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Post-traumatic stress disorder and depression symptoms of adolescents survived from a seriously-hit area in China: A 3-year follow-up study

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ABSTRACT

The objective of this study is to analyze the prevalence of probable PTSD and depression after earthquake and to find the risk factors. Adolescents having experienced an earthquake were recruited (n = 330) and assessed within 1 month of the trauma. Follow-up surveys were conducted 12 months, 24 months and 36 months later, respectively. Symptoms were assessed by the Children's Revised Impact of Event Scale and the Depression Self-Rating Scale for Children. Results indicate that the prevalence of probable PTSD in different stages was 42.2%, 20.1%, 30.3% and 11.2%. The corresponding rate of depression was 32.3%, 20.7%, 31.0% and 30.3%. The sub-symptoms of PTSD, intrusion and arousal, tended to decrease at the 1st year, followed by a rebound at the 2nd year, then dropping again at the 3rd year. The avoidance showed a consistent diminishing. The PTSD symptoms were significantly associated with gender and the degree of earthquake exposure. However, the gender, family relationship and despair played crucial roles in the development of depressive symptoms. Despite of the tendency of timing abatement, the prevalence of probable PTSD and depression might show rebound at the second year, which remind us a vital threshold for psychological intervention.

1. Introduction

Natural disasters, including earthquake, flood, tornadoes, etc. may make survivors suffered from psychiatric symptoms, sometimes even rising to the level of diagnosable psychiatric illness.(Tips:Thanks a lot for your careful comment, and as your understanding, we do mean that may leave survivors with psychiatric symptoms, sometimes rising to the level of diagnosable psychiatric illness. So we revised the first sentence to make it more clear.) However, Posttraumatic stress disorder (PTSD) has been found to be the most prevalent type of psychiatric morbidity after earthquakes (Farooqui et al., 2017), which may also be the most frequent and debilitating one (Norris et al., 2002). Other psychiatric disorder, e.g., major depressive disorder and generalized anxiety disorder, are also frequent after natural disasters (Farooqui et al., al.,2017) and one study on adolescents has demonstrated that PTSD, depression, and anxiety were highly comorbid (Fan et al., 2011). Researches in last three decades are mainly focused on PTSD reactions after earthquake, tsunami and hurricane. The findings, in general, reported on PTSD prevalence ranging from 3.6% (Navarro-Mateu et al., 2017) to 60% (Madakasira and O'brien, 1987). There are also many studies specifying PTSD among children and adolescents. One study focused on the 2008 Wenchuan earthquake in China found the prevalence of PTSD was 2.5% in adolescents from seriously hit areas 6 months after the earthquake (Ma et al., 2011). Another study reported that, 1 year after the earthquake in Lorca (Spain), the rate of PTSD among students aged 8 to 12 was 40.1% (López-García et al., 2014). As depression is associated with PTSD, many literatures also explored the rates of depression among adolescents. For instance, Tang et al. found that 20.9% of adolescents still met the criteria for major depression 12-months after the 2013 Ya'an earthquake in China (Tang et al., 2017). Many researches have showed that the psychological impact of earthquakes for adolescents for both PTSD and depression may last for many years after the event (Du et al., 2018; Chui et al., 2017; Eksi and Braun, 2009; Goenjian et al., 2011; Asarnow et al., 2000; Kolaitis et al., 2003). (Tips: here we add a latest article about earthquake) Because the trauma effects may be long lasting, it is important to investigate the mental health of adolescents who experienced a traumatic situation not just immediately after the trauma but after several years have passed (Tips: Thanks for your suggestion, and we have replaced the original sentence with your new sentence.).

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Since PTSD may occur after a long period of time and its symptoms present without the survivors' awareness, many researchers hold it as important to study it through the longitudinal method, or doing follow-up surveys. One study in Sichuan discovered that 18 months post-earthquake, the prevalence of PTSD symptoms among bereaved survivors decreased from 38.9% to 16.8% (Hu et al., 2016). In Bulut's research based on 1-, 2- and 3-years post-earthquake follow-up surveys, the possible rates of PTSD for students were 68%, 48%, and 39%, respectively (Bulut, 2010). The findings above mostly proposed a decline in severity of PTSD symptoms, while Goenjian et al. reported an intractability which may be manifested by the fact that the severity of PTSD symptoms increased significantly only among adolescents not treated with psychotherapy (Goenjian et al., 1997). Though in recent years, the long time follow-up surveys on Chinese disaster-survivors continue to increase, for instance, one study conducted by Guo et al. reported that the prevalence of PTSD was 58.2% at 2 months, 19.8% at 14 months, 19.0% at 26 months, and 8.0% at 44 months among adult after the 2008 Wenchuan earthquake (Guo et al., 2014), and when it comes to the special group, children or adolescents, the report of Tang et al. found that the 12-month post earthquake assessment indicated a PTSD prevalence of 43.9% as well as depression (20.9%) among their adolescent subjects, while the 30-month assessment indicated that 15.7% of their subjects still met the criteria for PTSD, and 21.6% met the criteria for depression (Tang et al., 2017), and another study conducted by Shi et al. revealed that the prevalence rates of probable PTSD at 12-month and 18-month post-earthquake were 18.90% and 11.92% in adolescents (Shi et al., 2018). It is visible that most of these researches focused on different time-point after earthquake, which made the results diversified, and it is also difficult to recognize the practical variation trend of the rate of PTSD or depression among adolescents for successive year post-earthquake. Therefore, it is necessary to evaluate the particular population-the adolecents, through uniform time-point post-earthquake, which might help us to comprehend the process of their psychopathology after a trauma. (Tips:It's very grateful for your notice of other literature about earthquake. We have read the articles you mentioned and searched for the latest studies on earthquake, and updated parts of our references, please see the red parts in the reference part. What's more, it is really very important to clarify the advantage of our study, so we revised some sentences in the introduction part and discussion part. and we have deleted that sentence ``When it comes to the special group, children or adolescents, the related research is nevertheless scarce.'' in our introduction. Instead, we listed 2 different articles which reported the related research on adolescents.)

