the Depression Self-Rating Scale (KADS-6) with severity of PTSD and depression symptoms were explored using ANOVA and multiple hierarchical linear regression. Prevalence of post-traumatic stress and depression symptoms were higher among left-behind children than among those not left behind, and both types of symptoms were more severe in children exposed to both earthquakes than in children exposed only to the Lushan earthquake. Our results suggest that earthquake exposure is a strong risk factor for PTSD, whereas being left behind is a strong risk factor for depression.

1. Introduction

China's rapid economic development and unprecedented urbanization have attracted many rural parents to migrate to large urban centers for employment opportunities, while their children are left behind to be cared for by other family members. According to Wu, China has witnessed an explosive growth of left-behind children in recent decades (Wu et al., 2015). These children, usually in rural areas, stay at home while at least one parent relocates elsewhere to work for at least six months per year (Tang et al., 2018a,b). The resulting lack of parental care limits the ability of left-behind children to face life's negative events (He et al., 2012). Chinese left-behind children experience significant mental health problems (Fan et al., 2010; Jia et al., 2010), one of the best studied of which is depression (He et al., 2012; Ge et al., 2006).

The risk of mental health problems among Chinese children and adolescents may be particularly high in areas such as the Longmenshan seismic fault zone in Sichuan province, where many children are left behind by parents seeking work, similar to the situation in many other remote rural areas in China. In addition, this area has witnessed two devastating earthquakes, the 2008 Wenchuan earthquake (Ms.8.0 based on the China Earthquake Networks Center) and the 2013 Lushan earthquake (Ms.7.0). As a result, this population of young people offers the unusual possibility of analyzing how two types of trauma —exposure to up to two major earthquakes, and being left behind by migrating parent(s)—influence the severity of post-traumatic stress disorder (PTSD) and depression symptoms.

Earthquakes give rise to many problems, such as social instability and psychological morbidity. They not only create tremendous changes in the external environment, but also affect victims' cognitive knowledge and psychological reactions (Tang et al., 2016). Earthquake disasters have been found to be associated with an increased prevalence in severe psychiatric symptomatology, stress, PTSD, depression, somatic complaints, and nightmares (Karanci and Rüstemli, 1995; Roberts et al., 2010). Previous systematic reviews have documented that PTSD and depression are the most commonly studied and probably the most frequent psychopathology in the aftermath of disasters (Norris et al., 2002; Galea et al., 2016; Cardeña, 2007). Furthermore, previous exposure to a traumatic event has been found to be associated with greater mental disorder risk, with multiple previous events having a stronger effect

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https://doi.org/10.1016/j.psychres.2019.01.109
Received 1 May 2018; Received in revised form 21 January 2019; Accepted 21 January 2019
Available online 19 March 2019
0165-1781/

than a single previous event (Breslau et al., 2008). Several post-earthquake studies have compared characteristics of children and adolescents exposed to earthquakes at various impact levels with non-exposed control children (Giannopoulou et al., 2006; Wang et al., 2000), and have reported discrepant results about the relationship between the severity of PTSD or depression and the magnitude of the disaster impact (Pynoos et al., 1993; Shaw et al., 1995).

Another condition that may influence children and adolescents' severity of PTSD or depression is being left behind by parents seeking work. Previous studies have documented that parents' absence affects boys and girls differently, with girls consistently more vulnerable than boys (Li et al., 2015; Salloum et al., 2017). In addition, parental migration appears to affect younger children and only-children to a greater extent than older children or children with siblings (Tang et al., 2018a,b). Who takes care of the left-behind child (Tang et al., 2018a,b) and how long the child remains separated from the parent(s) (Xu et al., 2018) also affect risk of mental health problems in the child.

Here we analyze the influence of the double risk factors of being left behind and of being exposed to up to two major earthquakes in a unique student population in China. We wanted to test the idea, suggested from earlier studies, that PTSD is the most likely mental health disease after an earthquake (Galea et al., 2016), while depression is the most common mental illness of left-behind children (He et al., 2012). We also wanted to verify and extend previous studies examining how PTSD and depression depend on gender, age, level of earthquake exposure, frequency of traumatic events, duration of being left behind, and type of caregiver.

