Original Article

One-year follow-up study of post-traumatic stress disorder among adolescents following the Wen-Chuan earthquake in China

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Summary **Post-traumatic stress disorder (PTSD) is the most common psychological disorder among victims of natural disasters. PTSD prevalence and risk factors among adolescents remain unidentified among victims of the Wen-Chuan earthquake. This study screened survivors to determine the prevalence of PTSD and examined risk factors for PTSD among adolescents at three Wen-Chuan secondary schools. PTSD screening was done using the PTSD Checklist-Civilian version (PCL-C). A generalized estimating equation approach was used to control for repeated measurements in the same individuals and to predict risk factors for PTSD. The study included 1,474 students in grades 7, 8, 10 and 11 from three Wen-Chuan secondary schools at 4, 6, 9, and 12 months after the earthquake. The average age of students was 15.0 (13.0, 16.0) both at the first and the second time point, and 16.0 (14.0, 17.0) at the third and the fourth time point. The screened prevalence of PTSD was 11.2%, 8.8%, 6.8% and 5.7% at 4, 6, 9, and 12 months after the earthquake, respectively. Risk factors for PTSD were: time duration, school location (the proximity of epicenter), grade, nationality, parent injury, and severe property damage. In conclusion, PTSD risk factors are in accordance with previous studies; however, the role of nationality and time duration in post-traumatic stress disorder merits further research.**

Keywords: Post-traumatic stress disorder, earthquake, adolescents, risk factor, generalized estimating equations

1. Introduction

On May 12, 2008, an earthquake measuring 8.0 on the Richter Scale struck Wen-Chuan County, Sichuan, China, leading to 69,226 deaths and 374,643 injured, with 17,923 listed as missing up to September 11, 2008 (*1*). The earthquake not only caused tremendous damage to people's physical health, but also had deleterious consequences for psychological health. The effects on mental health, which often persist long after the disaster, have been shown to vary according to individuals' exposure to, and experiences emanating from, the event. Studies have also indicated that these effects can depend upon various socio-demographic characteristics such as age and gender (*2*). Previous epidemiological studies have explored the psychological well-being of seismic victims (*3,4*). It has been shown that after a natural disaster such as an earthquake survivors are susceptible to post-traumatic stress disorder (PTSD) (*5,6*), the most common psychiatric condition seen among earthquake survivors (*7-9*). Previous investigations have examined post-traumatic stress disorder among survivors after the Wen-Chuan earthquake. Few studies, however, have included large representative samples of secondary school students.

This study examined the prevalence of PTSD among adolescents as well as socio-demographic and post-earthquake variables associated with PTSD, especially the time factor in the trajectory of PTSD.

2. Materials and Methods

2.1. *Subjects*

The study used cluster sampling. We selected all the students from grades 7, 8, 10, and 11 in three secondary

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schools (Wei-Zhou, Mian-Chi, Qi-Pan-Gou) originally located in Wen-Chuan County, who resumed their classes in the suburbs of Cheng-Du City after the disastrous earthquake. Grades 9 and 12 were excluded due to the pressures of entering middle school and college. We conducted the baseline survey at about 4 months after the earthquake and follow-up surveys at 6, 9, and 12 months after the earthquake. Students who transferred from other schools after the Wen-Chuan earthquake were excluded. These investigations, with the class as the unit, were conducted by eight well-trained and experienced investigators with training in epidemiology who received unified training about how to explain items in self-administered questionnaires and to keep students from talking to each other when filling out the questionnaire. The investigation process took about thirty minutes per class.

2.2. *Measures*

In the baseline study, background data such as gender, nationality, place of residence before earthquake, personal and parent injury, hospitalization, and severe property damage in earthquake were collected; the PTSD instrument used in the study was the PTSD Checklist-Civilian version (PCL-C). The same PTSD instrument was used in follow-up studies.

The PTSD Checklist-Civilian version (PCL-C) (*10*) is a 17-item self-reported rating-scale instrument ranging from 1 (not at all) to 5 (extremely) that measures symptoms of PTSD in the past month. The PCL parallels diagnostic Criteria B, C, and D for PTSD, as delineated in the DSM-IV (*11*). There are two alternative ways of PCL scoring: one is based on endorsement (a symptom rating of at least 3) of one or more "reexperiencing" symptoms (items 1-5), three "avoidance" symptoms (items 6-12), and two "arousal" symptoms (items 13-17); the other, the most commonly used method of scoring, involves summing the responses from the 17 items yielding a score ranging from 17 to 85 and selecting a cutoff within this range. A cutoff of either 48 or 50 resulted in an estimated prevalence of PTSD that matches the true prevalence most closely (*12*). A score of 50 is considered the optimally efficient PTSD cutoff score which provides good diagnostic sensitivity (0.82) and specificity (0.83), with a kappa coefficient of 0.64 (*13,14*). Several psychometric studies have supported the reliability and validity of the PCL with a variety of samples (*10,15,16*), and the PCL has been previously used with adolescents (*17-19*), which is an indication of its support in this study group.

