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# Post-traumatic Stress Disorder among adult survivors of the Wenchuan Earthquake in China: A repeated cross-sectional study

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ABSTRACT

The objective of the study was to examine trends in the prevalence of Posttraumatic Stress Disorder (PTSD) in Wenchuan, China, over the four-year period following its 2008 earthquake, and to explore the risk factors related to current PTSD. Chi-square analysis and multivariate logistic regression analysis were used to assess PTSD morbidity and identify associated risk factors. The results indicated that the prevalence of PTSD was 58.2% at two months, 22.10% at 8 months, 19.8% at 14 months, 19.0% at 26 months, and 8.0% at about 44 months after the earthquake. Female gender, being married, low education, non-drinking, and poor self-perceived health status were significantly associated with PTSD during the early period following the earthquake. Depression was significantly associated with survivors' PTSD throughout the study period.



## 1. Introduction

Earthquakes are common natural disasters, and on average 939 earthquakes of a magnitude between 5 and 8 on the Richter scale occur around the world each year (Naeem et al., 2011). Compared to other types of natural disasters, earthquakes strike more quickly, often without warning, are more uncontrollable, and affect larger populations; they leave injury, death, and destruction in their wake (Altindag, Ozen, & Sir, 2005). Compared to disasters occurring in developed countries, those that occur in developing countries tend to lead to more severe consequences, including mental health consequences, among affected populations, in part because of a context of lower availability of resources in general, and of mental health treatment resources in particular (Norris et al., 2002). However, due to low levels of funding support and public attention, relatively few post-earthquake research studies have been conducted in developing countries (Tural et al., 2004). Neria et al. reviewed 116 studies of the mental health consequences of natural disasters, of which seventy six were from developed countries and only 40 from developing countries (Neria, Nandi, & Galea, 2008). Clearly, then, there is a need for more research on the short- and long-term mental health consequences of severe earthquake in developing countries.

On May 12, 2008, a magnitude 8.0 earthquake struck the area around Wenchuan, in the north western part of China's Sichuan province. It left 69,227 people dead, 374,643 injured, 17,923 missing, and millions homeless (SCIOC, 2008). Kun et al. reported a PTSD prevalence of 45.5% in a heavily damaged county in the earthquake area 3 months after the earthquake (Kun et al., 2009). PTSD prevalence rates of 26.3% and 52.2% were reported in two independent studies one year after the earthquake (Liu et al., 2012; Zhang, Shi, Wang, & Liu, 2011). Studies of the impact of the Wenchuan earthquake on the mental health of the survivors found that female gender, older age, lower household income, ethnic minority status, low educational level, living in a shelter or temporary house, death or a bodily injury in one's family, and household damage, were important risks factors associated with PTSD among adults (Kun et al., 2009; Wang et al., 2009; Zhang & Ho, 2011; Zhang et al., 2011). The long-term sequelae of earthquakes tend to receive little research attention. A recent systematic review (Xiao et al., 2011) found that the number of published journal articles on the health consequences of an earthquake tend to drop dramatically 2 years after its occurrence. To the best of our knowledge, very few studies to date have focused on the adult survivors of the Wenchuan earthquake, and none have examined the long-term mental health effects of this disaster.

Though a large number of studies have investigated the development of PTSD and changes in PTSD symptom severity over time, these studies had some limitations which should be noted. First, most of these studies have been conducted among

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individuals exposed to combat (Bonanno et al., 2012), or bereavement (Bonanno et al., 2002). Little is known about long-term trends in PTSD among earthquake survivors. Second, the picture of post-event psychological sequelae emerging from these studies is inconsistent and often confusing. One study found that general psychological morbidity tends to decline over time, and to stabilize at about 12 months after an earthquake, and that PTSD symptom levels tend to stabilize after about 18 months (Carr et al., 1997). A longitudinal study of earthquake-affected communities in northern China, however, reported a higher prevalence of psychopathology at nine months than at three months post-event (Wang et al., 2000). Moreover, findings concerning the risk factors for post-disaster psychological problems have also been inconsistent. Two meta-analytic studies (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2003) found that although quite a few risk factors have been identified, most have only shown small effect sizes, and little predictive value for predicting who develops PTSD (Brewin, 2005; Brewin et al., 2000). Finally, although rigorous methods have sometimes been used, a widely divergent array of questionnaires, surveys, interviews, and psychiatric classification systems have been employed, limiting comparability across studies and likely contributing to the wide variation and inconsistencies of the findings of earthquake research (Tural et al., 2004).

The objectives of the present study were to estimate the prevalence of probable PTSD at different time points following an earthquake, and to identify the factors associated with PTSD, using data from a repeated cross-sectional survey conducted in China.