2. Methods

2.1. Participants

We conducted a cross-sectional survey in the cities of Lushan, Baoxing and Tianquan 3 years after the Lushan earthquake. A total of 2956 students were recruited from cities heavily damaged in the 2008 and 2013 earthquakes. In the end, 2447 completed questionnaires (response rate, 82.8%) were included in the analysis, comprising 898 questionnaires from Lushan, 800 from Baoxing, and 749 from Tianquan (Fig. 1). Lushan and Baoxing were heavily damaged in the Lushan earthquake, while Tianquan was only moderately damaged. In the earlier Wenchuan earthquake, Lushan was heavily damaged, while Baoxing and Tianquan were moderately damaged. All three cities are situated in remote rural areas and have substantial proportions of left-behind children. As a result, we expected to be able to sample large numbers of students who had been exposed to at least one major earthquake and who had experienced being left behind. The Ministry of Education approved the study and permitted the involvement of junior and senior high school students. The head masters of the schools also gave their approval for the study, and the students themselves as well as their legal guardians gave informed consent.

In order to ensure that all participants in our study had experienced at least one earthquake, we stipulated exposure to the Lushan earthquake, but not the Wenchuan earthquake, as an inclusion criterion. This is because when parents move to cities from the countryside for work, they often take their children with them but then send them back to the countryside when they are older (Su et al., 2013). We assumed that our survey was sufficiently soon after the Lushan earthquake that nearly all children in the three cities had been exposed to it. However, we considered it likely that a substantial proportion of children who had experienced the Wenchuan earthquake had already moved back to the countryside by the time of our survey. Students were also excluded if (a) their assessment for possible PTSD or depression symptoms was incomplete; (b) they were younger than 5 years old at the time of the Wenchuan earthquake, since we judged that they would be unlikely to remember the traumatic experience; or (c) they were no longer adolescents at the time of the Lushan earthquake. Therefore, participants had to be aged 13–18 years.

2.2. Procedures

Participants were recruited with the cooperation of the Bureaus of Education in Lushan, Baoxing and Tianquan in order to gain access to a representative sample of adolescent students in those cities. A survey team was formed from psychology teachers and psychology graduate students. After a week of training at West China School of Public Health at Sichuan University, the survey team stayed in the earthquake-struck area between April 25 and 29, 2016, approximately 36 months after the Lushan earthquake. The sampling methods are as follows: firstly, this research was approved by the Ministry of Education, and then through the discussion and analysis of experts from the Ministry of Education and the survey team, representative schools were selected. The predefined plan was to include four schools in Lushan, four in Baoxing and three in Tianquan. Next, among these schools, grades with the majority of the students are between 13 and 18 years old were selected. Students in grades 1–2 in junior middle school and grades 1–2 in senior high school were eligible. (The Ministry of Education did not allow participation by students in grade 3 because they were facing pressures to enter university.) Finally, questionnaires were distributed to students in the classes of these grades.

An assessment questionnaire, described in the next section, was designed based on literature review and input from psychiatrists. All study investigators reviewed the measures and came to an agreement on how to describe each item to respondents. Potentially confusing items were replaced with the most equivalent expression in the local dialect.

2.3. Measures

The first part of the questionnaire gathered basic demographic information including age, gender, home, school, grades, only-child status, left-behind status, caregiver's type, and earthquake exposure. Children were defined as "left behind" if they were left by one or both parents for periods of at least 6 months per year; otherwise, they were classified as "not left behind". The second part of the questionnaire included the Children's Revised Impact of Event Scale (CRIES-13) and the Depression Self-Rating Scale (KADS-6), which were used to assess depression and PTSD symptoms over the preceding month.

2.3.1. PTSD

PTSD symptoms were assessed using CRIES-13, a newly developed 13-item scale adapted from the IES-8 (Perrin et al., 2005). This self-report scale has been extensively validated in studies of adolescents in the aftermath of the Wenchuan earthquake (Lau et al., 2013; Zhang et al., 2011) and may even be more useful than the CRIES-8 (Dow et al., 2012; Verlinden et al., 2014). The scale was designed specifically for the screening and assessment of PTSD severity in children and adolescents, not for formal diagnosis of a mental health disorder. Each question is answered on a 4-point scale (never—0 point, very few—1 point, sometimes—3 points, often—5 points) with no reversed items. The total score (from 0 to 65) indicates severity of post-traumatic stress reactions; scores higher than 30 indicate that the individual is more seriously affected by stress and so may require further assessment and monitoring, although the individual may not necessarily suffer from PTSD. The scale has demonstrated satisfactory internal consistency, good convergent validity and good reliability (Perrin et al., 2005; Lau et al., 2013). The Chinese version of the CRIES is valid and reliable for assessing PTSD symptoms among Chinese adolescents who experienced the 2008 Wenchuan earthquake (Lau et al., 2013). In a sample of Chinese primary school children, the scale reported a Cronbach α of 0.84 (Chen et al., 1995). In the current study, Cronbach's α for all items was 0.88.