Though the prevalence of mental disorders after a trauma is crucial, it is also very necessary to explore the risk factors which might make the survivors susceptible to suffer from these disorders. Mahat–Shamir et al. ever reported that physical proximity to the site of the traumatic event was a significant predictor associated with PTSD symptoms (Mahat-Shamir et al., 2017). While loss of relative, injury of body, damage of house, and emotional instability were found to be the shared risk factors for PTSD only and comorbidity of PTSD and anxiety in flood survivors (Dai et al., 2017). Among the multitudinous risk factors, a review including the studies published in the last 20 years concluded that females seemed to be the most widely-affected group after an earthquake (Farooqui et al., 2017). From the literature we reviewed, it is not hard to discover that the study on the risk factors for PTSD or depression among the children or adolescents after an earthquake was inadequate especially in China.

Considering all the shortage in the field of children or adolescents, we designed this study based on the hypothesis that the rates of suspected PTSD and depression among adolescents might show the trend of change in their own style, which is different from the results of adults and some extensional risk factors might take part in the emergence of their mental disorders.

The authors here conducted a longitudinal follow-up survey on subjects, aging 15–18, after the 5.12 earthquake hit their hometown and school in Dujiangyan, a city 100 km away from the epicenter Wenchuan, Sichuan Province, China. The investigating periods were set at 4 different time points—1 month, 1 year, 2 years and 3 years after the quake. We set up the baseline in the first survey, then collected data in following stages, and finished the tendency chart accordingly.

The aim of this study includes: (1) to determine the prevalence of probable PTSD and depression in a 3-year post-earthquake period in a middle school student sample from a seriously-hit area; (2) to describe the symptom patterns of PTSD; and (3) to identify long-term predictors of symptoms of PTSD and depression. We hold the belief that it is vital to explore the longitudinal mental health assessment and evaluation of disaster survivors, especially the adolescents. On the basis of data analyses, the most appropriate measures of intervention could be designed to ensure the victims away from the psychosis.

2. Methods

2.1. Subjects

On May 12, 2008, a devastating earthquake measuring 8.0 on the Richter scale struck Wenchuan, a small town in Sichuan Province, China. The quake destroyed buildings and natural geography of the region, and severely impacted neighboring towns and cities, Beichuan, Mianyang, Shifang, and Dujiangyan. An overall of 69,227 toll was reported, 374,643 severely injured and disabled, along with 17,923 more reported missing. The city involved in this study, Dujiangyan, was among the most seriously hit areas. According to the data provided by local government, there were 3091 people killed in the quake, with 141 missing (Xu et al., 2012). Teaching buildings in three local schools collapsed, trapping thousands of students, some wounded, some killed or dying for lack of air or aid.

The subjects in this study were all from Juyuan Middle school in Dujiangyan, which is one of the three schools mentioned above, with a casualty of 283 (Wu et al., 2011). The first survey was conducted one month after the earthquake, enrolling all of the 1650 junior survivors. A few students failed to understand the contents of the questionnaire, some others were unwilling to complete the questionnaire. The number of students excluded in this study was 7, and their data were excluded.

Each student in the first survey was granted a unique ID number. The method of stratified sampling was utilized to sample 330 students as the subjects of our follow-up study. The grade was set as the stratified factor (Because students were assigned to different grade according to their age, namely students in the same grade shared the most similar characteristic). To be specific, among the 3 grades of the school, simple random sampling (the random number table method was used to select the students' ID number) was used to sample 118 students from grade 1, then 110 students from grade 2, and 102 students from grade 3 according to the proportionality of 1:5. The data of these 330 students then formed the baseline (marked as T1). The same tools were used to investigate the same subjects at three other stages: on 1st , 2nd, 3rd year after the quake (marked as T2, T3, and T4) . The number of students finishing all the four surveys was 294, the 36 remainders exiting either because of transferring to another school (11 students), relocating (23 students), or dropping out of school (2 students).The rate of subject loss was 10.9%, not a systematic difference in demographic status.

The research was approved by the Institutional Review Board of West China Hospital and the Bureau of Education in Dujiangyan. Informed consent was obtained from parents and teachers of the participants prior to each survey stage.

2.2. Measures

The demographic questionnaire items, as shown in Table 1, include gender, age, nationality, family relations, an inventory of earthquake exposure experiences, and the feeling of despair. The scale was adapted

Table 1
Demographic characteristics of the sample.

Variable and its assignment	Total(n = 294)	
	n	%
Gender		
1 = male	152	51.7
2 = female	142	48.3
Age, mean(SD), yrs	16.34(1.036)	
Ethnic		
1 = Han	290	98.6
2 = Qiang	2	0.70
3 = Zang	1	0.35
4 = Hui	1	0.35
Family relation		
1 = well	202	68.7
2 = common	68	23.1
3 = bad	24	8.2
Trapp or not		
1 = no	232	78.9
2 = yes	62	21.1
Injured or not		
1 = no	196	66.7
2 = yes	98	33.3
Hospitalization or not		
1 = no	263	89.5
2 = yes	31	10.5
Whether or not witnessed injury		
1 = no	201	68.4
2 = yes	93	31.6
Whether or not witnessed death		
1 = no	290	98.6
2 = yes	4	1.40
Whether or not witnessed collapse		
1 = no	188	63.9
2 = yes	106	36.1
The severity of teachers'/friends' injury		
1 = safe	128	43.5
2 = somebody injured	163	55.4
3 = somebody dead	3	1.10
The severity of family's injury		
1 = safe	192	65.3
2 = somebody injured	97	33.0
3 = somebody dead	5	1.70
The length of living in transferred safe place, mean(SD), days	2.02(2.171)	
Felt despair or not		
1 = no	78	26.5
2 = yes but mild	179	60.9
3 = very	37	12.6

from a prior earthquake exposure scale based on the DSM-IV A-1 and A-2 criteria for stress-related disorders (Pynoos et al., 2004).

