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Latent growth curves and predictors of depressive symptoms among Chinese adolescent earthquake survivors☆

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ABSTRACT

The objective of this longitudinal study was to identify growth curves and related predictors of depressive symptoms among Chinese adolescent earthquake survivors. A total of 1573 adolescent survivors of the 8-magnitude Wenchuan earthquake were assessed through the Depression Self-Rating Scale for Children (cutoff for probable clinical depression: 15), Social Support Rate Scale, Adolescent Self-Rating Life Events Checklist, and a self-designed questionnaire covering earthquake exposure and demographic information at 6-, 12-, 18-, 24- and 30-months after the earthquake. Data were analyzed using growth mixture modeling (GMM) and multinomial logistic regression. The prevalence rates of depressive symptoms were 27.6%, 40.6%, 30.9%, 37.5% and 29.8% at 6-, 12-, 18-, 24- and 30-months, respectively. GMM analysis showed four patterns of growth curves for depressive symptoms: chronic depression (25.6% of the sample), recovery (1.7%), delayed depression (4.3%), and resilience (68.4%). Female gender was related with decreased probability of resilience. Direct witness of tragic scenes during the earthquake was related with higher risk for chronic depression. More negative life events and fewer social support were also common predictors of not developing the resilience pattern. The need of providing appropriate individualized interventions for high-risk adolescent earthquake survivors is indicated.

1. Introduction

Earthquake is one of the most common natural disasters that are usually unpredictable, uncontrollable, and may cause great loss of life and property. Although it has been extensively evidenced that psychiatric disorders are prevalent in earthquake survivors, especially in children and adolescents (Davidson & McFarlane, 2006; Furr, Comer, Edmunds, & Kendall, 2010), previous research has also indicated that there are highly variable psychopathological reactive responses among earthquake survivors (Bonanno, Brewin, Kaniasty, & La Greca, 2010; Norris et al., 2002), and that the occurrence possibility of depression following earthquake among different populations varies in a wide range (Ekşi et al., 2007; Goenjian et al., 2011; Qu et al., 2012; Sharan, Chaudhary, Kavathekar, & Saxena, 1996). Yet, up till now, limited research has used growth mixture modeling or similar statistical techniques to explore the possible patterns of time-course depression trajectories among earthquake survivors. There are longitudinal studies that demonstrated the existence of heterogeneous time-course trajectories of psychiatric symptoms (including depressive symptoms) following traumatic experiences such as breast cancer (Deshields, Tibbs, Fan, & Taylor, 2006), severe acute respiratory syndrome (Bonanno et al., 2008), severe physical injury (deRoon-Cassini, Mancini, Rusch, & Bonanno, 2010), and exposure to war (Bonanno, Mancini et al., 2012). In general, these studies observed four patterns of growth trajectories for post-traumatic psychiatric symptoms: 1) chronic dysfunction (i.e., prolonged severe symptoms); 2) recovery (i.e., initial moderate to severe symptoms followed by a gradual relief); 3) delayed dysfunction (i.e., postponed outbreak of severe symptoms); and 4) resilience (i.e., stable minimal or no symptoms). However, it remains relatively unclear about the heterogeneity in the long-term course of depressive symptoms following earthquake. Our prior study collected four waves of data from a large sample of Chinese adolescents exposed to the 2008 Wenchuan earthquake, subsequently at 6-, 12-, 18- and 24-months after the disaster, and reported the time-varying changes of depressive symptoms of the whole sample, without examining individual variation in developmental trajectories of depressive symptoms (Ye, Fan, Li, & Han, 2014). Thus, the primary purpose of the present study was to include data from further follow-up and identify the latent growth curves of post-earthquake depression in Chinese adolescent earthquake survivors.

Several predictive factors for the occurrence of depression following earthquake have been widely documented, such as gender, age, injury severity, social support, exposure to earthquake, and post-earthquake life adversity (Armenian et al., 2002; Ekşi et al., 2007; Goenjian et al., 2011; Sharan et al., 1996). One drawback existing in previous studies is that they mostly used the cross-sectional design, thus making it difficult to understand whether the predictive validities of these factors

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would be different for different people at different time points after earthquake. Only a few studies have longitudinally investigated the time-varying relationships between these predictors and post-earthquake depression. For example, Ye et al. (2014) reported that whereas loss/injury of family members and direct witness of tragic scenes during the earthquake could account for higher risk of adolescents' depression from 6 to 18 months following the earthquake, they could not predict adolescents' depression from 18 to 24 months following the earthquake. However, there is a dearth of research regarding the association of these predictors to the cluster membership of depression growth trajectories, i.e. whether and how these predictors are differently related to different clusters of depression growth trajectories. Accordingly, the present study also intended to contribute to the literature by addressing this issue.