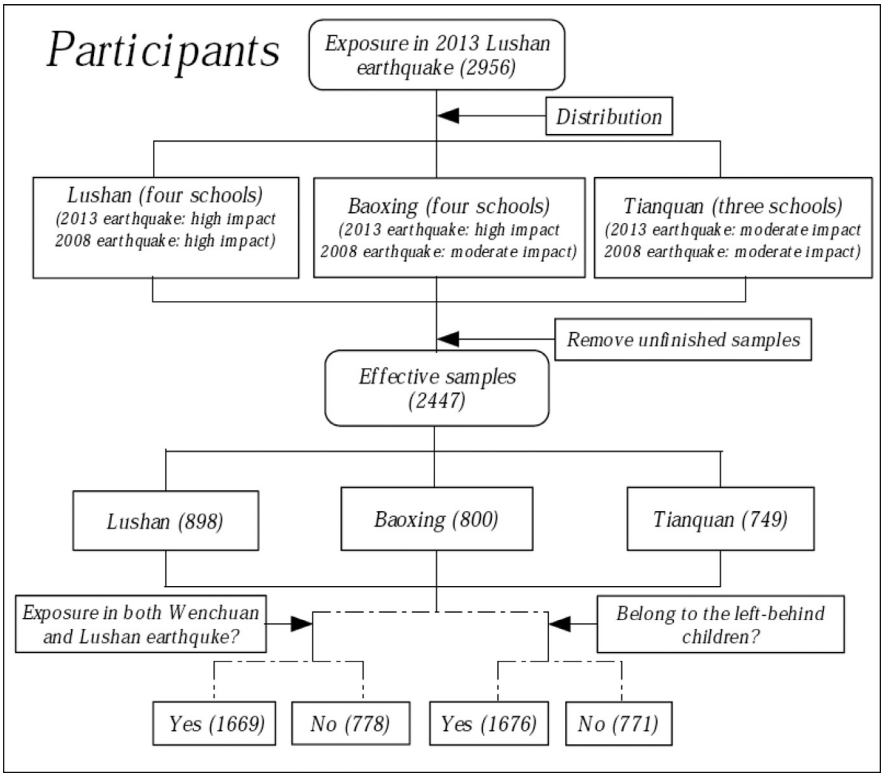

Fig. 1. Sample information.

2.3.2. Depression

Depression severity was measured using the 6-item KADS-6 (Messer et al., 1995), which largely focuses on selected or clinical samples of children or adolescents (Kutcher and Chehi, 2007). The total score ranges from 0 to 18, and the cut-off score is 6. Because the KADS-6 is intended for screening purposes and is not intended for formal diagnosis, the cut-off score serves only to identify children who may require further assessment and monitoring, though they may not necessarily suffer depression. This instrument has been found to have sensitivity of 0.92 and specificity of 0.71, making it efficient and effective for identifying major depressive episodes in adolescents (Leblanc et al., 2002). In the present study, Cronbach's alpha was 0.92.

2.4. Statistical analysis

All statistical procedures were performed using SPSS 17.0 (IBM, Chicago, IL, USA). Simple descriptive statistics such as frequencies, numbers and proportions were reported when appropriate. One-way ANOVA was used to examine associations between categorical variables. Differences in prevalence of probable PTSD or depression between children exposed to one or both earthquakes or between children left behind and not left behind were explored using the chi-squared test. Multiple hierarchical linear regression was performed to examine association between each potential risk factor and severity of PTSD (based on CRIES-13 score) or of depression (KADS-6 score). Significance was defined as $p < 0.05$.

