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Gender differences in trajectories of mental health symptoms among Chinese earthquake survivors

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ABSTRACT

Background: Posttraumatic stress symptoms and depressive symptoms are prevalent after natural disasters. However, in a Chinese trauma context, little research examined the long-term trajectories of these two symptoms with a gender perspective.

Methods: Data came from an 8-year longitudinal survey of 3522 Wenchuan earthquake adult survivors. We used multilevel growth-curve models to investigate the trajectories of PTSS and depressive symptoms; adopted conditional growth-curve models to explore the gender differences in trajectories together with gendered factors associated with mental health symptoms; conducted Chow tests to examine the significance of gender differences. Standardized coefficients, P values, and effect sizes were reported.

Results: With covariates controlled, both linear ($\beta = -1.33$, $p < 0.001$, Cohen's $d = 0.79$) and quadratic effects ($\beta = 1.03$, $p < 0.001$, Cohen's $d = 0.59$) of time were significant in PTSS trajectory, whereas quadratic effect ($\beta = 0.27$, $p < 0.001$, Cohen's $d = 0.14$) in the declining depressive trajectory was clinically nonsignificant. Compared with men, women are at higher risk of PTSS ($\beta = 0.12$, $p < 0.001$, Cohen's $d = 0.21$) and depressive symptoms ($\beta = 0.10$, $p < 0.001$, Cohen's $d = 0.20$), but also with a faster-declining rate in PTSS within first five years after the disaster. No gender difference was found regarding depressive trajectory. Additionally, poor education and income associate with more PTSS in women, while sickness predicts severer depression in women and more PTSS in men.

Conclusions: This study proposes a gendered U-shape trajectory for PTSS and a declining depressive trajectory without gender difference. The findings of this study shed light on mental health intervention in future natural disasters.

1. Introduction

Posttraumatic stress symptoms (PTSS) and depressive symptoms are prevalent mental health outcomes of natural disasters such as earthquakes. Trauma studies began to focus on the psychological burden of natural disasters during the past years, which estimated a 4.1 percent to 67.07 percent prevalence for PTSS (Tang et al., 2017) and a 5 percent to 50 percent prevalence for depressive symptoms (Tang et al., 2014). Besides prevalence, a growing literature has detailed heterogeneous trajectories of mental health symptoms after disasters (Beaglehole et al., 2019). Current knowledge regarding the course of PTSS and depressive symptoms is based primarily on retrospective studies in Western contexts (Galatzer-Levy, 2015; Norris et al., 2009), and allocate individuals into groups. In common, there were four distinct patterns, noted as resilience, chronic, delayed onset, and recovery, respectively (Bonanno, 2004). However, to comprehensively evaluate the mental health burden of disasters, longitudinal research on psychopathology typically presumes a variable-oriented model in which changes over time for each individual are assumed to reflect variation within a generalizable and normative pattern (Karamustafalioglu et al., 2006). A systematic review showed that the mean prevalence of PTSS across 35 disaster studies dropped from 28.0% at 1 month to 14.8% at 12 months (Santiago et al., 2013), but only one of these studies was conducted in the Asian context. Later, a quadratic effect of time on psychological

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symptoms was observed, indicating a decelerated decrease in symptoms over time (Lungu et al., 2020). Knowing the patterns of mental health symptoms informs health system interventions after a disaster, but to our knowledge, evidence concerning the long-term trajectories of mental health indicators including PTSS and depressive symptoms is lacking in the Chinese adult population.

1.1. Gender as a perspective

Gender differences in mental health symptoms are conceived as one of the most robust phenomena in psychiatry. In general, the gender gap in PTSS is well-established with a substantial 2:1 ratio favoring women, which is not a product of measurement error, methodological bias, reporting bias, or file-drawer effects (Christiansen and Berke, 2020). When it comes to differences in depression, a recent meta-analysis also reported an average odds ratio of 1.95 for women versus men (Hyde and Mezulis, 2020). It has been argued that gender associates with mental health symptoms via a series of mediation and moderation effects (Christiansen and Hansen, 2015; Hyde and Mezulis, 2020), with socio-cultural gender and biological sex are involved.

The vulnerability-stress model is helpful to understand why gender differences in mental health symptoms emerged (Cicchetti and Rogosch, 1996; Hankin and Abramson, 2001). On the one hand, vulnerabilities regarding affective, biological, and cognitive factors mediate the effects of gender on PTSS and depressive symptoms. Often, women are higher in negative emotionality and attentional reactivity, which lowers the thresholds of psychological diseases; whereas substantial affective suppression in men causes under-reporting of symptoms (Christiansen, 2015; Mauer et al., 2020). In addition, when confronted with internal and/or external stresses, biological characteristics including gonadal hormone and genetic factors of women are critical to cognitive-behavioral models of PTSS and depression development (Wray et al., 2018; Yehuda et al., 2015). Also, women engaged in more brooding and reflection (i.e., rumination) after experiencing traumas, and such cognitive vulnerabilities prospectively predict elevated levels of psychological symptoms (Spendelow et al., 2017). On the other hand, gender moderates the effects of stress-related factors and other adverse events on PTSS together with depressive symptoms. Since women and men developed differential approaches and levels of effectiveness in coping with trauma-related stressors, previous evidence revealed that gender moderates the relationships of pretraumatic, peritraumatic, and posttraumatic factors with mental health outcomes (Christiansen, 2015). However, effect sizes and the significance of moderation effects vary between different studies (McAllister et al., 2018; Christiansen, 2015). Thus, we hypothesize in the current study that women have higher levels of PTSS and depressive symptoms than men in the aftermath of the Wenchuan earthquake, but whether and how gender modifies the associations between traumatic or non-traumatic stressors and mental health indicators are open for discussion.