Specific objectives of the present study were: 1) to examine the prevalence of depressive symptoms in adolescent survivors of the 8-magnitude Wenchuan earthquake, which occurred on May 12, 2008, 2) to identify clusters of adolescents showing distinct growth curves of depressive symptoms, through using growth mixture modeling, and 3) to explore significant predictors for the cluster membership.

2. Method

2.1. Participants and procedure

A total of 2463 students in the 7th–10th grades from two high schools in Dujiangyan City (which is 21 km away from the epicenter and one of the ten most affected areas by the earthquake) completed a package of questionnaires 6-months after the Wenchuan earthquake. The questionnaires assessed demographic characteristics, earthquake exposure, depressive symptoms, post-earthquake negative life events, and social support. Among them, only 7th and 10th graders, totally 1573 target students, were voluntarily recruited for the current study so that participants could be followed for at least 2 years before their graduation. Participants came from a variety of socio-economic backgrounds and thus could be considered representative of high school student population in the area.

All 1573 target students participated in the initial survey 6-months after the earthquake (T_1; November 10–17, 2008) and were successfully followed up in 12-months (T_2; May 18–22, 2009), 18-months (T_3; November 23–27, 2009), 24-months (T_4; May 17–21, 2010) and 30-months (T_5; November 22–26, 2010). However, not all of them provided complete data on the measure of depressive symptoms at each wave of survey. Specifically, 1565 participants (99.5%) provided it at T_1, 1429 (90.8%) at T_2, 1287 (81.8%) at T_3, 1312 (83.4%) at T_4, and 1035 (65.8%) at T_5. Only those (N = 1501) who provided complete data on the measure of depressive symptoms in at least 2 waves were included in the analyses for the current study. Table 1 presents demographics and earthquake exposure of the sample.

Ethics approval was granted by the Human Research Ethics Committee of the corresponding author's institution. Signed informed consent from both participants and their parents was obtained before each participant commenced the study. Participants were informed that they could withdraw from the study at any time.

2.2. Measures

Demographic information such as gender, age, number of siblings, grade, and location of residence was obtained at T_1.

Depressive symptoms were measured by the Depression Self-Rating Scale for Children (DSRSC, Chinese-language version) (Su, Wang, Zhu, Luo, & Yang, 2003). Participants rated on a 3-point scale to report the frequency of 18 symptoms (0 = 'never' to 2 = 'mostly'). Su et al. (2003) established a norm for 8- to 16-year-old Chinese children from 14 cities in China and reported an average score of depressive symptoms of 9.77 (SD = 4.83). As it has been recommended for Chinese children, a cutoff score of 15 was considered for the presence of significant depressive symptoms (Su et al., 2003). In this study, Cronbach's alphas were 0.80, 0.81, 0.82, 0.84 and 0.84 at T_1, T_2, T_3, T_4 and T_5, respectively.

Table 1
Demographics and earthquake exposure of participants (N = 1501).

Variable	n (%) or mean (SD)
Age at initial survey	15.0 (1.3)
Gender	
Female	826 (55.0)
Male	675 (45.0)
Grade	
7th grade	215 (14.3)
10th grade	1286 (85.7)
No. of children in the family	
1	1243 (82.8)
≥2	258 (17.2)
Residence location (n = 1459)[a]	
Urban	992 (68.0)
Rural	467 (32.0)
Family member injury or killed/missing (n = 1471)[a]	
No	1093 (74.3)
Injured	186 (12.6)
Killed/missing	192 (13.1)
House damage (n = 1467)[a]	
Minor/no	456 (31.1)
Moderate	381 (26.0)
Severe	630 (42.9)
Property loss other than house damage (n = 1475)[a]	
Minor/no	636 (43.1)
Moderate	516 (35.0)
Severe	323 (21.9)
Direct witness of tragic scenes (n = 1418)[a]	
No	570 (40.2)
Yes	848 (59.8)

[a] Number of participants differed from N = 1501 due to missing data.

Intensity of exposure to the earthquake was assessed at T_1 using four items: death, injury and/or missing of family members, house damage, property loss, and direct witness of tragic scenes. The first item included five choices: 1 = death of a family member, 2 = missing of a family member, 3 = severe injury of a family member, 4 = moderate injury of a family member, and 5 = none of the above. The other three items were rated on a 5-point scale, with 1 representing the highest level of exposure and 5 representing the lowest.