2.5. Ethical standards

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 Bureaus of Lushan, Tianquan, and Baoxing. The study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. In accordance with Chinese law, consent for this study was obtained from the subjects themselves, their legal guardians, 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 withdraw from the study at any time without penalty. Subjects were told that their responses and scores would remain anonymous.

3. Results

In the total sample, 1676 (68.5%) were left-behind children. Descriptive statistics of the overall sample can be seen in Table 1. Most children (1669, 68.20%) were exposed to both the Wenchuan and Lushan earthquakes, while the remaining 778 (31.80%) were exposed only to the Lushan earthquake. Age ranged from 13 to 18 years, and mean age was 15.05 year (SD 1.488). There was a preponderance of females (1409, 57.60%) over males (1038, 42.40%).

Mean PTSD and depression scores were compared between left-behind children and children not left behind (Table 2). Among left-behind children, females showed a significantly higher PTSD score than males (16.44 *vs* 13.49, $p < 0.001$) and significantly higher depression score (5.64 *vs* 4.62, $p < 0.001$). Similar results were observed among children not left behind: PTSD, 14.45 *vs* 10.9 ($p < 0.001$); depression, 5.02 *vs* 4.27 ($p = 0.008$). Among left-behind children, only-child status did not significantly influence PTSD score ($p = 0.245$) or depression ($p = 0.087$). Similar results were observed among children not left behind (PTSD, $p = 0.079$; depression, $p = 0.135$). PTSD score did not vary significantly with age among left-behind children ($p = 0.057$) or children not left behind ($p = 0.116$). In contrast, depression score did vary significantly with age among left-behind children ($p = 0.002$) and children not left behind ($p = 0.008$). Duration of being left behind did not influence PTSD score among left-behind children ($p = 0.298$) or children not left behind ($p = 0.310$). Duration did, however, influence depression score among left-behind children ($p = 0.009$) and children not left behind ($p = 0.002$). Among left-behind children, type of caregiver influenced PTSD score ($p = 0.010$) and depression score

Table 1
Demographic data of the study population.

	Total (2447)		Left-behind children (1676)		Children not left behind (771)	
	n	%	*n*	%	*n*	%
Gender						
Female	1409	57.6%	996	59.5%	413	53.6%
Male	1038	42.4%	680	40.5%	358	46.4%
Only Child						
Yes	470	19.2%	302	18.1%	168	21.8%
No	1977	80.8%	1374	81.9%	603	78.2%
Age, year						
13	408	16.7%	258	15.4%	150	19.4%
14	649	26.5%	363	21.6%	286	37.0%
15	431	17.6%	300	17.9%	131	17.1%
16	498	20.3%	396	23.7%	102	13.2%
17	302	12.4%	240	14.3%	62	8.1%
18	159	6.5%	119	7.1%	40	5.2%
Duration of being left behind						
Never	514	21%	–	–	514	66.7%
<6 months	257	10.5%	–	–	257	33.3%
6 months–1 year	732	29.9%	732	43.6%	–	–
1 year–2 years	504	20.6%	504	30.2%	–	–
2 years–3 years	145	5.9%	145	8.6%	–	–
+3 years	295	12.1%	295	17.6%	–	–
Caregiver type						
Parent	1499	61.3%	832	49.6%	667	86.5%
Grandparent	760	31%	694	41.4%	66	8.5%
Other	97	4%	79	4.7%	18	2.4%
Living alone	91	3.7%	71	4.3%	20	2.6%
Level of impact (city)						
Lushan	898	36.7%	630	37.6%	268	34.8%
Baoxing	800	32.7%	557	33.2%	243	31.5%
Tianquan	749	30.6%	489	29.2%	260	33.7%
Earthquake exposure						
Wenchuan and Lushan	1669	68.2%	1084	64.7%	585	75.9%
Lushan	778	31.8%	592	35.3%	186	24.1%

($p = 0.001$). Among children not left behind, type of caregiver did not influence either PTSD score ($p = 0.414$) or depression ($p = 0.126$). Among left-behind children, level of earthquake exposure (captured in the *city* variable) influenced PTSD score ($p < 0.001$) and depression score ($p = 0.030$). Similar results were observed among children not left behind (PTSD, $p < 0.001$; depression, $p = 0.043$). Among left-behind children, those who experienced both the Wenchuan and Lushan earthquakes showed significantly higher PTSD scores than those who experienced only the Lushan earthquake (15.85 *vs* 11.24, $p < 0.001$), as well as significantly higher depression scores (5.35 *vs* 4.37, $p < 0.001$). Similar results were observed among children not left behind (PTSD, 14.78 *vs* 10.68, $p < 0.001$; depression, 5.27 *vs* 4.26, $p < 0.001$).