Moreover, no consensus about gender differences in mental health trajectories has been reached. One of the most frequently discussed factors affecting the trajectories of trauma-focused psychopathologies is psychological intervention. In some studies, women were found to have more severe and chronic psychopathologies, thereby demonstrating a worrying trend, although they generally respond better to treatments than men (Kilpatrick et al., 2013; Tolin and Foa, 2006). By contrast, one meta-analysis suggested that women showed a greater reduction in mental health symptoms at both post-intervention and short-term follow-up (Wade et al., 2016). Another factor accounting for the trajectories of PTSS and depressive symptoms is trauma-related experiences following the initial exposure. For instance, women in the military had a 6–7 times higher rate of PTSS than men before the initiation of OIF (Operation Iraqi Freedom, OIF), but there was no difference in PTSS by gender by 2008 (Cameron et al., 2019). However, another study suggests mental health recovers more slowly for women than for men when societal conditions improved, indicating a linear relationship between societal improvement and the gender difference in PTSS (Zuckerman et al., 2017). Sometimes, trajectories of mental health indicators for men and women differ qualitatively. One study in Korea unraveled four sub-groups of depressive trajectories for men but five sub-groups for women (Lee et al., 2017). Another study from Australia reported a cubic trajectory for depressive symptoms among boys and a quadratic trajectory among girls (Lewis et al., 2020). Differences in trauma types, population age, cultural factors, methodological designs, and types of psychological symptoms contributed to this inconsistency. Thus, with evidence from Chinese adults, this study aims to investigate the trajectories of PTSS and depressive symptoms after the Wenchuan earthquake, also to identify possible gender differences.

1.2. The Wenchuan earthquake

One of the worst natural disasters in recent Chinese history occurred on May 12, 2008. A devastating earthquake with a magnitude of 8.0 on the Richter scale struck Wenchuan in Sichuan Province. A total of 237 counties and 252,000 km^2 areas were severely damaged, and victims there were reported to be vulnerable to adverse mental health outcomes (Zhou et al., 2015). Types of psychological rehabilitation projects, including clinics in hospitals, hotlines for consultation, professional staffs serving in communities and villages et al., were conducted in disaster areas (NDRCC, 2008), but mental health remained attention-worthy in affected populations. Our previous review provides a detailed description of the changing prevalence of psychiatric disorders (Fu et al., 2019). As noted, the prevalence of PTSS among adult survivors of the Wenchuan earthquake varied from the highest 56.8% (2 months after the disaster), 8.0% at 14 months, and 11.8% 8 years after the disaster. Comparatively, the prevalence of depression was more stable. Among adult survivors, 22.9% had significant depressive symptoms 8 months after the earthquake, followed by a prevalence of 37.6% at the 14th month follow-up and about 20% at the 26th month follow-up and afterward. However, cross-sectional analyses provide limited evidence to investigate the long-term trajectories of PTSS and depressive symptoms.

1.3. Aims and hypotheses

This study aims to explore the trajectories of PTSS and depressive symptoms among Wenchuan earthquake adult survivors, particularly from a gender perspective. Based on the literature review above, there are three hypotheses in the current study. First, we propose that women present higher levels of PTSS and depressive symptoms than men in the aftermath of trauma. Our second hypothesis concerns the trajectories of mental health symptoms, and whether this longitudinal sample of adult men and women in China presents differential patterns. Based on the available literature, we hypothesize that PTSS and depressive symptoms would decrease with quadratic effects in the long run. At the same time, the trajectories for women and men would be differential. Last, we explore potential correlates relating to mental health symptoms with different effect sizes across gender. As noted by previous studies (Ando et al., 2017; van den Berg et al., 2012), factors in this study including socioeconomic factors such as education and income; stressors such as sickness; cultural factors such as ethnic beliefs, and gender norms in social support and substance use. We presume that there would be a significant gender difference in the risk factors of mental health symptoms.