## 2. Method

### 2.1. Study design and participants

This study was a five-wave, community-based repeated cross-sectional survey conducted among survivors of the Sichuan earthquake. A central difficulty in designing robust post-disaster research is the logistical challenge of making contact with persons who are within the sampling frame of interest (Galea & Maxwell, 2009). Procuring services, reestablishing homes and employment, and searching for loved ones are pressing needs of persons in post-disaster situations. These needs leave little time for research participation, and result in low response rates and high potential loss to follow-up. In a repeated cross-sectional survey, each wave is cross-sectional and can produce a large number of enrollees. This method makes it possible to compare across convenience samples within the same disaster area, improving the efficacy of these samples for scientific generalization and inference (Galea & Maxwell, 2009).

The survey was conducted in July 2008 (about 7 weeks after the earthquake), January 2009, July 2009, August 2010 and January 2012, over a period of more than four years. Participants were recruited from two different sites in the area that was severely affected by the earthquake. The first site was the township of Yongan (115.7 km from the epicenter), which is located in a mountainous area. Over 90% of the buildings in Yongan were damaged in the earthquake. The second site was the township of Guangji (58.3 km from the epicenter), which is located on a plain. Over 96% of the buildings in Guangji were damaged in the earthquake. These two townships were selected because both are close to the epicenter but at somewhat different distances, both suffered severe destruction in the earthquake, and both had similar socioeconomic and demographic characteristics before the earthquake.

Target sample sizes were calculated according to the populations of the two townships; estimated PTSD prevalence was calculated based on previous research. Previous studies had found PTSD prevalence after earthquakes ranging from 13% to 30.3%, in Northern and Southern China (Cao, McFarlane, & Klimidis, 2003; Wang et al., 2000). Accordingly, 22% was used as the estimated PTSD prevalence. It was determined that, in order to limit sampling error to 3%, the study would need to have a sample of 1035 adults from a total population of 63,990 (29 villages in total), with an expected rate of sample loss of approximately 30%, based on previous studies, being taken into account.

This repeated cross-sectional study used a combined multistage systematic sampling and convenience sampling design to select participants. At the first stage, 12 of the total 29 villages were random selected from the two survey townships. In the second stage, households, rather than individuals were systematically selected, according to registration information, as the basic unit for the entire survey. But for a number of villages where many of the former residents were no longer residing in their homes, systematic sampling was not feasible; non-random sampling methods were therefore also used in these villages. Adults over age 16 in each household were selected for participation. The same villages were involved in the survey at all five waves. While the number of participating respondents per household selected based on convenience changed over time, the overall number of subjects per survey wave also varied considerably over time. The actual samples achieved at the five waves consisted of 1073, 1362, 1213, 1183, and 1400 adults respectively. A higher than 90% response rate was achieved at each wave. These samples were representative of two townships that were severely affected by the Wenchuan earthquake.

Face-to-face interviews were conducted by 18 college students in both Chinese and the local languages from Sichuan University. All the interviewers were thoroughly trained before the survey. This included five sessions: introduction, sampling design and procedures, review of the questionnaire, methods and techniques of interviewing, potential difficulties in survey. Interviewers were required to show their documents and identification and explain the aims of the interview prior to receiving permission to enter the participants' houses. Interviewers read each question appearing on the respondents, and then wrote their answers on the questionnaire. The average interview time was 1 h. All participants gave verbal consent (this method was preferred over the written consent method due to illiteracy) after being informed as to the aim of the survey and their right to refuse to participate. The study protocol was approved by the institutional review board of the School of Social Development and Public Policy at Beijing Normal University.

Subjects who had responded to all of the PTSD-related questions and all of the socio-demographic questions were included in this study's analyses. The final numbers of subjects included in the analyses for the five waves, according to these criteria, were 1066, 1344, 1210, 1174 and 1281, respectively.

### 2.2. Measurement

#### 2.2.1. Posttraumatic stress disorder (PTSD)

Probable PTSD was assessed by the Impact of Event Scale-Revised (IES-R) (Weiss & Marmar, 1997), a self-report instrument widely used in the field of traumatic stress. It includes 22 items used to measure the three major symptom clusters of PTSD: intrusion, avoidance, and hyper-arousal. The IES-R's measures have been found to have good and stable psychometric properties (Creamer, Bell, & Failla, 2003). The Chinese version of the IES-R has been found to have satisfactory psychometric properties, comparable to those of the original English version (Chen et al., 2007; Wu & Chan, 2003). Each participant was asked to indicate the frequency of their distress using 4 response options (0 = not at all, 1 = seldom, 3 = sometimes, 5 = often) (Chan et al., 2011, 2012; Qu, Tian, et al., 2012; Qu, Wang, et al., 2012). Subscale scores were calculated as the means of the responses to all of the items in the specific subscale,