The Children's Revised Impact of Event Scale (CRIES) (Dyregrov and Yule, 1995) was a newly developed self-report scale revised from the Impact of Event Scale (IES) (Horowitz et al., 1979), including all 8 items of the original version, with 5 new items derived from the arousal criteria in the DSM-IV classification. Each question was answered on a 4-point scale (not at all, rarely, sometimes, often), scoring 0, 1, 3, 5 with no reversed items. The total score ranged from 0 to 65. The result could be divided into three factors, representing the symptoms of intrusion, avoidance and arousal. It was used in a survey of 2976 children aged 9–14 years who had experienced war in Mostar and was confirmed with excellent reliability and predictive validity (Smith et al., 2002). Chinese scholars also used it to evaluate its effectiveness on Native students and suggested that when the cut-point was 30, the scale had a good separation for PTSD and non-PTSD (Jing et al., 2010).

The Depression Self-Rating Scale for Children (DSRSC) was designed to assess the extent of depression among children. The self-report scale includes 18 items. Each question was answered on a 3-point scale (most, sometimes, never), scoring 2, 1, 0 with 8 items being scored in a reversed way. When using a cut-off score of 15, it has a good internal consistency and can be used to distinguish clinically depressed from non-depressed children well (Birleson, 1981). Chinese scholars set up a norm of Chinese children in city and found it as applicable as well (Su et al., 2003). (Tips: Thanks for your suggestion, and we have replaced the original sentence by your new sentence.)

2.3. Statistical analyses

Descriptive statistics were computed for all variables. Differences between categorical variables were analyzed with chi-square tests. The repeated-measures of ANOVA were used to analyze the disparity among the four time-points on the CRIES, both total scores and sub-category scores, and DSRSC scores. Meanwhile, Eta squares were calculated to specify the effect sizes. Additionally, pairwise comparisons were used to detect which means of the variable at different time-points differed significantly from others. At last, the Binary logistic regression was used to examine independent predictors of PTSD and depressive symptoms in the full sample range. Statistical significance was set at the level of $P < 0.05$.

All statistical analyses were carried out by the Statistical Package for Social Science, (version 11.0).

3. Results

3.1. Demographic characteristics

The characteristics of the subjects are summarized in Table 1. All of the demographic data of the 294 subjects who had completed all the four stages of surveys were collected at the T1 (1 month post-earthquake). Those who dropped out of the follow-up study did not differ from those who completed all on any of the demographic measures. The age of the samples ranged from 15 to 18 years old, with the mean age of 16.34 ± 1.036 years old. As shown in Table 1, the exposure experience in earthquake is scaled as: whether or not being trapped/ buried/ hospitalized, injured; intact but witnessing injury/ death/collapse; whether or not feeling despair; experiencing severe injury /death of teachers'/friends'/ family's; and the length of period living in transferred safe place (e.g. safe camp).

3.2. The results of the mean scores of CRIES and DSRSC in long-term

Table 2 shows the mean values (standard deviation) of CRIES and DSRSC. The repeated-measures of ANOVA showed that there were significant differences (Eta squares displayed to show effect sizes) in all the variables through different time-points (F (2.89, 843.61) = 37.822, $p < 0.001$; F (2.91, 849.13) = 33.780, $p < 0.001$; F (2.92, 853.20) = 8.066, $p < 0.001$; F (2.89, 843.24) = 24.950, $p < 0.001$; F (2.96, 860.24) = 5.640, $p = 0.001$). The results of pairwise comparisons test, showing which means of the variable at different time-points differed from others, are put in the footnote of Table 2. (Tips: We have revised the corresponding part in red colour, which all the "$p = 0.000$" have been replaced, and we have revised the format of our Table 2 and so on.)

Because the results were complicated, two figures were designed here to illustrate the trend of change. The scores of CRIES, with the highest position at the baseline T1 declined sharply at T2 (1 year post-earthquake), then tasked an obvious rebound at T3 (2 years post-earthquake), but eventually dropped again at T4 (3 years post-earthquake). The results listed in footnote of Table 2 also indicated that significant rebound emerged at T3. The variation for the scores of DSRSC, in contrast, achieved the lowest point at T2 (significance proved in footnote of Table 2) and kept a relatively smooth strike at other time-points. (Fig. 1a)

Table 2
Repeated measure of ANOVA: the disparity among the four time-points on the CRIES mean scores, as well as its sub-category scores, and DSRSC scores.

	T1(1month) (Mean ± SD,n = 294)	T2(1year)	T3(2years)	T4(3years)	F	P	η^2
Total of CRIES	27.05 ± 12.56[a]	17.72 ± 13.62[b]	22.62 ± 12.81[c]	18.46 ± 9.01	37.822	<0.001	0.115
Intrusion	8.49 ± 5.05[d]	5.33 ± 4.87[e]	7.33 ± 4.79[f]	5.30 ± 3.62	33.780	<0.001	0.104
Avoidance	7.56 ± 4.95[g]	5.89 ± 5.41	5.90 ± 4.86	5.93 ± 4.24	8.066	<0.001	0.027
Arousal	9.74 ± 5.66[h]	6.50 ± 5.79[i]	9.40 ± 5.85[j]	7.24 ± 4.38	24.950	<0.001	0.079
Total of DSRSC	11.67 ± 6.02[k]	9.92 ± 5.87[l]	11.52 ± 5.49	11.23 ± 4.89	5.640	0.001	0.019

[a] The total score of CRIES on T1 was higher than T2 (P<0.001), T3 (P = 0.006), and T4 (P < 0.001)significantly.
[b] The total score of CRIES on T3 was higher than T2 significantly (P < 0.001).
[c] The total score of CRIES on T3 was higher than T4 significantly (P < 0.001).
[d] The score of intrusion on T1 was higher than T2, T3, and T4 significantly (P < 0.001).
[e] The score of intrusion on T3 was higher than T2 significantly (P < 0.001).
[f] The score of intrusion on T3 was higher than T4 significantly (P < 0.001).
[g] The score of avoidance on T1 was higher than T2, T3, and T4 significantly (P < 0.001).
[h] The score of arousal on T1 was higher than T2 and T4 significantly (P < 0.001).
[i] The score of arousal on T3 was higher than T2 significantly (P < 0.001).
[j] The score of arousal on T3 was higher than T4 significantly (P < 0.001).
[k] The score of DSRSC on T1 was higher than T2 significantly (P = 0.001).
[l] The score of DSRSC on T3 was higher than T2 significantly (P = 0.001) and T4 was higher than T2 significantly (P = 0.007).