Post-earthquake negative life events were recorded at T_1 and T_4 for a time period of last six months, using the Adolescent Self-Rating Life Events Checklist (Chinese-language version) (Liu et al., 1997), which comprises 26 items and assesses life events including: interpersonal conflicts, academic pressure, family conflicts, punishment by guardians or teachers, humiliation, monetary loss, health problems, and death or illness of family members. A 5-point scale was used to rate the severity of negative life events (1 = 'never happened' to 5 = 'happened with very strong impact'), with a higher total score indicating greater severity. In this study, Cronbach's alphas were 0.88 and 0.91 at T_1 and T_4, respectively.

Post-earthquake social support was measured by the Social Support Rate Scale (Xiao, 1994) at T_1 and T_4 for a time period of last six months. It includes 10 items clustering into 3 dimensions of objective support, subjective support, and utilization of social support. In this study, we adjusted the semantic expression of some items to suit the sample characteristics. For example, we changed "perceived support from the spouse" into "perceived support from companions". In this study, Cronbach's alphas were 0.76 and 0.80 at T_1 and T_4, respectively.

2.3. Statistical analysis

As noted above, we include in the analyses only the participants (N = 1501) who provided complete data on DSRSCS in at least 2 waves. Among them, 872 (58.1%) provided complete data on DSRSC across all five waves and 629 (41.9%) had missing data on DSRSC in at

least one wave. To clarify the missing data mechanism, we used the *t*-test to compare the mean scores of depressive symptoms at the initial wave between participants who provided complete data across all waves and those who had missing data in at least one wave. There was no significant between-group difference ($t = -0.98$, $df = 1491$, $p = .329$), suggesting that the attrition was unrelated to the initial depressive symptoms and the data were missing randomly (Rubin, 1976). The expectation–maximization algorithm was then applied for filling missing data.

Because some categories within the four items of earthquake exposure had very few participants, we recorded the first three items into three categories (severe, moderate, minor/no), and the last item 'direct witness of tragic scenes' into two categories (yes and no). Negative life events and social support were treated as continuous variables.

The prevalence rate of depression at each time point was computed using the cutoff point of 15 (i.e., scored ≥ 15) on the DSRSC. Growth mixture modeling (GMM) was applied to identify discrete patterns of growth curves of depressive symptoms. One- to six-cluster unconditional models (without covariates) were first tested. The best fitting model was selected based on the lowest information criteria (AIC and BIC), a high entropy (close to 1.0), and statistically significant *p* values for both the Lo–Mendell–Rubin (LRT) and bootstrap likelihood ratio test (BLRT) (Muthén, 2003). Then, demographics and questionnaire variables including earthquake exposure, social support, and negative life events were entered as covariates to create conditional models. Only variables whose inclusion allowed for model convergence and improved model fit were retained. Then, a multinomial logistic regression was performed using depression cluster membership as the categorical outcome variable to identify significant predictors. All analyses were performed using SPSS 20.0 and Mplus 7.0.

3. Results

3.1. Prevalence and latent clusters of depression

The prevalence rates of depressive symptoms were 27.6%, 40.6%, 30.9%, 37.5% and 29.8% at T_1, T_2, T_3, T_4 and T_5, respectively. Regarding time-varying changes of depressive symptoms among the whole sample: (1) 97 participants (6.5%) who scored above the cutoff point at T_1 had no longer significant depressive symptoms at T_2 (i.e., got better), and 292 (19.5%) who did not show significant symptoms at T_1 turned to meet the criterion for depression at T_2 (i.e., got worse); (2) from T_2 to T_3, 254 participants (16.9%) got better and 109 (7.3%) got worse; (3) from T_3 to T_4, 114 participants (7.6%) got better and 213 (14.2%) got worse; and (4) from T_4 to T_5, 215 participants (14.3%) got better and 100 (6.7%) got worse. Of the whole sample, 38.5% (n = 578) did not meet the criterion for significant depressive symptoms at any of the five time points, while 11.6% (n = 174) had significant depressive symptoms at all five time points.