2.3. *Statistical analysis*

The data were analyzed on a personal computer with SAS software (version 9.1, SAS Institute, Inc., Cary,

NC). Missing values were compensated by using the average score of each symptom if only 1 or 2 items were missing; data were considered invalid if 3 or more items were missing. Variables were tested for normal distribution. All values were reported as medians for partially distributed variables. All *p* values were two-sided; a *p* value < 0.05 was considered statistically significant.

In the first step, we tested whether PTSD or other demographic variables were predictive of dropout, to find out whether there were any sample differences between the baseline and follow-up investigations which would have impacts on data analysis. Using logistic regression, we ran separate models for each predictor and adjusted for drop-out status (drop-out or follow-up) on sex, grade, nationality, residence, personal injury, personal hospitalization, parent injury, severe property damage, and PTSD (a total PCL-C score of > 50 was encoded as 1, < 50 as 0).

The impact of several variables on PTSD was analyzed using regression modeling by a generalized estimating equation to control for repeated measurements in the same individuals. Analyses were conducted in the GENMOD procedure, with logit link and an autoregressive correlation matrix. Ten variables were entered into GEE: time point (1, 2, 3, 4), school location (Wei-Zhou, Mian-Chi, Qi-Pan-Gou), grade (7th, 8th, 10th, 11th), gender (male, female), nationality (Han, Minorities), residence (urban, rural), personal injury (yes/no), personal hospitalization (yes/no), parent injury (yes/no), and severe property damage (yes/no).

3. Results

3.1. *Study population*

Overall, 1,966 students were eligible to participate; 1,966, 1,928 (98.1%), 1,823 (92.7%) and 1,842 (93.7%) questionnaires were received respectively at 4, 6, 9, and 12 months after the earthquake, of which 1,960 (99.7%), 1,925 (99.8%), 1,511 (82.9%) and 1,840 (99.9%) were valid; 1,490 (75.9%) students completed all four questionnaires and 1,474 were valid (some students did not complete all four questionnaires due to sick leave or home visits at the time of the investigation). Tests of normal distribution showed that age was partially normally distributed; thus the median (QL, QU) was used to describe the distribution. The students' average age was 15.0 (13.0, 16.0) both at the first and the second time point, and 16.0 (14.0, 17.0) at the third and the fourth time point. Demographic characteristics of subjects are summarized in Table 1.

3.2. *Dropout analysis*

To determine the extent to which baseline measures predicted subsequent attrition, a dichotomous indicator

Table 1. Socio-demographic characteristics of subjects

Characteristic	No.	Proportion (%)
Gender		
Male	663	45.0
Female	811	55.0
School location		
Wei-Zhou	907	61.5
Mian-Chi	249	16.9
Qi-Pan-Gou	318	21.6
Grade		
7th	391	26.5
8th	262	17.8
10th	390	26.5
11th	431	29.2
Nationality		
Han	175	11.9
Minorities	1,299	88.1
Residence		
Urban	639	43.4
Rural	835	56.6
Personal injury		
Yes	69	4.7
No	1,405	95.3
Personal hospitalization		
Yes	14	0.9
No	1,460	99.1
Parent injury		
Yes	153	10.4
No	1,321	89.6
Severe property damage[*]		
Yes	1,254	85.1
No	220	14.9
Total	1,474	100

[*]Severe property damage refers to: a, place of residence rendered uninhabitable by damage or demolition; or b, major loss of money or destruction of expensive appliances in the earthquake.

of dropout was created, and logistic regression was used. None of the predictors approached statistical significance ($p > 0.05$).

3.3. *PTSD prevalence and risk factors*

The proportion of participants who met screening criteria (50-point cutoff) for PTSD was calculated: it was 11.2% ($n = 165$) of students in the baseline study, 8.8% ($n = 129$) at 6-month follow-up, 6.8% ($n = 100$) at 9-month follow-up, and 5.7% ($n = 84$) at 12-month follow-up.