and the total score was calculated as the mean response across all items. Since there is no recommended cutoff point for the IES-R (Christianson & Marren, 2012), this study adopted a mean score of 2.0 across all items of the IES-R as the cutoff point, as was done in earlier studies (Chan et al., 2011; Qu, Tian, et al., 2012; Qu, Wang, et al., 2012). One earlier study using this cutoff point reported a sensitivity of .89 and a specificity of .90 (Wohlfarth, van den Brink, Winkel, & ter Smitten, 2003).The internal consistency coefficients (Cronbach's alpha) of the whole scale in the present study were 0.87, 0.92, 0.88, 0.91, and 0.91, for the five waves, respectively.

#### 2.2.2. Risk factor

*Depression*: The Chinese edition of the Center for Epidemiologic Studies Depression (CES-D) (Wang, 1999) Scale was used to assess probable major depression. This scale is the most widely used depression-screening scale and has been used in many 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, as this has been shown to be a good predictor for major depression in Chinese populations (Cheng & Chan, 2005). Prior studies found that negative self-concept strongly associated with the development of depression is causally implicated in the etiology of post-traumatic distress (Guthrie & Bryant, 2006).

*Health behavior*: In this study, all subjects were asked "Do you currently consume cigarettes?" The participants were also asked, "Do you currently consume alcoholic beverages?" The response options for these questions were: 1 ('Yes'), 2('No'/'quit'). Previous studies have found alcohol use and cigarette consumption to be associated with posttraumatic stress disorder (PTSD) after disasters (Jacobsen, Southwick, & Kosten, 2001; Tural et al., 2004).

*Health status*: Survey participants were asked, "In the past six months, did you suffer from any chronic illness that has been diagnosed by a doctor?" The participants were also asked, "Have you been suffering from any illness (including acute and chronic illnesses) over the past two weeks?" With regard to their general health, the participants were asked, "How would you rate your health compared with that of your peers of the same age?" The response options for this question were: 3 ('very good or good'), 2 ('fair'), and 1 ('poor or very poor'). PTSD has been found to be associated with self-reported mental and physical health problems and poor health-related quality of life in trauma-exposed individuals (Dobie et al., 2004).

#### 2.2.3. Demography, socioeconomic status

The following demographic and socioeconomic information was also collected in the survey: township of residence (Anxian/Guangji); gender; ethnicity (Han or minority (including Qiang, Tibetan, Hui, Mongol and other minority groups)); age (18–35 years, 35–55 years, >55years); marital status (married/other status); education (primary school or below/middle school or above); household monthly per capita income (≦150USD, 150–300, ≧300).

### 2.3. Statistical analysis

The SPSS 17.0 (SPSS Inc, Chicago, IL) was used for statistical analysis. Descriptive statistics were performed for all of the socio-demographic variables. Chi-square tests were performed to determine whether PTSD categories were significantly related to any of the socio-demographic, health, mental health and behavioral variables. We used these tests to examine the relationships between the variables at each time point. Logistic regression and linear analyses were used to examine the effect of the risk factors on PTSD at each time point. Because the three health status variables were highly correlated, we selected self-reported health as the measure of general physical health status to be included as an independent variable in the regression models.

## 3. Results

### 3.1. Descriptive analysis

Due to the population movements necessitated by the earthquake and by post-quake restoration and reconstruction, few participants ($N = 45$) participated in every wave of the survey study; the five study samples were each essentially independent. The majority of each sample was female and belonged to the Han ethnic group, which makes up most of the population of China. Also, because the surveyed townships were both located in a rural area, most of the participants were farm workers with relatively low levels of education (Table A.1).

The characteristics of the participants who did and did not have PTSD at each study wave are summarized in Table B.1. In general, the prevalence of probable PTSD was highest 2 months after the earthquake, with 58.2% of the participants who completed all the screening questions at Time1 having probable PTSD. The prevalence dropped dramatically, to 22.1% at 8 months after the earthquake, 19.8% at 14 months post-earthquake, 19.0% at 26 months post-earthquake, and ending at 8.0% at the fifth wave, which was conducted about 44 months after the earthquake. In addition, at time1, 62.3% of participant with low levels of education, but only 47.1% of participant with more than an elementary school education, had probable PTSD. Unlike previous studies, our results indicate that smoking and drinking may have been positive and effective coping techniques, as used by this population of survivors. The prevalence of PTSD was 61.5% among the non-smokers, higher than among the smokers (50.3%), at Time1. Similarly with regard to drinking, the prevalence of PTSD among the non-drinkers was 63.9%, higher than among the drinkers (43.8%). These positive effects of smoking and drinking were statistically significant at Time1, but became non-significant by Time5. Physical health status and depression were also independently associated with PTSD. There was higher prevalence of PTSD among participants with chronic or two-week physical illnesses. Those with probable PTSD were more likely to report poor overall health status and probable depression.