3.3. The results of the mean scores of 3 factors of CRIES

The scores of intrusion and arousal showed the same trend of change as that of the total scores of CRIES. The scores of arousal at T1 and T3 did not show a significant difference (t = 0.746, p > 0.05), though the intrusion did (t = 3.16, p < *0.001*). (Re. h–j in the footnote of Table 2) As for the avoidance, the scores at T1 were at the peak and decreased at T2, then kept steady as a horizontal line through T3 and T4. (Fig. 1b)

Table 3
Chi-squared test: the rates of PTSD and depressive symptoms among different time.

	T1%(n)	T2%(n)	T3%(n)	T4%(n)	χ^2	P
PTSD	42.2(124)	20.1(59)	30.3(89)	11.2(33)	81.458	<0.001
Depression	32.3(95)	20.7(61)	31.0(91)	30.3(89)	11.949	0.008

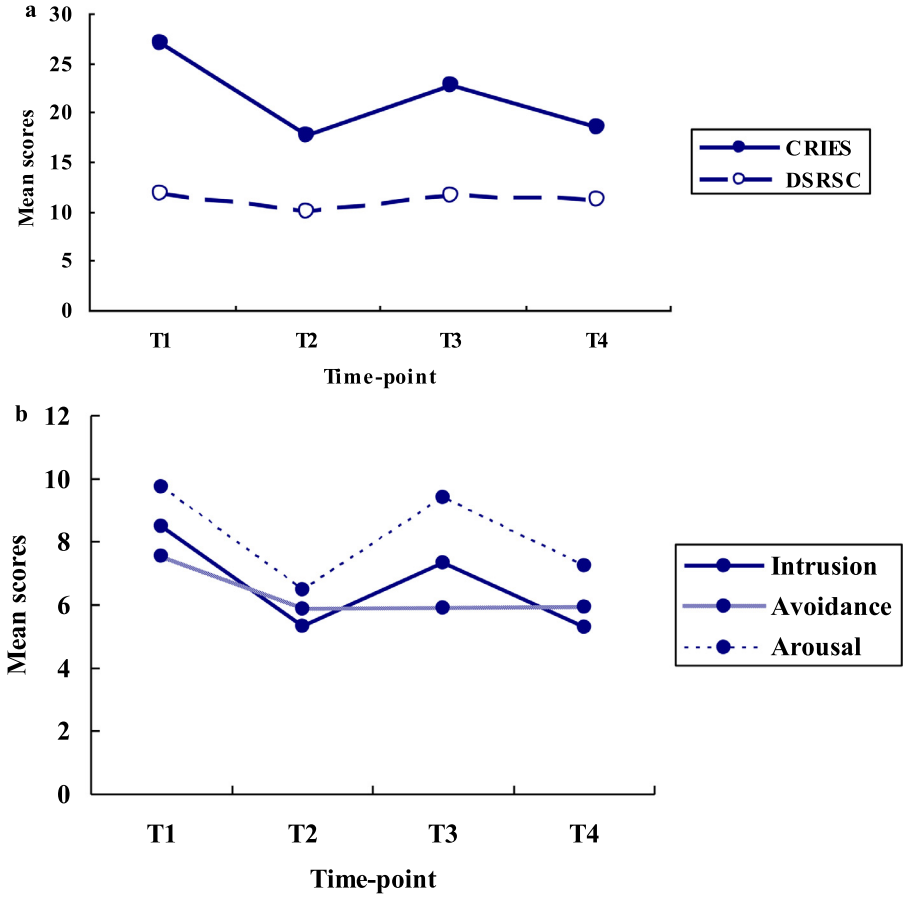

Fig. 1. a: the tendency chart of the mean total scores of CRIES and DSRSC, Fig.1b: The tendency chart of the mean scores of the three sub- category of PTSD.

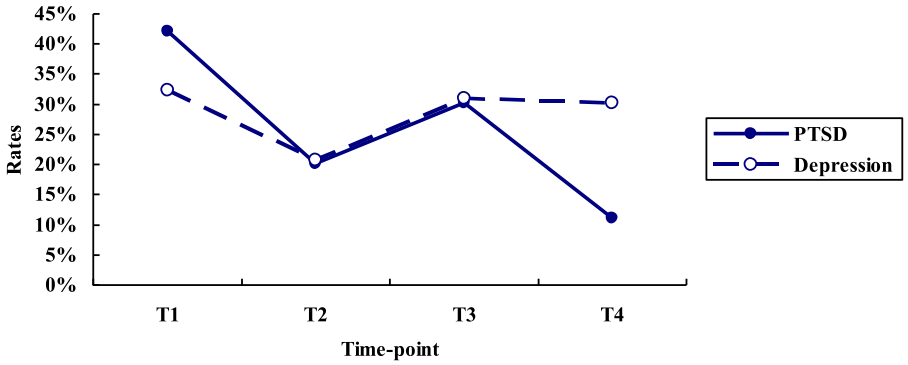

Fig. 2. The tendency chart of the rates of PTSD and depressive symptoms over time.

3.4. The prevalence rates of probable PTSD and depression over time

Table 3 shows the percentages of the subjects whose scores were higher than the cut-off scores, which could be used to estimate the rates of probable PTSD and depression. Significant disparity existed among the four time-points for the rates of probable PTSD ($\chi 2 = 81.458$, $df = 3$, $p < 0.001$), as well as the depression ($\chi 2 = 11.949$, $df = 3$, $p = 0.008$). The tendency of change for the rates was similar, namely declining first, then elevating with a rebound at T3, but redropping at T4. Please be noted that the extent of second drop on the rate of depression was far smaller than PTSD. (Fig. 2)

3.5. The prognoses of PTSD symptoms in long-term

The prognoses of PTSD symptoms of the subjects, those whose score on CRIES outstripped the cut-point and hence seemed to have PTSD, were traced. Follow-up surveys showed that at T3 the largest number of students were estimated as newly developing PTSD symptoms (Fig. 3).