Prevalence of probable PTSD was 21.7% among all subjects, 23.7% among left-behind children, and 17.4% among children not left behind (Table 3). Prevalence was significantly higher among left-behind children than among children not left behind ($\chi^2 = 12.364$, $p < 0.001$). In addition, prevalence was higher among children exposed to both the Wenchuan and Lushan earthquakes than to only the Lushan earthquake, regardless of whether the sample was all subjects (23.8% *vs* 17.2%; $\chi^2 = 13.452$, $p < 0.001$), left-behind children (25.9% *vs* 19.6%; $\chi^2 = 8.482$, $p < 0.01$), or children not left behind (19.8% *vs* 9.7%; $\chi^2 = 10.129$, $p < 0.001$).

Prevalence of probable depression was 31.6% among all subjects, 35.9% among left-behind children, and 22.2% among children not left behind. Prevalence was significantly higher among left-behind children than among children not left behind ($\chi^2 = 46.131$, $p < 0.001$). As with PTSD, prevalence of probable depression was significantly higher among children exposed to both earthquakes than among those exposed only to the Lushan earthquake, whether the sample was all subjects (33.8% *vs* 26.9%; $\chi^2 = 11.789$, $p < 0.001$), left-behind children (38.9% *vs* 30.4%; $\chi^2 = 12.088$, $p < 0.001$), or children not left behind (24.3% *vs* 15.6%; $\chi^2 = 6.163$, $p < 0.05$).

Hierarchical regression analyses were performed using PTSD and depression scores as dependent variables (Table 4). Demographic characteristics explained 3.7% of variation in PTSD score ($\Delta R^2 = 0.037$, $p < 0.01$) and 4.3% of variation in depression score ($\Delta R^2 = 0.043$, $p < 0.01$). Different types of earthquake exposure accounted for 18.2% of variation in PTSD score ($\Delta R^2 = 0.182$, $p < 0.001$) and 12.5% of variation in depression score ($\Delta R^2 = 0.125$, $p < 0.001$). Items related to being left behind accounted for 11.3% of variation in PTSD score ($\Delta R^2 = 0.113$, $p < 0.001$) and 17.9% of variation in depression score ($\Delta R^2 = 0.179$, $p < 0.001$). These results identified earthquake exposure as the strongest factor contributing to PTSD, and being left behind as the strongest factor contributing to depression.

4. Discussion

This study examined PTSD and depression in a unique population of young people, most of whom were "left behind" by one or both parents in search of urban job opportunities and most of whom experienced two major earthquakes within just five years. Many in this population are likely to have experienced physical and/or psychological trauma. The fact that just over 30% of our sample did not experience the earlier Wenchuan earthquake but did experience the Lushan earthquake reflects the fact that many farmers in China bring their small children with them when they migrate to cities, then they send the older children back to the countryside to be taken care of by grandparents or other relatives (Fan et al., 2010; Xu et al., 2018).

We found in this study that PTSD and depression outcomes differed depending on the child's gender, with females being more vulnerable to negative outcomes than males. This is in line with previous findings (He et al., 2012; Pascual et al., 2012) with studies suggesting that females are at higher risk of mental health problems (Pascual et al., 2012; Ying et al., 2013). The greater vulnerability of females may reflect the fact that in the remote, mountainous study area, traditional culture leads families and society to pay less attention to girls than boys. This can mean that girls perceive less love and attention from their parents, leading them to be easily confused and to experience negative emotions when faced with difficulties. The greater vulnerability of females in our study may also reflect that many students experienced two earthquakes, and girls are more fearful when they face the same trauma again (Breslau et al., 2008). Girls are more vulnerable than boys to negative effects of parents' absence (Li et al., 2015). Such gender effects may reflect that females are more responsive to stress and perceive threats more strongly than males (Dedovic et al., 2009).