2. Methods

2.1. Study design and participants

Data in this study were obtained from a community-based longitudinal survey, to investigate mental health among Wenchuan earthquake survivors. As existing studies suggested, the prevalence of PTSS in

mainland China ranged from 13% to 30.3% (Cao et al., 2003; Wang et al., 2000). Therefore, to estimate the sample size, the current study used the average of these prevalence estimates (22%), with expected attrition of 30%, and a sampling error within 3%. As a result, the sample size of this study was determined as 1035 participants. A total of six waves in the survey were conducted in two severely affected townships. Yongan (in Mianyang) is a mountainous township, locates 115.7 km from the epicenter, with over 90% of whose buildings were damaged during the earthquake. Guangji (in Mianzhu) locates on a plain, about 58.3 km away from the epicenter, with 96% of its buildings being damaged during the disaster. Both townships were close to the epicenter but at somewhat different distances, and they had similar socioeconomic and demographic characteristics before the earthquake. In total, there were 29 villages and about 63,990 residents in these two townships.

The study employed a multi-stage systematic sampling design to select participants. Households rather than individuals were systematically selected as a basic unit for the entire survey. For each selected household, we invited an adult member to participate. Baseline (wave 1) was conducted among 1017 adults from 12 of 29 villages, at 2 months after the onset of the earthquake (throughout July 2008). Follow-up studies were repeated five times, at 8 months, 14 months, 26 months, 44 months, and 93 months (7.75 years) after the trauma, respectively. For individuals that were unavailable in follow-up studies, another adult member in his/her household was invited. For vacant households in a village, their nearest neighbors were selected as supplementary. From wave 2 to wave 6, a total of 2505 new respondents were recruited. Details for sample construction in six waves were presented in Fig. S1.

In total, this study surveyed 3522 individuals, ages ranging from 18 to 87 years old. Due to death, migration, or replacement by another family member, 1146 of the 3522 respondents engaged in a single wave of this study, which resulted in an attrition rate of 32.5%. Among participants reporting at least 2 observations, 18.9% of them engaged in 3 waves, 8.6% in 4 waves, 2.6% in 5 waves, and <1% in all 6 waves. A total of 7090 person-time observations were collected through six waves of this study.

2.2. Measurements

PTSS were assessed by the Impact of Event Scale-Revised (IES-R) (Hyer and Brown, 2008), a self-report instrument widely used in the field of traumatic stress. It includes 22 items to measure three major symptom clusters: intrusion, avoidance, and hyperarousal. The IES-R has good and stable psychometric properties (Creamer et al., 2003). The Chinese version of the IES-R has been found to have satisfactory psychometric properties, comparable to those of the original English version (Wu and Chan, 2003). In this study, each participant was asked to indicate how often they had suffered from the types of distress described in each of the 22 items, on a four-point scale (0 = not at all, 1 = seldom, 2 = sometimes, 3 = often). The internal consistency coefficients (Cronbach's alpha) of the whole scale in six waves of this study were 0.87, 0.92, 0.88, 0.91, 0.91, and 0.93, respectively. We applied a cutoff point of mean score of 2.0 across all items, following the example of previous research (Qu et al., 2012).

Depressive symptoms were evaluated by the Chinese edition of the Center for Epidemiologic Studies Depressive symptoms (CES-D) (Wang, 1999) Scale. This scale is the most widely used depression screening scale and has been frequently used in community-based studies. The Chinese version of the CES-D scale has shown good reliability and validity across all age groups in urban populations (Zhang et al., 2010). In our study, we used 21 as the cutoff point, which is a good predictor for major depressive symptoms in Chinese populations (Cheng and Chan, 2005).

Time was used to indicate the interval between survey panels and the disaster with a year unit. The coefficient of Time and Time^2 denotes the linear and quadratic trend of the mental health indicators, respectively.

The primary independent variable in this study was gender. Gender was a dichotomous categorical variable with 0 for men and 1 for women. Covariates were a set of factors that might associate with the levels of PTSS and depressive symptoms, such as age, education (primary school or below/middle school or above), income (below average/above average), area (Mianyang/Mianzhu), ethnicity (Han/Minorities), marital status (partnered/unpartnered), drinking (yes/no) or smoking behaviors (yes/no), and whether had chronic or acute sickness within the last two weeks (yes/no).

2.3. Statistics

Descriptive analyses were conducted to introduce the sample distribution and test the variable characteristics between gender. As data was structured as unbalanced cross-sectional time series, we adopted multilevel growth-curve modeling (MGCM) (Halaby, 2007) to explore a generalized trajectory for PTSS and depressive symptoms among all survivors. Moreover, we divided the total sample into women and men, used conditional growth-curve models to explore the gender differences in mental health trajectories, as well as the gendered factors relating to mental health sequels. All variables included in regression models have been standardized. P values with Benjamini & Hochberg correction were used to indicate the significance of the coefficients at 95% level, and cohen's d denotes the magnitude of the effect sizes. Chow tests were conducted to examine the significance of the gender differences above. All models were estimated via Stata 14 (Stata Statistical Software: Release 14, 2015).