GMM analysis showed that for unconditional modeling, a four-cluster solution was optimal (Table 2). A series of nested analyses were further conducted on the four-cluster solution to identify possible covariates that might improve model fit. In the final model, cluster assignment and growth parameters were regressed on gender, age, number of siblings, earthquake exposure, negative life events at T_1 and T_4, and social support at T_1 and T_4, which resulted in an improvement in model fit, AIC = 39,686.89, BIC = 39,959.85, SSBIC = 39,794.67, entropy = 0.854. Table 3 presents parameter estimates in the final model. Fig. 1 illustrates the mean scores of depressive symptoms for each cluster (based on the unconditional modeling) at each time point, as well as the comparison with the norm for Chinese children on the DSRSC. Based on the initial levels and change patterns of depressive symptoms, the four clusters were labeled as chronic depression (25.6% of the sample), recovery (1.7%), delayed depression (4.3%), and resilience (68.4%).

3.2. Predictors of depression cluster membership

Since the resilience cluster comprised the majority of the sample and was the focus of our interest, we designated it as the referent cluster while running the multinomial logistic regression. Predictors tested in the logistic regression were gender, age, number of siblings, earthquake exposure, negative life events at T_1 and T_4, and social support at T_1 and T_4. Significant predictors are shown in Table 4. Males were less likely to show chronic depression [OR = 0.60, 95% confidence interval (95% CI) = 0.45–0.79] and recovery patterns (OR = 0.33, 95% CI = 0.12–0.88) in relation to the pattern of resilience. As for earthquake exposure, adolescents who directly witnessed tragic scenes during the earthquake were more likely to develop chronic depression (OR = 1.32, 95% CI = 1.00–1.75).

Post-earthquake negative life events and social support also predicted cluster membership of depressive symptoms. More negative life events at T_1 significantly increased the probability of belonging to the clusters of chronic depression (OR = 1.04, 95% CI = 1.03–1.06) and recovery (OR = 1.09, 95% CI = 1.06–1.12). More negative life events at T_4 were also related with higher risk of chronic depression (OR = 1.01, 95% CI = 1.00–1.02). The probability of developing chronic depression could also be accounted for by fewer social support at T_1 (OR = 0.91, 95% CI = 0.89–0.93). Adolescents reported fewer social support at T_1 (OR = 0.83, 95% CI = 0.77–0.89) and greater social support at T_4 (OR = 1.10, 95% CI = 1.03–1.18) were more likely to exhibit the recovery pattern than the resilience one. Greater social support at T_1 (OR = 1.10, 95% CI = 1.05–1.15) and fewer social support at T_4 (OR = 0.95, 95% CI = 0.92–0.99) were related with increased possibility of having delayed depression.

4. Discussion

To our knowledge, this is the first study that used growth mixture modeling to explore the latent growth curves of depressive symptoms and related predictors among Chinese adolescent earthquake survivors. The prevalence rates of depressive symptoms were 27.6%, 40.6%, 30.9%, 37.5% and 29.8% at 6-, 12-, 18-, 24- and 30-months, respectively. As compared with previous studies that estimated depression prevalence in other samples who survived from the Wenchuan earthquake,

Table 2
Fit indices for one- to six-cluster growth mixture models (unconditional) for depressive symptoms among Chinese adolescent earthquake survivors.

Fit indices	Growth mixture model					
	1 Cluster	2 Cluster	3 Cluster	4 Cluster	5 Cluster	6 Cluster
AIC	42913.89	42872.88	42849.15	42821.64	42819.28	42812.11
BIC	42967.02	42941.96	42934.17	42922.61	42936.19	42947.96
SSBIC	42935.26	42900.66	42883.34	42862.25	42866.30	42868.54
Entropy		0.592	0.844	0.721	0.754	0.641
LRT *p* value		0.002	0.201	0.030	0.045	0.295
BLRT *p* value		<0.001	<0.001	<0.001	0.182	0.111

Abbreviations: AIC = Akaike information criterion, BIC = Bayesian information criterion, SSBIC = sample size adjusted Bayesian information criterion, LRT = Lo–Mendell–Rubin test, BLRT = bootstrapped likelihood ratio test.

Table 3
Growth factor parameter estimates (standard error) of 4-cluster conditional model for depressive symptoms among Chinese adolescent earthquake survivors.