3.6. The predictors of symptoms of PTSD and depression at T4

The risk factors of symptoms of PTSD and depression at T4 are shown in Table 4. (The assignments of the variables were shown in Table 1). The four variables, gender (female), collapse witnessing, severe injury of family, and living in transferred safe place for a longer time, made significant contributions to the generation of PTSD symptoms. To be specific, female subjects, subjects with poor family relation, and subjects reporting feeling more despair showed significant positiveness in the presence of depressive symptoms. (Tips: Thanks for your suggestion, and we have revised the last sentence in the part of results, which replaced the “clinical depression” with “depressive symptoms’. because of your notification, we realized that our scales couldn't diagnose PTSD and depressive disorder, we revised the expression in our whole article, which can be seen in the many red parts through the manuscript, including the parts in abstract.)

Table 4
Binary logistic regression: the risk factors of PTSD and depressive symptoms in T4.

	PTSD		Depression	
	OR	95%CI	OR	95%CI
Gender	1.069	(1.021—1.120)**	1.367	(1.115—1.676) **
Age	1.151	(0.518—2.557)	0.783	(0.558—1.100)
Ethnic	0.285	(0.036—2.274)	1.355	(0.958—1.916)
Family relation	1.023	(0.928—1.127)	1.875	(1.050—3.348) *
Trapp or not	1.092	(0.690—1.728)	1.220	(0.901—1.653)
Injured or not	1.086	(0.826—1.427)	1.019	(0.582—1.783)
Hospitalization or not	1.373	(0.553—3.409)	1.106	(0.714—1.714)
Whether or not witnessed injury	1.150	(0.928—1.426)	1.193	(0.917—1.551)
Whether or not witnessed death	1.043	(0.804—1.352)	1.140	(0.954—1.362)
Whether or not witnessed collapse	1.014	(1.002—1.027) *	1.028	(0.952—1.111)
The severity of teachers’/ friends’ injury	1.027	(0.856—1.233)	1.083	(0.840—1.395)
The severity of family's injury	1.141	(1.020—1.277) *	1.439	(0.700—2.955)
The length of living in transferred safe place	1.416	(1.027—1.954) *	1.045	(0.911—1.198)
Felt despair or not	1.133	(0.982—1.308)	1.096	(1.027—1.169) **

* $P < 0.05$.
** $P < 0.01$.

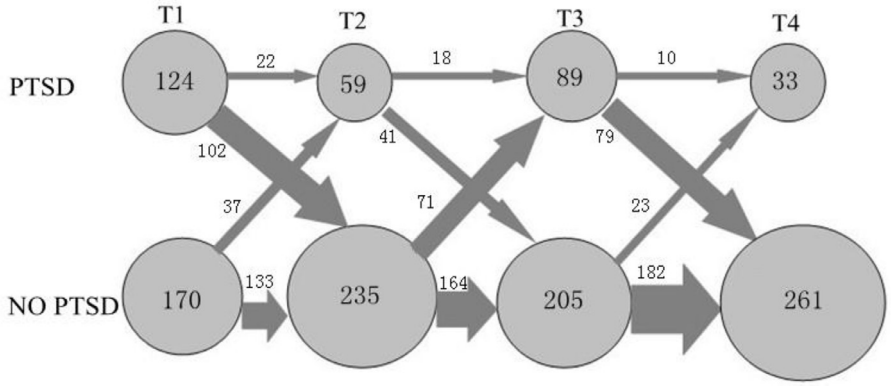

Fig. 3. The subjects’ prognosis of PTSD symptoms over time. The number in the circle represents the number of people, and the number near the arrowhead represents the number of people changed into another condition.

4. Discussion

The present study analyzed the prevalence rates of probable PTSD and depression longitudinally and tried to discover the long-term predictors. It was the first systemic follow-up research using the design of repeated measures over 3 successive years for middle school students from a seriously-hit area in China as we have known, and which was also the first one to analyze the change tendency and found the vital time-point for psychological intervention. (Tips: we add this sentence to clarify the advantage of our study.)

The rates of probable PTSD in our study are 42.2% (1 month post-earthquake), 20.1% (1 year post-earthquake), 30.3% (2 year post-earthquake) and 11.2% (3 year post-earthquake), respectively. Liu et al. (2012) and Jia et al. (2013) both reported about PTSD prevalence of 26.3% and 10.7% at the 1st year and 3rd year after the Wenchuan earthquake. Our rates resembled theirs closely. However, when referring to the follow-up study, the results were manifold. It is interesting that most researchers have described decreasing rates of PTSD over time (Hu et al., 2016; Karamustafalioglu et al., 2006; Önder et al., 2006; Guo et al., 2014). However, there has been no literature reporting a rebound in this area but ours. We discovered that the rate of probable PTSD increased at a certain stage, namely at 2 year post-earthquake. The reason might come from the reports on ”delayed-onset PTSD”, which is defined in the DSM -IV-TR as a specifier for PTSD at least 6 months have passed between the traumatic event and the onset of the symptoms (Andrews et al., 2007). Delayed-onset PTSD has also been reported by Tang et al. (2017) and Berninger et al. (2010) as common among survivors who'd experienced trauma. In the Fig. 3, the time of 2 year post-earthquake shows the largest number of newly-developed PTSD, possibly indicating a key period more vulnerable for middle school students to develop delayed-onset PTSD. If the government could put more psychological intervention at this stage, it might stop them from developing into PTSD. In fact, a few subjects we studied showed PTSD symptoms continually through the whole research. Based on epidemiological studies we propose that, when symptoms persist beyond 3–6 months, they are likely to become chronic (Galea et al., 2005), and the lingering PTSD symptoms may negatively influence socioeconomic development in many years later till adulthood (Thordardottir et al., 2016). Hence, strengthening children's support systems post-disaster may be important, which can prevent the long-term sequelae of symptoms.