MGCM demonstrates a mean trajectory across included individuals and decomposes the total variance into inter-individual variance and intra-individual changes (Willett and Sayer, 1994). In the current study, we constructed a two-level multilevel regression (MLR) model: repeated measures of each individual for level_1, and individuals for level_0. The mixed growth-curve model for Y_{ij} of individual i at occasion j, was written as:

$$Y_{ij} = \gamma_{00} + \gamma_{10}T_{ij} + \sum_{q=2}^{5}\gamma_{q0}X_{1qij} + \sum_{q=1}^{6}\gamma_{0q}X_{0qij} + \left[\zeta_{0i} + \zeta_{1i}T_{ij} + \varepsilon_{ij}\right],$$

where γ_{00} denotes the average true initial status at wave 1, γ_{10} refers to the average true rate of change, and T_{ij} represents time since the baseline for individual i at occasion j. Meanwhile, X_{0q} is a set of dummy individual-level characteristics, including gender, area, education, ethnicity, smoking, drinking, while X_{1q} is a series of dummy occasional-level characteristics, such as income, sickness, marital status, and age. γ_{0q} and γ_{q0} are the fixed effects of corresponding variables. This model partitions the total random errors into components at different levels, while ζ_{0i} denoting inter-person random effects in initial status and ζ_{1i} representing inter-person random effects in the rate of change, ε_{ij} is the intra-person random errors. Each of the three types of random errors has its own variance.

3. Results

3.1. Descriptive analyses

In Table 1 the characteristics of men and women in this study, together with the significance and magnitude of their differences, are presented. Compared with men, women are at higher risks of PTSS and depression, given the higher prevalence in the rate of onsets and more symptoms. Across six waves, about 15.48% of men had diagnosed PTSS and 20.6% had major depression, whereas the corresponding prevalence among women was 26.97% and 29.11%, respectively. Regarding PTSS, the mean value was 1.05 (SD = 0.90) for men and 1.44 (SD = 1.00) for women, where a significant difference exists ($\eta^2 = 0.41$, $p < 0.001$). When it comes to depressive symptoms, a mean value of 14.77 (SD = 7.24) was found for men and a value of 17.01 (SD = 7.87) was for

Table 1
Socio-demographic characteristics and mental health status of the sample by gender division (Obs = 7090).

Variables	Total		Men		Women		P value	η2	Cramer's V
	N(Mean)	%(SD)	N(Mean)	%(SD)	N(Mean)	%(SD)			
Waves							**<0.001*****		0.09
Wave1	1017	14.34	388	12.73	629	15.57			
Wave2	1322	18.65	479	15.71	843	20.86			
Wave3	1168	16.47	521	17.09	647	16.01			
Wave4	1082	15.26	462	15.15	620	15.34			
Wave5	1205	17.00	591	19.38	614	15.19			
Wave6	1296	18.68	608	19.94	688	17.03			
PTSS	1.27	0.98	1.05	0.90	1.44	1.00	**<0.001*****	**0.41**	
Depressive scores	16.03	7.68	14.77	7.24	17.01	7.87	**<0.001*****	**0.34**	
PTSD							**<0.001*****		**0.14**
Yes	1562	22.03	472	15.48	1090	26.97			
No	5528	77.97	2577	84.52	2951	73.03			
Depression							**<0.001*****		**0.10**
Yes	1538	25.38	547	20.60	991	29.11			
No	4521	74.62	2108	79.40	2413	70.89			
Age	51.46	14.08	53.89	14.28	49.63	13.65	**<0.001*****	**0.30**	
Area							0.82		−0.01
Mianzhu	3914	55.20	1688	55.36	2226	55.09			
Mianyang	3176	44.80	1361	44.64	1815	44.91			
Education							**<0.001*****		**0.13**
High	1988	28.04	1059	34.73	929	22.99			
Low	5102	71.96	1990	65.27	3112	77.01			
Ethnic							**<0.001*****		0.06
Minority	348	4.91	106	3.48	242	5.99			
Han	6742	95.09	2943	96.52	3799	94.01			
Income							0.08		−0.02
High	3528	49.76	1481	48.57	2047	50.66			
Low	3562	50.24	1568	51.43	1994	49.34			
Smoking							**<0.001*****		**−0.51**
Yes	2135	30.11	1738	57.00	397	9.82			
No	4955	69.89	1311	43.00	3644	90.18			
Drinking							**<0.001*****		**−0.50**
Yes	2073	29.24	1697	55.66	376	9.30			
No	5017	70.76	1352	44.34	3665	90.70			
Sickness							**<0.001*****		0.09
Yes	2944	41.52	1103	36.18	1841	45.56			
No	4146	58.48	1946	63.82	2200	54.44			
Marital status							**<0.001*****		0.05
Unpartnered	866	12.21	430	14.10	436	10.79			
Partnered	6224	87.79	2619	85.90	3605	89.21			

Notes: The sample size for depressive scores and depressive symptoms was 6059. Cohen's d & Cramer's V indicated the effect sizes of the gender difference. The value of 0.2–0.4 for Cohen's d denotes small effect; when df = 1, intervals for Cramer's V: <0.1: No effect, 0.1–0.3: Small effect, 0.3–0.5: Medium effect; >0.5: Large effect.