We found that age was not a significant contributor to PTSD in left-behind children or children not left behind. In contrast, age was a significant contributor to depression, and older age was associated with higher scores on the depression measure. This contrasts with a previous result that younger age is associated with greater susceptibility to negative outcomes related to parental migration (Tang et al., 2018a,b). Several factors may account for the apparent difference in how age influences PTSD or depression. Previous work (Giannopoulou et al., 2006) and our hierarchical regression analysis (Table 4) suggest that major trauma such as earthquakes are more likely to lead to PTSD than to depression. Depression, in contrast, seems to be arising from the cumulative effect of trauma (Chen et al., 1995). Neglect, such as among left-behind children, is likely to have cumulative effects on children as they grow up (Zhou et al., 2016). Younger children may also be less susceptible to depression because they are less capable of understanding parent-child separation or of dwelling on negative events in life (Fan et al., 2010; Wang et al., 2015). This may lead to lack of psychological stress, which in turn is associated with fewer mental problems (Matvienko-Sikar and Dockray, 2017).

PTSD and depression scores were highest among our students from Lushan, which the Wenchuan and Lushan earthquakes damaged to a

Table 2
Mean scores of PTSD and depression symptoms among left-behind children and children not left behind.

	Left-behind children				Children not left behind			
	PTSD		Depression		PTSD		Depression	
	Mean (*SD*)	*p* value	Mean (*SD*)	*p* value	Mean (*SD*)	*p* value	Mean (*SD*)	*p* value
Gender		***		***		***		0.008**
Female	16.44 (13.103)		5.64 (1.743)		14.45 (12.374)		5.02 (1.459)	
Male	13.49 (13.158)		4.62 (1.782)		10.90 (11.298)		4.27 (1.548)	
Only Child		0.245		0.087		0.079		0.135
Yes	14.44 (12.104)		4.86 (1.125)		11.36 (12.332)		4.63 (1.561)	
No	15.42 (11.116)		4.19 (1.321)		13.20 (11.898)		4.16 (1.558)	
Age, year		0.057		0.002**		0.116		0.008**
13	13.78 (10.865)		4.06 (0.963)		10.47 (11.722)		3.67 (0.720)	
14	13.80 (11.835)		4.74(1.052)		12.92 (12.104)		4.58 (0.873)	
15	14.82 (14.185)		4.67 (0.919)		12.91 (12.302)		4.63 (0.660)	
16	16.27 (13.688)		4.87(0.806)		14.09 (11.511)		4.82 (0.636)	
17	16.54 (13.391)		5.04 (0.804)		14.37 (12.451)		4.98 (0.641)	
18	17.61 (14.628)		5.38 (0.788)		14.63 (11.370)		5.17 (0.564)	
Duration of being left behind		0.298		0.009**		0.31		0.002**
None	–		–		12.01 (11.716)		3.18 (1.512)	
<6 months	–		–		14.38 (12.451)		4.03 (1.695)	
6 months–1 year	14.73 (12.509)		4.34 (1.852)		–		–	
1 year–2 years	15.20 (12.992)		4.57 (1.808)		–		–	
2 years–3 years	15.44 (13.185)		4.83 (1.538)		–		–	
>3 years	16.47 (15.090)		5.55 (1.645)		–		–	
Caregiver type		0.01**		0.001***		0.414		0.126
Parent	14.58 (13.081)		4.10 (1.922)		12.55 (11.997)		3.68 (1.566)	
Grandparent	15.41 (13.238)		4.38 (1.663)		13.89 (10.664)		3.72 (1.744)	
Other	19.53 (13.066)		5.37 (2.033)		14.00 (13.933)		4.09 (1.779)	
Living alone	16.59 (13.621)		4.81 (1.916)		16.45 (14.684)		3.65 (1.531)	
Level of impact (cities)		***		0.03*		***		0.043*
Lushan	16.36 (13.023)		5.05 (0.954)		14.98 (11.327)		5.02 (1.538)	
Baoxing	14.67 (12.464)		4.66 (1.637)		12.59 (10.823)		4.57 (1.236)	
Tianquan	13.02 (10.528)		4.35 (1.696)		11.21 (9.596)		4.26 (1.723)	
Earthquake exposure		***		***		***		***
Wenchuan and Lushan	15.85 (13.225)		5.35 (1.798)		14.78 (12.338)		5.27 (1.551)	
Lushan	11.24 (10.345)		4.37 (1.800)		10.68 (11.971)		4.26 (1.489)	