By means of a generalized estimating equation, the positive rate of PTSD at time point 1 (OR = 2.13, 95% CI = 1.66-2.73) and time point 2 (OR = 1.6, 95% CI = 1.27-2.02) were found to be significantly different compared with time point 4, as shown in Table 2; no statistical significance was found between rates at time points 3 and 4 ($p > 0.05$). Students in Mian-Chi Secondary School had higher odds of PTSD (OR = 3.16,

95% CI = 2.01-4.97). Students in the 8th, 10th, and 11th grade all had higher odds of PTSD than students in the 7th grade; in the 10th grade, values were the highest (OR = 3.08, 95% CI = 1.48-6.43). Students who belonged to minorities (OR = 1.77, 95% CI = 1.06-2.94), whose parent was injured (OR = 1.67, 95% CI = 1.14-2.45), or whose parent suffered severe property damage (OR = 2.12, 95% CI = 1.21-3.72) were more likely to be found through screening to have PTSD. Associations among variables such as gender, residence, personal injury, and personal hospitalization showed no statistical significance ($p > 0.05$).

4. Discussion

4.1. *PTSD prevalence and time as a risk factor*

Current estimates of the prevalence of PTSD in trauma populations are highly diverse: some illustrative figures range from 5% to 8% among victims of some natural disasters (*20*). The prevalence of PTSD among Chi-Chi earthquake survivors decreased from 8.3% at 6 months to 4.2% at 3 years after the earthquake (*21*). In this study, the prevalence of PTSD was 11.2%, 8.8%, 6.8%, and 5.7% at 4, 6, 9, and 12 months after the earthquake, respectively. However, the PTSD prevalence was lower than in other studies; this is presumably due mainly to diverging focuses on different categories of victims or the use of different instruments to measure PTSD (*22,23*). By choosing the cutoff of 50, the estimated prevalence of PTSD in our study may be closest to the actual prevalence, according to Artin Terhakopian's research (*12*).

Adolescents had relatively high chances of suffering PTSD proximately, that is, four months after the earthquake, with an OR of 2.13; the OR of PTSD six months after the earthquake was 1.6, and 1.2 nine months after the earthquake. Although no statistical significance was found at the 9th month compared to the other time points, we found that the prevalence of PTSD in secondary school students declined in this one-year follow-up study, and this decrease slowed as time went by. Previous studies indicate that most cases of spontaneous recovery from PTSD occur within the first year following exposure to the traumatic event, whereas an unremitting course is expected whenever the disorder is present for more than 5 years (*24,25*). Other studies also show a decrease in PTSD cases with time (*23,26*). Some studies have shown that the psychological consequences of earthquakes can be long-term (*27,28*), and the notion that PTSD symptoms decrease with time has been challenged by long-term studies (*29,30*). Therefore, although the prevalence of PTSD tended to decline in the first year following the Wen-Chuan earthquake, it is nonetheless possible that in the long run, PTSD will become chronic in some adolescents, which may significantly affect

Table 2. PTSD risk factors predicted by means of a generalized estimating equation

Background factors	Estimate	SE	*p*	OR	95% CI
Time points					
Time point 1	0.755	0.127	< 0.0001	2.13	1.66-2.73
Time point 2	0.471	0.117	< 0.0001	1.60	1.27-2.02
Time point 3	0.185	0.113	0.102	1.20	0.96-1.50
Time point 4	0.000			1.00	
School location					
Wei-Zhou	− 0.208	0.397	0.601	0.81	0.37-1.77
Mian-Chi	1.151	0.230	< 0.0001	3.16	2.01-4.97
Qi-Pan-Gou	0.000			1.00	
Grade					
8th grade	0.521	0.210	0.013	1.68	1.12-2.54
10th grade	1.125	0.375	0.0027	3.08	1.48-6.43
11th grade	1.057	0.382	0.0056	2.88	1.36-6.08
7th grade	0.000			1.00	
Gender					
Female	0.157	0.137	0.254	1.17	0.89-1.53
Male	0.000			1.00	
Nationality					
Minorities	0.569	0.259	0.028	1.77	1.06-2.94
Han	0.000			1.00	
Residence					
Rural	0.0003	0.170	0.998	1.00	0.72-1.40
Urban	0.000			1.00	
Personal injury					
Yes	0.475	0.298	0.111	1.61	0.90-2.88
No	0.000			1.00	
Personal hospitalization					
Yes	0.442	0.472	0.349	1.56	0.62-3.92
No	0.000			1.00	
Parent injury					
Yes	0.511	0.196	0.009	1.67	1.14-2.45
No	0.000			1.00	
Severe property damage					
Yes	0.752	0.287	0.009	2.12	1.21-3.72
No	0.000			1.00	

their psychological development. For example, in one study, Karakaya *et al*. have found very severe or severe degrees of post-traumatic stress symptoms in 22.2% of adolescents even three and a half years after the 1999 earthquake in Turkey (*30*).