Table 2
Trajectories of PTSS: Exploring functional forms and the covariance structure (Obs = 7090).

	Model 1		Model 2			Model 3			Model 4		
	β	*P value*	*β*	*P value*	*Cohen's d*	β	*P value*	*Cohen's d*	β	*P value*	*Cohen's d*
Intercept	0.01	0.38	0.01	0.33		0.02	0.21		0.01	0.64	
Time			**−0.31*****	<0.001	0.27	**−1.36*****	<0.001	0.20	**−1.33*****	<0.001	0.79
Time^2						**1.08*****	<0.001	0.20	**1.03*****	<0.001	0.59
Gender (ref: men)									**0.12*****	<0.001	0.21
Area (ref: Mianyang)									0.02	0.12	0.05
Education (ref: High)									0.06***	<0.001	0.12
Ethnic (ref: Han)									−0.01	0.92	<0.01
Income (ref: High)									0.05***	<0.001	0.13
Smoking (ref: No)									−0.01	0.69	0.01
Drinking (ref: No)									−0.04	0.001	0.08
Sickness (ref: No)									**0.12*****	<0.001	0.26
Marital status (ref: Unpartnered)									0.04***	<0.001	0.09
Age									0.05***	<0.001	0.10
Variance components	***Estimate***	***Std. Err.***	***Estimate***	***Std. Err.***		***Estimate***	***Std. Err.***		***Estimate***	***Std. Err.***	
In initial status	0.32	0.02	0.37	0.02		0.13	0.01		0.08	0.01	
In rate of change			<0.01	<0.01		0.01	<0.01		0.01	<0.01	
Covariance			−0.03	<0.01		−0.03	<0.01		−0.02	<0.01	
Within Person	0.95	0.01	0.89	0.01		0.70	0.02		0.69	0.01	
Chi2			803.61			1468.04			2084.70		

Notes: All variables in the model have been standardized. The values of coefficients and 95% confidence interval represent statistically significant at 0.05 level. P values have been adjusted with the Benjamini & Hochberg correction. The values of Cohen's d represent the clinically significance, d ≥ 0.2, d ≥ 0. 5, and d ≥ 0.8. represent small, medium, and large effect sizes, respectively. All nested models passed the Likelihood Ratio Test.

women, also with a significant gender difference ($\eta^2 = 0.34$, $p < 0.001$). No significant gender differences were found in the area distribution and between income groups. While respondents in this study were between 18 to 87 years old (Mean = 51.46, SD = 14.08), women were younger on average than men (49.63 vs 53.89; $\eta^2 = 0.30$, $p < 0.001$). Also, women were less likely to have a high education (22.99% vs 34.73%; Cramer's V = 0.13, $p < 0.001$), and developed fewer smoking (9.82% vs 57.0%; Cramer's V = −0.51, $p < 0.001$) or drinking behaviors (9.30% vs 55.66%; Cramer's V = −0.50, $p < 0.001$). More details regarding the sample description could be seen in Table 1.

3.2. The U-shape PTSS trajectory

Table 2 demonstrates the U-shape trajectory of PTSS. An intercept-only model was used to investigate the grand mean across individuals and occasions. Results of variance components indicated that about 25.2% of the total variance in PTSS was attributed to inter-person differences. With comparisons on model 2 and model 3, we found a U-shape trajectory of PTSS fitting the data better than a linear one. With covariates controlled, the relationship between time (X) and PTSS (Y) acted with the function of $Y = 1.03X^2$-1.33X-0.01, with a turning point at the 0.65 standardized time interval (about 5 years after the earthquake). Additionally, the U-shape trajectory accounted for about 26.3% of the intra-person variance. Moreover, women were found to have higher PTSS risks than men (β = 0.12, Cohen's d = 0.21, $p < 0.001$), and those with sickness were significantly riskier in PTSS than those not (β = 0.12, Cohen's d = 0.26, $p < 0.001$). However, the relationships between education, income, age, marital status, drinking behaviors with PTSS were statistically significant but were not obvious in clinical observations. Details could be seen in Table 2.

3.3. The declining depressive trajectory

In Table 3 a declining trajectory of depressive symptoms is explored. Model 5 indicated that about 28.5% of the variance in depressive symptoms across individuals and occasions was attributed to inter-person differences. Statistically, a significant quadratic effect of time in depressive symptoms was observed (β = 0.34, $p < 0.001$), but whose effect size was nonsignificant in clinical observations (Cohen's d = 0.16). Thus, we conservatively estimated a declining depressive trajectory, which accounted for 20.4% of the intra-person variance. Besides, gender difference exists in psychological development, as women had a higher risk of depressive symptoms than men (β = 0.10, Cohen's d = 0.20, $p < 0.001$). Also, having sickness (β = 0.14, Cohen's d = 0.30, $p < 0.001$) indicated an elevated level of depressive symptoms. More details could be seen in Table 3.