The results of this study also suggest that the mean scores of CRIES reported a descending trend in overall view, but showing a distinct rebound at T3 without surpassing the original data at T1 as well as the prevalence of probable PTSD. Survey of Bulut revealed that the mean scores of CRIES decreased between the 1st and 3rd year and between the 2nd and 3rd year, which indicates that PTSD symptoms tend to drop off gradually (Bulut, 2010). While the trend we found is different: a noticeable rebound at 2 year post-earthquake, that could be supplemented by the rates of PTSD mentioned above. It, to great extents, manifests a need for ongoing screening to identify middle school students with persistent PTSD symptoms.

As PTSD including 3 categories—re-experiencing the trauma, avoidance of places, people, and activities that are reminders of the trauma, and increased arousal, it is necessary to analyze the 3 scales of CRIES. Another result of this study indicates that the scores of subscales of CRIES had their own trend of change over time, which revealed the symptom patterns of PTSD. The intrusion and arousal had the similar trend with significant rebound at 2 year post-earthquake. However, the characteristic of avoidance was unique, with no significant fluctuating after its dropping. According to Norris et al.'s report, intrusion and arousal symptoms declined over time, while avoidance symptoms increased between 6 months and 30 months after the hurricane (Norris et al., 1999). Since our result was different from others, we reckoned the feature of delayed-onset PTSD as the main reason. As Bryant et al. have found that delayed-onset PTSD would be characterized by higher levels of physiological arousal and re-experiencing symptoms throughout their course of posttraumatic adjustment (Bryant and Harvey, 2002). According to our study, at the rebound time, parts of our subjects might just develop into delayed-onset PTSD, so they displayed obvious symptoms of intrusion and arousal, which also implicated that the therapy focusing on these symptoms should be intensified, so as to rehabilitate their mental health more properly. (Tips: Thanks for your suggestion, and we have revised this sentence.)

It has been demonstrated that PTSD and depression were highly associated among children (Fan et al., 2011), hence, the scores of DSRSC reflecting the condition of suspected depression should also be paid attention to. According to our results, the mean score of DSRSC declined slightly 1 year after the earthquake, then ascended gradually till keeping a parallel level as the baseline. When focusing on the rates of probable depressive disorder, the similar tendency could be observed. One study conducted in adolescents experienced the Wenchuan earthquake in China also showed that the rate of depression did not decline significantly during the 18-month follow-up (Chui et al., 2017). While we have found the significant drop at the given time, the reason might be interpreted with the effects of relatively short but efficient interventions supplied by the government and society, such as the short period of psychodynamic therapy, the limited crisis intervention, and so on . (Tips: Thanks for your suggestion, and we have added some intervention methods in this part.)When the survivors were provided with sufficient attention and psychological intervention, their symptoms of depression decreased definitely. As Goenjian et al. have reported, grief-focused psychotherapy is effective in halting the progression of depression (Goenjian et al., 2005). With time passing, the effects of transient non-systematical interventions faded gradually, so depressive symptoms presented in more and more subjects in the 2nd and/or 3rd year after the 5.12 earthquake. This result also alerted us that the persistent supportive therapy was necessary.

Another point revealed in our study is that the risk factors of PTSD symptoms 3 years after the earthquake included female, collapse witnessing, severe injury of family, and living in transferred safe place for a long time. Earlier researchers have drawn conclusions similar to variant extents. For example, Garza et al. proposed that there is increasing recognition of gender differences in PTSD, with women having double the rates of the disorder compared to men (Garza and Jovanovic, 2017). Adolescents who witnessed injury and death, with the loss of house and property, having family members injury were reported as more likely to develop PTSD (Roussos et al., 2005; Goenjian et al., 2005; Liu et al., 2010) . Besides, the experience of witnessing collapse might be a predisposing factor in that the disaster-related experience was traumatic and had lasting effects in children (Beauchesne et al., 2002). The time for living in a transferred safe place was comparatively a newly found factor, reported in little literature. Yet since it has been proved that danger threatening one's own life during a disaster are significantly associated with post-disaster mental health problems (Green et al., 1991; Lubit et al., 2003), we have reason to believe that moving to the safe place later meant to the adolescents some potential bigger danger, which actually made them more susceptible to PTSD.

Nor should it be ignored that, according to our data analyses, the female gender, poor family relationship and the reported feeling of more despair are significant risk factors for the presence of depressive symptoms. Roussos et al. noticed the gender factor in the conclusion (Roussos et al., 2005). But the other two factors are first reported by the authors here. After the disaster, the lack of family support would make the survivor hopeless, and family dysfunction is reported to be associated with depression (Martin et al., 1995). Furthermore, Park et al. also found that North Korean adolescent experienced traumatic events with lower levels of psychological social support were prone to develop depression (Park et al., 2017). The subjects with poor family relationship might not gain enough support from their family members, so chances for developing depression may be higher.. (Tips: Thanks for your suggestion, and we have revised this sentence as your comment)

5. Conclusion

Based on analyses on the prevalence of probable PTSD and depression longitudinally, the research group tries to explore the tendency toward and rates of probable PTSD and depression under the experience of a severe earthquake disaster. Studying on the same sample group for a long-term follow-up survey of 3 years, we try to find out possible predictors and identify the related risk factors. We hope the findings in this study provide valuable information for progressing mental health researches on problems among adolescent survivors after severe earthquake. As noted at the very beginning, systemic follow-up researches with repeated measures over 3 successive years for adolescent survivors from a seriously-hit area are scarce, either in China or over the world. The data, as the original first-hand data on the theme, are expected to be beneficial for planning suitable psychological intervention strategies for the targeted group, and, in a long-term program handle, be helpful for the government to frame long-term post-traumatic psychological interventions for students.

6. Limitations

Due to human resources shortage and technology limitation, we selected only self-reported rating scales as our tools without the ability to distinguish the sub-types of PTSD effectively. Though we remain skeptical whether part of our samples below the cut-off score suffer from the partial PTSD and whether part of them even have some psychiatric comorbiditis which could favor the onset of PTSD, the limitation restrained our further efforts to follow the clues. We would love to suggest for clinical-structured interviews if admitted. We also would consummate our study in the future by using the interview and amplifying the size of sample.

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Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2019.01.063.