4.2. *Different school location as a risk factor*

The present study showed that students in Mian-Chi Secondary School had a higher risk of PTSD. The reason is that Mian-Chi Secondary School is the nearest to the epicenter, in Ying-Xiu Township (the distance from epicenter to school in descending order is Mian-Chi, Qi-Pan-Gou, and Wei-Zhou). It was reported that proximity to the epicenter was the most powerful predictor of PTSD in the 1989 San Francisco

earthquake (*31*), and that children living closest to the epicenter suffered from severer PTSD symptoms than those living further from the epicenter in the 1988 Armenian earthquake (*32*). In addition, Mian-Chi Secondary School was hit by a boulder rolling down from the hills during the earthquake, killing 12 students and causing more than 20 injuries. In our investigation, the principal told us that all the students at Mian-Chi Secondary School had witnessed the tragedy. It has been proved that PTSD can occur in persons who have witnessed a violent injury or the unnatural death of another person (*33*).

4.3. *Grade as a risk factor*

Studies of disaster victims have highlighted the

influence of previous experiences and mental states on vulnerability to PTSD. For instance, it has been reported that the severity of PTSD symptoms in child survivors of a shipwreck was associated with mental problems existing before the disaster (*34*). Stressful life events occurring subsequent to the disaster were also related to the severity of PTSD (*35*). In our study, senior middle school students (*i.e.,* students in the 10th and 11th grades) had a higher risk of PTSD than junior middle school students (*i.e.,* students in the 7th and 8th grades). This suggests that senior middle school students might feel greater pressure due to their heavier study load than junior middle school students. The fact that students in the 10th grade had a higher risk than 11th grade students could be explained by presuming that before the earthquake occurred, students who were in the last stage of 9th grade (*i.e.,* the 10th grade in our present study) may have undergone great pressure while preparing to take their entrance exams for senior middle school; after the earthquake, the previous 9th grade students entered the 10th grade (the first year in senior middle school); thus students in the 10th grade may have faced greater difficulties in dealing with their new study environment, which in turn, could result in higher PTSD prevalence.

4.4. *Other factors related to PTSD*

As suggested in some studies, serious earthquake damage to the home and property is associated with psychological problems (*4,36*). Our study was consistent with this finding. Although a parent's injury has not been studied as a factor in previous research, this factor turned out to be one of the risk factors identified in our study. Female gender has been associated with PTSD in adolescents in some studies (*34,37*) but not in others (*38-40*). No statistically significant difference between boys and girls was found in PTSD prevalence in this study. The literature suggests that personal physical injury is a risk factor for the development of PTSD (*41*). However, in this study, personal injury was not significantly associated with PTSD. Presumably, the small number of injured students is largely responsible for the lack of significance. It may be assumed that, with a relatively large number of injured subjects, this factor would have become significant. Nationality was another risk factor of PTSD in our study: the Minority students had a greater risk of PTSD than the Han students. It may be postulated that the Han people could get more social support from the outside world, as most of the Han families had emigrated to Wen-Chuan for the sake of work and therefore could utilize a wider sphere of social resources after the earthquake. A search of the literature turned up no studies on differences in psychological morbidity between Han nationality and Minorities; further research is called for to investigate this phenomenon.

4.5. *Limitations and strengths*

Our study is subject to certain limitations. Firstly, the subjects of our study moved to the suburbs of Cheng-Du after the earthquake due to damage to their schools in Wen-Chuan. Hence, it is possible that the new school environment and great distance from family could have certain negative impacts on the subjects, which might also cause or aggravate PTSD. Secondly, some of the earthquake experiences were relatively rare. For example, only 0.9 percent of students were hospitalized and 4.7 percent of students were injured; this limited the statistical power to predict some of the risk factors of PTSD.

Despite those limitations, this study, to the best of our knowledge, is the first large-scale study with a sample of 1,474 students to estimate the prevalence of PTSD among adolescents at about 4, 6, 9, and 12 months after the Wen-Chuan earthquake. Another highlight of our study is the specific analysis of data by a generalized estimating equation to control for repeated measurements in the same individuals and to predict risk factors effectively.

5. Conclusion

In conclusion, the prevalence of PTSD in adolescents was 11.2%, 8.8%, 6.8%, and 5.7% at 4, 6, 9 and 12 months, respectively, after the earthquake. The risk factors of PTSD were time duration, school location (proximity to the epicenter), school grade, nationality, parent injury, and severe property damage during the earthquake. How nationality affected the development of PTSD deserves further study. In addition, long-term longitudinal studies are needed to clarify the role of time in the trajectory of PTSD.

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