3.4. Gender differences in mental health

In Table 4, we examined the gender differences in PTSS and depressive trajectories, as well as the significance and effect sizes of the factors associating with mental health symptoms. It was noteworthy that men and women were found to have different PTSS trajectories ($P_{Chow\ test} < 0.001$). Before the turning point arrived (about 5 years after the disaster), women had a faster-declining rate than men; but after the fifth year, women had a faster growth rate in developing PTSS. Regarding factors that have significant effects on PTSS, being ill was associated with substantial increases in PTSS for men (β = 0.14, Cohen's d = 0.27, $p < 0.001$), and to a lesser but significant extent for women (β = 0.12, Cohen's d = 0.25, $p < 0.001$). On the contrary, while there were no significant effects from income and education on PTSS among men, women with lower income (β = 0.08, Cohen's d = 0.20, $p < 0.001$) and less education (β = 0.09, Cohen's d = 0.19, $p < 0.001$) were found to have more PTSS. On depressive symptoms, the Chow tests revealed no significant gender difference in the trajectory. However, a gender gap existed in the association between being ill and depressive symptoms, as depressive symptoms in women (β = 0.16, Cohen's d = 0.33, $p < 0.001$) were more sensitive to illness than men (β = 0.12, Cohen's d = 0.26, $p < 0.001$).

4. Discussion

Natural disasters have long-lasting effects on the mental well-being of populations. In the current study, with longitudinal evidence from 3522 adult survivors of the Wenchuan earthquake, we found a U-shape trajectory for PTSS (with a turning point at the fifth year after trauma) and a clinically significant declining trend for depressive symptoms. There were noticeable gender differences regarding the development of PTSS, as women had a faster changing rate than men, been more vulnerable to economic and educational disadvantages, and developed a relationship between sickness and PTSS on a significant but much lower level. However, no gender difference exists in the trajectory of

Table 3
Trajectories of depressive symptoms: Exploring functional forms and the covariance structure (Obs = 6059).

	Model 5		Model 6			Model 7			Model 8		
	β	P value	β	P value	Cohen's d	β	P value	Cohen's d	β	P value	Cohen's d
Intercept	−0.01	0.51	0.01	0.37		0.04	0.01		0.05	<0.001	
Time			**−0.15*****	<0.001	0.29	**−0.49*****	<0.001	0.22	**−0.44*****	<0.001	0.20
Time^2						0.34***	<0.001	0.16	0.27***	<0.001	0.14
Gender (ref: men)									**0.10*****	<0.001	0.20
Area (ref: Mianyang)									0.04***	0.001	0.07
Education (ref: High)									0.06***	<0.001	0.12
Ethnic (ref: Han)									−0.01	0.57	0.02
Income (ref: High)									−0.02	0.09	0.08
Smoking (ref: No)									−0.01	0.86	<0.01
Drinking (ref: No)									−0.03	0.02	0.06
Sickness (ref: No)									**0.14*****	<0.001	0.30
Marital status (ref: Unpartnered)									0.02	0.05	0.07
Age									0.09***	<0.001	0.16
Variance components	***Estimate***	***Std. Err.***	***Estimate***	***Std. Err.***		***Estimate***	***Std. Err.***		***Estimate***	***Std. Err.***	
In initial status	0.37	0.02	0.13	0.02		0.13	0.02		0.11	0.03	
In rate of change			0.08	0.02		0.08	0.01		0.01	0.002	
Covariance			0.04	0.01		0.04	0.01		−0.02	0.01	
Within Person	0.93	0.01	0.75	0.02		0.74	0.02		0.73	0.02	
Chi2			119.05			158.42			596.89		

Notes: All variables in the model have been standardized. The values of coefficients and 95% confidence interval represent statistically significant at 0.05 level. P values have been adjusted with the Benjamini & Hochberg correction. The values of Cohen's d represent the clinically significance, d ≥ 0.2, d ≥ 0. 5, and d ≥ 0.8. represent small, medium, and large effect sizes, respectively. All nested models passed the Likelihood Ratio Test.

Table 4
Gender differences in mental health symptoms.