References

Andrews, B., Brewin, C., Philpott, R., Stewart, L., 2007. Delayed-onset posttraumatic stress disorder: a systematic review of the evidence. Am. J. Psychiatry 164 (9), 1319–1326.
Asarnow, J., Glynn, S., Pynoos, R.S., Nahum, J., Guthrie, D., Cantwell, D.P., et al., 2000. When the earth stops shaking: earthquake sequelae among children diagnosed for pre-earthquake psychopathology. J. Am. Acad. Child Adolesc. Psychiatry 39, 141–142.
Beauchesne, M.A., Kelley, B.R., Patsdaughter, C.A., Pickard, J., 2002. Attack on America: children's reactions and parents' responses. J. Pediatr. Health Care 16 (5), 213–221.
Berninger, A., Webber, M., Niles, J., Gustave, J., Lee, R., Cohen, H., 2010. Longitudinal study of probable post-traumatic stress disorder in fighters exposed to the World Trade Center disaster. Am. J. Ind. Med. 53 (12), 1177–1185.
Birleson, P., 1981. The validity of depressive disorder in childhood and the development of a self-rating scale: a research report. J. Child Psychol. Psychiatry 22 (1), 73–88.
Bryant, R.A., Harvey, A.G., 2002. Delayed-onset posttraumatic stress disorder: a prospective evaluation. Aust. N. Z. J. Psychiatry 36 (2), 205–209.
Bulut, S., 2010. Children's posttraumatic stress reactions and sub-symptoms: three years of a longitudinal investigation study after a direct exposure to the earthquake and school's collapse. Turk Psikol Derg 25 (66), 87–100.
Chui, C.H., Ran, M.S., Li, R.H., Fan, M., Zhang, Z., Li, Y.H., et al., 2017. Predictive factors of depression symptoms among adolescents in the 18-month follow-up after Wenchuan earthquake in China. J Ment Health 26 (1), 36–42.
Dai, W., Kaminga, A.C., Tan, H., Wang, J., Lai, Z., Wu, X., et al., 2017. Comorbidity of post-traumatic stress disorder and anxiety in flood survivors: Prevalence and shared risk factors. Medicine (Baltimore). 96 (36), e7994.
Du, B., Ma, X., Ou, X., Jin, Y., Ren, P., Li, J., 2018. The prevalence of posttraumatic stress in adolescents eight years after the Wenchuan earthquake. PsychiatryRes 262, 262–269.
Dyregrov, A., Yule, W., 1995. Screening measures: the development of the UNICEF screening battery. In: Paper presented at the Fourth European Conference on Traumatic Stress. Paris. May.
Eksi, A., Braun, K.L., 2009. Over-time changes in PTSD and depression among children surviving the 1999 Istanbul earthquake. Eur. Child Adolesc. Psychiatry 18 (6), 384–391.
Fan, F., Zhang, Y., Yang, Y., Mo, L., Liu, X., 2011. Symptoms of posttraumatic stress disorder, depression, and anxiety among adolescents following the 2008 Wenchuan earthquake in China. J. Trauma Stress 24, 44–53.
Farooqui, M., Quadri, S.A., Suriya, S.S., Khan, M.A., Ovais, M., Sohail, Z., et al., 2017. Posttraumatic stress disorder: a serious post-earthquake complication. Trends Psychiatry Psychother 39 (2), 135–143.
Galea, S., Nandi, A., Vlahov, D., 2005. The epidemiology of post-traumatic stress disorder after disasters. Epidemiol. Rev. 27 (1), 78–91.
Garza, K., Jovanovic, T., 2017. Impact of Gender on Child and Adolescent PTSD. Curr. Psychiatry Rep. 19 (11), 87.
Goenjian, A.K., Karayan, I., Pynoos, R.S., Minassian, D., Najarian, L.M., Steinberg, A.M., et al., 1997. . Outcome of psychotherapy among early adolescents after trauma. Am. J. Psychiatry 154 (4), 536–542.
Goenjian, A.K., Roussos, A., Steinberg, A.M., Sotiropoulou, C., Walling, D., Kakaki, M., et al., 2011. Longitudinal study of PTSD, depression, and quality of life among adolescents after the Parnitha earthquake. J. Affect Disord. 133, 509–515.
Goenjian, A.K., Walling, D., Steinberg, A.M., Karayan, I., Najarian, L.M., Pynoos, R., 2005. A prospective study of posttraumatic stress and depressive reactions among treated and untreated adolescents 5 years after a catastrophic disaster. Am. J. Psychiatry 162 (12), 2302–2308.
Green, B.L., Korol, M., Grace, M.C., Vary, M.G., Leonard, A.C., Gleser, G.C., et al., 1991. Children and disaster: age, gender, and parental effects on PTSD symptoms. J. Am. Acad. Child Adolesc. Psychiatry 30 (6), 945–951.
Guo, J., Wu, P., Tian, D., Wang, X., Zhang, W., Zhang, X., et al., 2014. Post-traumatic stress disorder among adult survivors of the Wenchuan earthquake in China: a repeated cross-sectional study. J. Anxiety Disord. 28 (1), 75–82.
Horowitz, M., Wilner, N., Alvarez, W., 1979. Impact of Event Scale: a measure of subjective stress. Psychosom. Med. 41 (3), 209–218.
Hu, X., Cao, X., Wang, H., Chen, Q., Liu, M., Yamamoto, A., 2016. Probable post-traumatic stress disorder and its predictors in disaster-bereaved survivors: a longitudinal study after the Sichuan earthquake. Arch. Psychiatr. Nurs. 30 (2), 192–197.
Jia, Z., Shi, L., Duan, G., Liu, W., Pan, X., Chen, Y., et al., 2013. Traumatic experiences and mental health consequences among child survivors of the 2008 Sichuan earthquake: a community-based follow-up study. BMC Public Health 13 (104), 1–9.
Jing, L., Chen, T., SiTu, M., Fang, H., Zhang, Y., Wang, D., 2010. The critical point research of the children's revised impact of event scale of Chinese edition. Chin. J. Behav. Med. Brain Sci. 19 (8), 757–759.
Karamustafalioglu, O., Zohar, J., Güveli, M., Gal, G., Bakim, B., Fostick, L., 2006. Natural course of post-traumatic stress disorder: a 20-month prospective study of Turkish earth-quake survivors. J. Clin. Psychiat. 67 (6), 882–889.
Kolaitis, G., Kotsopoulos, J., Tsiantis, J., Haritaki, S., Rigizou, F., Zacharaki, L., et al., 2003. Posttraumatic stress reactions among children following the Athens earthquake of September 1999. Eur. Child Adolesc. Psychiatry 12, 273–280.
Liu, K.Z., Liang, X.M., Guo, L.T., Li, Y., Li, X.R., Xin, B., et al., 2010. The acute stress disorder in the paediatric surgical children and adolescents injured in the Wenchuan earthquake of China. Steess Health 1, 75–81.
Liu, Z., Zeng, Z., Xiang, Y., Hou, F., Li, J., Li, T., 2012. A cross-sectional study on post-traumatic impact among qiang women in Maoxian County 1 year after the Wenchuan Earthquake, China. Asia Pac. J. Public Health 24 (1), 21–27.
López-García, J.J., López-Soler, C., 2014. Post-traumatic stress disorder in schoolchildren after the 2011 earthquake in Lorca (Spain). Gac. Sanit. 28 (3), 230–233.
Lubit, R., Rovine, D., Defrancisci, L., Eth, S., 2003. Impact of trauma on children. J. Psychiatr. Pract. 9 (2), 128–138.
Madakasira, S., O'BRIEN, K.F., 1987. Acute posttraumatic stress disorder in victims of a natural disaster. J. Nerv. Ment. Dis. 175 (5), 286–290.
Mahat-Shamir, M., Ring, L., Hamama-Raz, Y., Ben-Ezra, M., Pitcho-Prelorentzos, S., David, U.Y., et al., 2017. Do previous experience and geographic proximity matter? Possible predictors for diagnosing Adjustment disorder vs. PTSD. Psychiatry Res. S0165-1781 (17), 30169 -5.
Ma, X., Liu, X., Hu, X., Qiu, C., Wang, Y., Huang, Y., et al., 2011. Risk indicators for post-traumatic stress disorder in adolescents exposed to the 5.12 Wenchuan earthquake in China. Psychiatry Res. 189 (3), 385–391.
Martin, G., Rotaries, P., Pearce, C., Allison, S., 1995. Adolescent suicide, depression and family dysfunction. Acta Psychiatr. Scand. 92 (5), 336–344.
Navarro-Mateu, F., Salmerón, D., Vilagut, G., Tormo, M.J., Ruíz-Merino, G., Escámez, T., et al., 2017. Post-Traumatic Stress Disorder and other mental disorders in the general population after Lorca's earthquakes, 2011 (Murcia, Spain): a cross-sectional study. PLoS One 12 (7), e0179690.
Norris, F.H., Friedman, M.J., Watson, P.J., Byrne, C.M., Diaz, E., Kaniasty, K., 2002. 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. Psychiatry 65 (3), 207–239.
Norris, F.H., Perilla, J.L., Riad, J.K., Kaniasty, K., Lavizzo, E.A., 1999. Stability and change in stress, resources, and psychological distress following natural disaster: findings from Hurricane Andrew. Anxiety Stress Coping 12 (4), 363–396.