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

greater extent than the other two cities in our sample. These results are consistent with other studies indicating a relationship between the magnitude of disaster impact and severity of PTSD symptoms and depression symptoms, including among children and adolescents (Goenjian et al., 2001; Zhang et al., 2012; Xu et al., 2018). Consistent with this idea, we found that students in our study who experienced both the Wenchuan and Lushan earthquakes showed higher PTSD and depression prevalence than students who experienced only the Lushan earthquake. This may reflect the effect of residual negative feelings from the earlier Wenchuan earthquake. Children and adolescents experiencing repeated trauma report more severe emotional and behavioral problems than children experiencing no or one trauma (Carlson, 1991; Neuner et al., 2006). Indeed, the frequency of trauma events influences the risk of psychological problems (Breslau et al., 2008).

We found that left-behind children in our study showed more serious PTSD and depression than children not left behind, consistent with previous studies (Xu et al., 2018; Graham and Jordan, 2011; Su et al., 2013). Clearly, parental migration increases risk of several negative life events, including physical abuse, emotional neglect and exploitation (Graham and Jordan, 2011; Jin et al., 2017). In the absence of the parent(s), left-behind children must adapt to the change in the family structure and must deal with emotional difficulties related to separation from parents and inadequate parental care (Xu et al., 2018). In the long term, the combination of separation from parent(s), inadequate family supervision and inadequate emotional care greatly impact life quality as well as physical and psychological well-being as left-behind children grow up (Su et al., 2013; Plass-Christl et al., 2017). Many previous studies have documented that depression is the most common mental illness among left-behind children (He et al., 2012; Li et al., 2015; Ling et al., 2015), and that the duration of the separation plays an important role (Ling et al., 2015; Cheng and Sun, 2015). In the present study, the duration of being left behind did not significantly influence PTSD symptoms, but it did influence depression symptoms: longer time left behind was associated with more severe depression symptoms (table 2). The type of caregiver for students in our sample did not appear to significantly affect PTSD or depression severity among children not left behind; however, among left-behind children, having caregivers who were other types of caregivers (except parents and grandparents) was associated with higher PTSD and depression scores than living alone. This is in line with previous studies (Li et al., 2015; Xu et al., 2018). The influence of caregiver type on left-behind children may reflect that non-parental caregivers often have their own children and cannot provide adequate attention to the left-behind child. It may also reflect that such caregivers are more likely to exploit left-behind children to do farm work. Most left-behind children are left in the care of grandparents, which may mitigate the negative impacts of parental absence, but this can still disrupt the child-parent attachment (Poehlmann, 2003). Future research should examine in greater depth the relationship between type of caregiver and PTSD or depression severity in children.

Our hierarchical regression analysis identified earthquake exposure as the strongest explanatory variable in the PTSD model, whereas being left behind was the strongest explanatory variable in the depression model. These results are consistent with the idea that PTSD is the primary mental disease following earthquake trauma (Zhang et al., 2012), while depression is the most common mental problem among left-behind children (Cheng and Sun, 2015). It is intriguing that PTSD in our study correlated strongly with "unintentional" (and repeated) natural trauma (earthquake exposure), whereas depression was more related to "intentional" trauma in daily life (being left behind by parents). Future studies should confirm and extend this observation while also investigating variables contributing to both disorders. Several studies suggest that PTSD and depression symptoms are strongly inter-

Table 3
Estimated prevalence of probable PTSD and depression.

	All subjects (2447)			Left-behind children(1676)			Children not left behind (771)			$\chi 2$
Probable disorder (above cut-off score)	Exposure to Wenchuan and Lushan (1669)	Exposure to Lushan only (778)	$\chi 2$	Exposure to Wenchuan and Lushan (1084)	Exposure to Lushan only (592)	$\chi 2$	Exposure to Wenchuan and Lushan (585)	Exposure to Lushan only (186)	$\chi 2$	
PTSD (score ≥ 30)	531(21.7%)			397 (23.7%)			134 (17.4%)			12.364***
	397 (23.8%)	134 (17.2%)	13.452***	281 (25.9%)	116 (19.6%)	8.482**	116 (19.8%)	18 (9.7%)	10.129***	
Depression (score ≥ 6)	773 (31.6%)			602 (35.9%)			171 (22.2%)			46.131***
	564 (33.8%)	209 (26.9%)	11.789***	422 (38.9%)	180 (30.4%)	12.088***	142 (24.3%)	29 (15.6%)	6.163*	