	PTSS							Depressive symptoms						
	Men (Model 9)			Women (Model 10)			Chow test	Men (Model 11)			Women (Model 12)			Chow test
	β	P value	Cohen's d	β	P value	Cohen's d		β	P value	Cohen's d	β	P value	Cohen's d	
Intercept	0.15	<0.001		0.12	<0.001			0.06	0.01					
Time	**−1.15*****	<0.001	0.72	**−1.48*****	<0.001	0.83	<0.001	**−0.41*****	<0.001	0.20	**−0.48*****	<0.001	0.20	0.94
Time^2	**0.87*****	<0.001	0.54	**1.17*****	<0.001	0.64	<0.001	0.21***	0.007	0.11	0.34***	<0.001	0.14	0.86
Area (ref: Mianyang)	0.01	0.40	0.05	0.02	0.15	0.05		0.05***	0.01	0.08	0.04***	0.03	0.06	0.93
Education (ref: High)	0.03	0.07	0.06	**0.09*****	<0.001	0.19	<0.001	0.06***	0.002	0.12	0.06***	0.003	0.12	0.78
Ethnic (ref: Han)	−0.01	0.83	0.01	−0.01	0.80	0.01		−0.01	0.76	<0.01	−0.01	0.63	0.02	
Income (ref: High)	0.02	0.13	0.07	**0.08*****	<0.001	0.20	<0.001	−0.01	0.47	0.06	−0.03	0.16	0.04	
Smoking (ref: No)	−0.01	0.39	0.04	0.02	0.39	0.03		−0.01	0.62	0.01	0.01	0.95	0.01	
Drinking (ref: No)	−0.04	0.003	0.11	−0.03	0.18	0.04	0.41	−0.05***	0.001	0.12	0.01***	0.85	<0.01	0.01
Sickness (ref: No)	**0.14*****	<0.001	0.27	**0.12*****	<0.001	0.25	<0.001	**0.12*****	<0.001	0.26	**0.16*****	<0.001	0.33	<0.001
Marital status (ref: Unpartnered)	0.02	0.29	0.04	0.06***	<0.001	0.12	<0.001	−0.05***	0.003	0.14	0.01	0.67	0.01	0.001
Age	0.08***	<0.001	0.17	0.04	0.04	0.07	0.002	**0.08*****	<0.001	0.16	0.10	<0.001	0.16	<0.001
Variance components	***Estimate***	***Std. Err.***		***Estimate***	***Std. Err.***			***Estimate***	***Std. Err.***		***Estimate***	***Std. Err.***		
In initial status	0.09	0.02		0.07	0.02			0.07	0.02		0.09	0.02		
In rate of change	0.01	<0.01		<0.01	<0.01			.07	0.02		0.09	0.02		
Covariance	−0.03	0.01		−0.01	<0.01			0.04	0.01		0.02	0.01		
Within Person	0.59	0.02		0.76	0.02			0.66	0.03		0.78	0.03		
Chi2	735.17			1078.97				237.16			262.54			

Notes: All variables in the model have been standardized. The values of coefficients and 95% confidence interval represent statistically significant at 0.05 level. P values have been adjusted with the Benjamini & Hochberg correction. The values of Cohen's d represent the clinically significance, d ≥ 0.2, d ≥ 0. 5, and d ≥ 0.8. represent small, medium, and large effect sizes, respectively. Values of Chow tests indicate the significance of differences in standardized coefficients between the women and men subsample, with the cutoff point at 0.05. All nested models passed the Likelihood Ratio Test.

depressive symptoms, yet women being ill are comparatively risker than men in gaining depressive symptoms. Findings in this study reinforce the gender differences in mental health studies and shed light on psychological intervention strategies targeting vulnerable disaster survivors.

This study reveals that PTSS and depressive symptoms in the aftermath of trauma evolve with different trajectories, as clinically significant curvilinear and linear patterns were found for PTSS and depressive symptoms, respectively. In line with previous studies (Ljungman et al., 2014; Norris et al., 2004), within the first five years after the earthquake, PTSS initially declined but subsequently stabilized. Besides a natural resilience mechanism, the decline that abated with time could be more or less explained by a decelerated growth in external support, given the direct association between PTSS and traumatic loss. According to the Earthquake Relief Headquarter in China (NDRCC, 2008), the government was about to use a total of 1 billion Yuan for restoration and reconstruction in earthquake-affected areas. About 75% of the funds were used by the year 2009, and all disaster relief programs would evacuate from affected areas before 2012. Moreover, an ensuing trauma, the 2013 Lushan earthquake, disrupted the declining trend of PTSS. As Bryant et al. noted, direct or indirect exposure to a later trauma would evoke rumination regarding previous experiences, which might arouse accumulative mental health risks afterward (Bryant et al., 2013). The Lushan earthquake epicenter was only 85 km from the Wenchuan earthquake epicenter (Xu et al., 2013). Unfortunately, few psychological interventions were delivered to Wenchuan-earthquake affected populations after the onset of the Lushan earthquake, due to limited mental health resources in the Sichuan province. Moreover, we found the quadratic effect of time on depressive symptoms was statistically significant but not clinically significant, differing from previous studies (Lenferink et al., 2020; Ljungman et al., 2014). According to the cognitive theory of depressive symptoms (Haaga et al., 1991), beliefs of low self-worth and the tendency to attribute negative events to causes that are global and stable are associated with developments of depressed mood. Thus, it's reasonable for this study to assume that once cognitive beliefs were intervened and improved at the initial stage of post-earthquake reconstruction, they would persist rather than change in the future, and thereby lead to a stable decline in depressive symptoms. During this process, a slowed decrease might occur as people aged, but this change seems too small to be perceivable in their daily lives. Thus, promoting positive beliefs and cognitive styles is of utmost importance in post-earthquake depression interventions, and timely supports are essential for PTSS intervention when survivors are exposed to secondary disasters.