Önder, E., Tural, Ü., Aker, T., Kılıç, C., Erdoğan, S., 2006. Prevalence of psychiatric disorders three years after the 1999 earthquake in Turkey: Marmara Earthquake Survey (MES). Soc. Psychiatry Psychiatr. Epidemiol. 41 (11), 868–874.
Park, S., Lee, M., Jeon, J.Y., 2017. Factors Affecting Depressive Symptoms among North Korean Adolescent Refugees Residing in South Korea. Int. J. Environ. Res. Public Health 14 (8), E912.
Pynoos, R., Schreiber, M., Steinberg, A., 2004. Comprehensive Textbook of Psychiatry (Vol. 8). LippincottWilliams&Wilkins Press, New York.
Roussos, A., Goenjian, A.K., Steinberg, A.M., Sotiropoulou, C., Kakaki, M., Kabakos, C., et al., 2005. Posttraumatic stress and depressive reactions among children and adolescents after the 1999 earthquake in Ano Liosia, Greece. Am. J. Psychiatry 162 (3), 530–537.
Shi, X., Zhou, Y., Geng, F., Li, Y., Zhou, J., Lei, B., et al., 2018. Posttraumatic stress disorder symptoms in parents and adolescents after the Wenchuan earthquake: a longitudinal actor-partner interdependence model. J. Affect. Disord. 226, 301–306.
Smith, P., Perrin, S., Yule, W., Hacam, B., Stuvland, R., 2002. War exposure among children from Bosnia-Hercegovina: psychological adjustment in a community sample. J. Trauma Stress 15 (2), 147–156.
Su, L., Wang, K., Zhu, Y., 2003. Norm of the depression self-rating scale for children in Chinese urban children. Chin. Mental Health J. 17 (8), 547–549.
Tang, W., Zhao, J., Lu, Y., Yan, T., Wang, L., Zhang, J., et al., 2017. Mental health problems among children and adolescents experiencing two major earthquakes in remote mountainous regions: a longitudinal study. Compr. Psychiatry 72, 66–73.
Thordardottir, E.B., Valdimarsdottir, U.A., Hansdottir, I., Hauksdóttir, A., Dyregrov, A., Shipherd, J.C., et al., 2016. Sixteen-year follow-up of childhood avalanche survivors. Eur. J. Psychotraumatol. 7, 30995.
Wu, H., Yan, Z., Dong, K., Yang, S., Meng, C., Zhao, C., et al., 2011. Study on space-time distribution of death toll of Dujiangyan in the Wenchuan earthquake. Earthauake Res. ShanXi 148 (4), 40–45.
Xu, C., Liu, A., Wen, Z., 2012. Study on casualties of Dujiangyan City in Wenchuan earthquake. J. Earthquake Eng. Eng. Vibr. 32 (1), 182–188.