Cluster	Intercept		Slope	
	Estimate (S.E.)	*p* value	Estimate (S.E.)	*p* value
Chronic depression	15.97 (0.53)	<0.001	−0.11 (0.11)	0.353
Recovery	12.26 (0.98)	<0.001	−1.37 (0.27)	<0.001
Delayed depression	5.33 (0.46)	<0.001	−0.17 (0.18)	0.357
Resilience	9.75 (0.23)	<0.001	−0.01 (0.09)	0.893

prevalence rates of depressive symptoms reported in this study were relatively lower. For example, in a study by Cheng et al. (2015), a sample of 182 temporary settlement residents reported a depression prevalence rate of 48.9% at 12-months after the earthquake. Another study (Liu, Fan, & Liu, 2013) investigated 155 bereaved parents in this disaster and found that 65.8% and 44.5% of them respectively endorsing depression at 18- and 24-months post-earthquake. These discrepant estimates may be due to demographic variation across samples, different severities of samples' earthquake exposure, or different measures of depressive symptoms. The current results also showed that the prevalence rates of depressive symptoms tended to be higher at 12- and 24-months, indicating an "anniversary effect". This highlights the importance of providing adolescent earthquake survivors with more intensive mental health support around the anniversary dates.

The current study identified four patterns of growth curves for depressive symptoms: resilience, chronic depression, delayed depression, and recovery. The majority of the sample (68.4% for resilience) were euthymic across time. This is consistent with previous studies that explored the heterogeneity in depressive trajectories following traumatic experiences other than earthquake (Bonanno, Mancini et al., 2012; Bonanno et al., 2008; deRoon-Cassini et al., 2010; Deshields et al., 2006). For example, one study (Bonanno, Kennedy, Galatzer-Levy, Lude, & Elfström, 2012) longitudinally followed 233 patients suffering from spinal cord injury for 2 years and found that most of them were euthymic. These studies together with our results suggest that most people can have good adaptation to real-life traumatic events. In contrast with the resilience cluster, consistent with recent meta-analyses (Bonanno et al., 2010), about one fourth of the current sample exhibited chronic depression (25.6%). Two other growth curves revealed in the current sample were delayed depression (4.3%) and recovery (1.7%). These patterns have been commonly observed in aforementioned studies regarding the developmental trajectories of depressive symptoms post-trauma. It should be noted, however, that the proportions of our sample showing these two patterns were relatively lower than those in past studies. For example, Bonanno, Kennedy et al. (2012) reported that delayed depression and recovery respectively comprised 9.8% and 13.3% of the 233 spinal cord-injured patients. Also, deRoon-Cassini et al. (2010) followed 330 physical injury victims for six months and found that 17% and 14% of them showed delayed depression and recovery, respectively. These inconsistent proportions might be attributable to differences in sample demographics, trauma types, duration and frequency of the follow-up, instruments used to evaluate the depressive symptoms, the definition of significant depressive symptomatology, as well as the presence and the extent of risk/protective factors across studies.

Our study also verified the association of earthquake exposure, gender, social support, and post-earthquake negative life events in predicting cluster membership of depressive symptoms. Greater severity of earthquake exposure increases the risk for post-earthquake depression (Armenian et al., 2002; Qu et al., 2012; Sharan et al., 1996). Consistent with these findings, our study found that direct witness of tragic scenes during the earthquake could put adolescent survivors at higher risk for chronic depression. As for gender, our data showed an association between male gender and decreased probability of chronicity and recovery in relation to resilience. That is, female gender was related with decreased probability of resilience. Previous studies have pointed out that females rather than males are more prone to post-earthquake depression (Goenjian et al., 2011; Sharan et al., 1996). However, these studies were mainly cross-sectional and only examined the gender effect on depressive symptoms at one point in time after earthquake. Unlike these studies, the current study explored how gender was related to distinct growth curves of depressive symptoms and demonstrated that females were less likely to maintain euthymia in the post-earthquake adaptation process.

Post-earthquake negative life events and social support were also found to be notable contributing factors to the heterogeneity of depression growth curves. Having more negative life events at 6-months after the earthquake significantly increased the probability of developing chronicity and recovery patterns. Prior studies have reported that individuals' mental health after a disaster may be more susceptible to post-disaster negative life events rather than the disaster per se (Freedy, Saladin, Kilpatrick, Resnick, & Saunders, 1994). Negative life events could by themselves aggravate adolescents' post-earthquake stress reactions and increase the ongoing daily hassles, which could in turn have strong adverse impact on their mental health status. As for social support, chronic depression was associated with fewer social support at 6-months. The recovery pattern could be accounted for by fewer social support at 6-months and greater social support at 24-months. Conversely, greater social support at 6-months and fewer social support at 24-months could increase the risk for delayed depression. As the literature (Armenian et al., 2002; Xu, Mo, & Wu, 2013), these