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

correlated (Tural et al., 2012; Kilpatrick et al., 2003; Goenjian et al., 1995) and that variables associated with one disorder are often associated with the other as well (Zhang et al., 2012; Roussos et al., 2005). One study also documented that depression and associated negative cognitions related to depression are actually predictive of later acute PTSD symptomology following a traumatic event or cumulative trauma (Su and Chen, 2018). In other words, those who have negative cognitions, prior to exposure to trauma, may be more likely to be affected by trauma and suffer the effects of PTSD. Therefore, as part of prevention efforts, working with children who are left behind and teaching them positive and proactive adaptive coping skills to reduce depression may help reduce PTSD symptomology when and if an earthquake or other disaster occurs.

4.1. Strengths and limitations

This is, to our knowledge, the first analysis of a population vulnerable to being left behind by migrating parents and exposed to two major earthquakes. It is also one of the few studies to examine how these two attributes influence PTSD and depression. At the same time, the study has some limitations. We were not permitted to analyze older students, and our age range (13–18 years) was quite narrow because we restricted participants to those who could have had childhood/adolescent memories of the Wenchuan and Lushan earthquakes. Second, we analyzed only adolescents who were in school, raising the possibility that our results cannot be generalized to adolescents not enrolled in schools, which may be an appreciable population given that education in China is compulsory only until the age of 17 years. Third, we did not collect data on socio-economic status of caregivers. Fourth, while our large sample likely helped us robustly detect strong associations and differences, it may also have magnified relatively small associations and differences that are not meaningful in practice (Thompson, 2002). In the end, our findings should serve only as guidelines for future research and intervention efforts.

4.2. Conclusions

Left-behind children in the Longmenshan seismic fault zone show more severe PTSD and depression than children not left-behind, and the severity of depression increases with longer separation from parents. The severity of depression increases when the left-behind child's caregiver is someone other than the parent or grandparent. PTSD and depression are also more serious among those who experienced both Wenchuan and Lushan earthquakes than among those who experienced only the Lushan earthquake. In addition, living in cities more severely damaged by earthquakes was associated with more severe mental problems. Our results suggest that earthquake trauma is a strong predictor of PTSD, whereas being left behind is a strong predictor of depression. Further studies are needed to verify that "unintentional" (and repeated) natural trauma is the main factor leading to PTSD, while "intentional" trauma in passive life events are the main factors that cause depression.

Our findings argue for greater governmental intervention to rebuild the Longmenshan seismic fault zone. They suggest that school teachers should pay more attention to this particularly vulnerable group. Finally, our analysis highlights the importance for parents to communicate and spend more time with their children.

Acknowledgments

The research is supported by the Propaganda Department of the People's Republic of China (no. 2016zybw03) and the Major Bidding Program of the National Social Science Foundation of China (no. 17ZDA286) and the Fundamental Research Funds for the Central Universities (no. LH2018013).

Table 4
Analysis of potential factors affecting PTSD and depression scores.

Variable	PTSD Beta	ΔR^2	R^2	Depression Beta	ΔR^2	R^2
Step 1: Demographic statistics		0.037*	0.037*		0.043**	0.043**
Gender	2.812**			2.157**		
Age	0.304			1.043*		
Only child	−0.243			−0.031		
Step 2: Earthquake		0.182***	0.219***		0.125***	0.168***
Earthquake exposure	5.052***			2.199**		
Level of impact (city)	1.163**			1.002*		
Step 3: Left-behind status		0.113***	0.332***		0.179***	0.347***
Duration of being left behind	0.983			2.091**		
Caregiver type	2.128**			2.078**		

Beta = standardized coefficients derived from the final step; R^2 = explanation rate; ΔR^2 = change in explanation rate in each step.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Conflicts of interest

Jiuping Xu declares that he has no conflicts of interest. Yan Wang declares that she has no conflicts of interest. Jingdong Zhao declares that he has no conflicts of interest. Wanjie Tang declares that he has no conflicts of interest. Yi Lu declares that he has no conflicts of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2019.01.109.

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