Besides, this study proposes that women have a faster-declining rate in PTSS than men in the first five years. As most existing studies indicated (Akerkar and Fordham, 2017), women presented an elevated level of acute PTSS than men, but the gender gap began to converge with psychological interventions. Often, masculinity causes men to refuse to acknowledge psychological trauma and PTSS, and thereby prevent cognitive-emotional processing of the trauma and keep men from seeking treatments (Cox and O'Loughlin, 2017). Besides, within the Chinese society dominant ideals of masculinity generally include self-reliance, forbearance, and being action-oriented. But living up to these ideals is not easy for men during the initial stage of post-disaster reconstruction, especially for those who were older in this study. However, no significant gender difference was observed in the depressive trajectory. On the one hand, it might because respondents in our sample are relatively old, and previous studies proposed that gender differences in depressive symptoms narrowed as the population age (Ditlevsen and Elklit, 2010). On the other hand, more protection from psychological intervention provided to women might counterbalance their vulnerability for depression, and thereby narrow the gap in depressive trajectory. Taken together, mental health trajectories in men and women support the claim that PTSS are psychological responses relating more to trauma-related factors, whereas the development of depressive symptoms is primarily based on stable cognitions.

Moreover, gender moderates the effects of distal socioeconomic and proximal sickness on psychological responses. For example, education and income, as two main indicators of socioeconomic status, demonstrate significant associations with women's PTSS but not for men. Two possible channels account for this difference: mental health literacy, and accumulative vulnerabilities from gender inequalities. Mental health literacy refers to the knowledge on mental health disorders that aid individuals' recognition, management, and prevention (Jorm et al., 1997). As mentioned above, prevalent affective suppression in men impedes their growth in mental health literacy and also the effect of such literacy on mental health outcomes (Addis and Mahalik, 2003). But higher education may promote higher mental health literacy among women. Income can also increase access to high-quality interventions, which can lead to better mental health outcomes. On the other hand, in a context that the distribution of educational resources and work opportunities are both favoring men, the competition for material resources is fiercer among women. Thus, women are supposed to have more positive traits than men for a certain degree of educational attainment and income promotion. By contrast, more vulnerabilities go to women than men in undesirable socioeconomic circumstances (Apfel, 1982), which predict elevated risks of trauma experiences and increase the likelihood to experience PTSS in return. Meanwhile, being ill predicted greater PTSS risk in men but more depressive symptoms in women. As shown in a previous study (Schofield et al., 2000), having acute or chronic sickness may threaten masculine ideals of dominance, and hurts men's capabilities in trauma coping, while both are important for PTSS reduction. Meanwhile, persons with sicknesses are more prone to experiencing co-occurring pain and depression (Birk et al., 2019; Jiang et al., 2020), and women further engage in ruminations on the reason or negative consequences of such stressors (Mezo and Baker, 2012), and therefore have higher vulnerability towards depression. The findings of this study implicate that women with poor socioeconomic status should intensively care in PTSS intervention, and more cognitive therapies resolving negative psychological changes after sickness should be adopted in public communication programs.

5. Strengths and limitations

This study innovatively explores the trajectories of PTSS and depressive symptoms with a gender perspective in the Chines context. However, several limitations should be acknowledged. First, the interval between panels is varying and was long as 49 months between the last two panels. The longer the interval between surveys the higher the attrition rate would be. In the current study, only one in three respondents participated in three surveys or above. Second, we used the concept of masculism and masculine ideals, and the empowerment of psychological interventions to explain why mental health differs between gender. Despite these explanations are theoretically rational, the factors above have not been evaluated in the survey. Third, we suggest that reductions in psychological interventions and the onset of the Lushan earthquake explained why PTSS increased from the fifth year, but there might be other factors contributing to this change. Apart from these limitations, this study is one of the few studies investigating a gendered trajectory of PTSS after natural disasters. As most of the existing studies were conducted within three years after the trauma, this study provides valuable evidence to reveal the trajectories with an 8-year timescale.

6. Conclusion

This study investigated the long-term trajectories of PTSS and depressive symptoms with a gender perspective. It has been noted that the PTSS trajectory is declining with quadratic effects, with a turning point at the fifth-year post-earthquake. PTSS in women decline at a faster rate in the first five years but also grow at a quicker speed after the fifth year. Depressive symptoms evolve within a declining trend, and there is no gender difference in its trajectory. Additionally, less education and lower income indicate greater PTSS risk for women. Having sickness predicts more PTSS in men and more depressive symptoms in women. The findings of this study shed light on mental health intervention in future natural disasters.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2021.07.034.

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Ethical standards

The study protocol was approved by the institutional review board of the School of Social Development and Public Policy at Beijing Normal University. Oral informed consent was obtained from all participants. Each participant completed the questionnaire independently.

Data availability

The data that support the findings of this study are available on request from the corresponding author Dr. Jing Guo [at jing624218@163.com]/ jing624218@bjmu.edu.cn.

Conflict of interest

None exist.

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