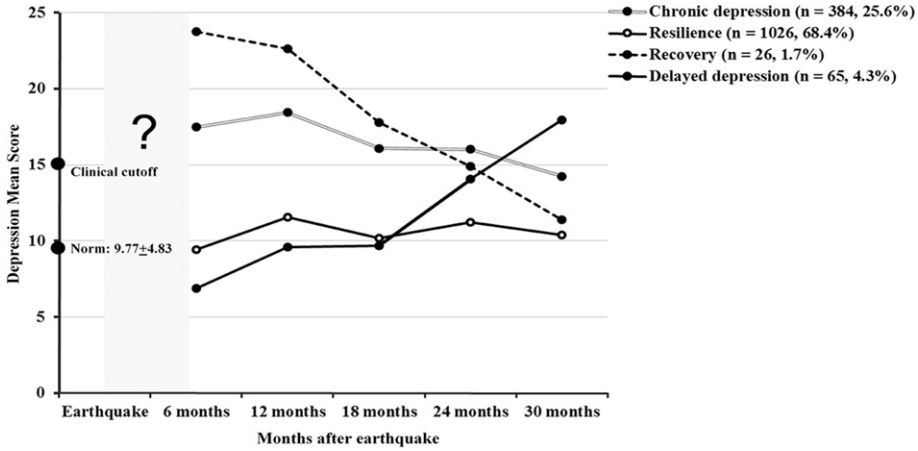

Fig. 1. Four patterns of growth curves of depressive symptoms among Chinese adolescent earthquake survivors.

Table 4
Multinomial logistic regression for predictors of depression cluster membership among Chinese adolescent earthquake survivors[a].

		Chronic depression vs. resilience		Recovery vs. resilience		Delayed depression vs. resilience	
		OR	95% CI	OR	95% CI	OR	95% CI
Gender	Female	1	–	1	–	1	–
	Male	0.60***	0.45–0.79	0.33*	0.12–0.88	1.24	0.73–2.12
Negative life events 12-months		1.04***	1.03–1.06	1.09***	1.06–1.12	1.00	0.97–1.02
Negative life events 24-months		1.01^	1.00–1.02	0.98	0.94–1.02	1.01	0.99–1.04
Social support 12-months		0.91***	0.89–0.93	0.83***	0.77–0.89	1.10***	1.05–1.15
Social support 24-months		1.00	0.98–1.02	1.10**	1.03–1.18	0.95*	0.92–0.99
Witness of tragic scenes	No	1	–	1	–	1	–
	Yes	1.32^	1.00–1.75	1.84	0.71–4.77	1.36	0.78–2.37

Abbreviations: OR = odds ratio, CI = confidence interval.
[a] Resilience was the referent cluster.
^ $p < 0.06$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

findings suggest that social support may be a protective factor against depression after traumatic experiences. Social support might promote recovery from depression by buffering the negative impact of traumatic experiences and subsequent daily-life adversity on people's psychological wellbeing.

It should be noted that this study had some methodological limitations. First, depressive symptoms and other variables were assessed using self-report measures. As opposed to more objective assessments like clinical interviews, self-report measures may be prone to reporting bias. However, we used in the study well-established measures that are wildly utilized in psychopathological research and practice among adolescents in China. In addition, self-report measures could provide an insight into how one perceives his/her own mental status, which serves as a basis of clinical diagnosis of mental disorders. Second, data were collected in school settings, making it difficult to continue the follow-up after the participants graduated from the selected schools. To extend the follow-up period as long as possible, only 7th and 10th grade students were included for this study, so that they can be tracked for at least two years before their graduation. Finally, we could not administrate assessments immediately after the earthquake, because during the first 6 months after the earthquake we applied for ethical approval for the study and data collection could not start until the ethical approval had been obtained. Despite the lack of data during the first 6 months, our study had been carefully designed and organized and thus was able to follow a large sample of adolescents for over two years after the earthquake.

Despite the limitations, this study made a unique contribution to the literature, as it is the first known study that employed sophisticated analytic procedures to examine potential patterns of depression growth curves and related predictors among Chinese adolescent earthquake survivors. The results could inform mental health professionals regarding the identification of adolescents who are at risk of chronic depressive symptoms post-earthquake and are possibly having exacerbation of their depressive symptoms during the anniversary dates. Providing individualized mental health services and interventions for adolescent earthquake survivors particularly those with significant clinical depression is indicated.

Conflict of interest

The authors report no potential conflicts of interest.

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