As illustrated in Fig. A.1, females were more likely to have PTSD than males. The prevalence of PTSD was higher among female participants than male even 26 months after earthquake (22.9% vs 13.7%). 66.6% of female respondents had probable PTSD 2 months after the earthquake, after which the prevalence fell gradually, to 24.8%, 23.0%, 22.9% and, finally, 8.8%.

At every wave of the study, the prevalence of PTSD was higher among depressed participants than among those who were not

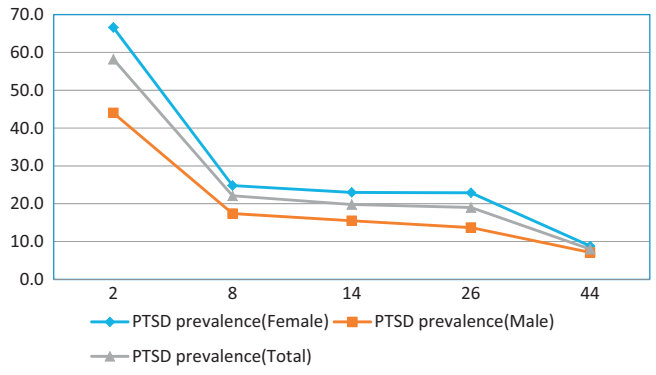


**Fig. A.1.** PTSD prevalence by gender, from the 5-wave survey among adults in the Wenchuan earthquake area in China.

**Table A.1**
Descriptive of the 5-wave survey sample in the Wenchuan earthquake areas in China[a].

| | T1[b] % (*N*) | T2[b] % (*N*) | T3[b] % (*N*) | T4[b] % (*N*) | T5[b] % (*N*) |
|---|---|---|---|---|---|
| Total | *N* = 1066 | *N* = 1344 | *N* = 1210 | *N* = 1174 | *N* = 1281 |
| Town | | | | | |
| Anxian | 39.2 (418) | 43.8 (589) | 47.4 (573) | 43.9 (515) | 49.2 (630) |
| Guangji | 60.8 (648) | 56.2 (755) | 52.6 (637) | 56.1 (659) | 50.8 (651) |
| Gender | | | | | |
| Male | 37.3 (398) | 36.0 (484) | 43.3 (524) | 42.2 (496) | 49.5 (634) |
| Female | 62.7 (668) | 64.0 (860) | 56.7 (686) | 57.8 (678) | 50.5 (647) |
| Ethnicity | | | | | |
| Han | 97.0 (1034) | 96.9 (1303) | 97.4 (1178) | 97.1 (1140) | 96.7 (1239) |
| Minority | 3.0 (32) | 3.1 (41) | 2.6 (32) | 2.9 (34) | 3.3 (42) |
| Age | | | | | |
| 18–35 | 13.8 (147) | 17.6 (236) | 13.2 (160) | 13.2 (155) | 14.5 (186) |
| 35–55 | 50.7 (541) | 46.9 (631) | 51.7 (626) | 48.0 (563) | 52.5 (672) |
| >55 | 35.5 (378) | 35.5 (477) | 35.0 (424) | 38.8 (456) | 33.0 (423) |
| Marital status | | | | | |
| Married | 88.7 (946) | 90.0 (1209) | 91.1 (1102) | 88.6 (1040) | 88.0 (1127) |
| Unmarried | 11.3 (120) | 10.0 (135) | 8.9 (108) | 11.4 (134) | 12.0 (154) |
| Education | | | | | |
| Primary school or below | 72.7 (775) | 71.7 (963) | 72.4 (876) | 73.1 (858) | 71.0 (910) |
| Middle school or above | 27.3 (291) | 28.3 (381) | 27.6 (334) | 26.9 (316) | 29.0 (371) |
| Income | | | | | |
| ≦USD 150 | 68.3 (675) | 42.2 (556) | 24.7 (294) | 27.3 (308) | 20.0 (243) |
| 150–300 | 28.4 (281) | 33.8 (445) | 33.3 (395) | 30.2 (341) | 23.5 (286) |
| ≧300 | 3.2 (32) | 24.0 (316) | 42.0 (498) | 42.6 (481) | 56.5 (686) |

[a] Percentages were calculated for each wave of data collection.
[b] T1 = 2 months after the earthquake; T2 = 8 months after the earthquake; T3 = 14 months after the earthquake; T4 = 26 months after the earthquake; T5 = 44 months after the earthquake.

depressed. Among those with probable depression, 52.9% also had probable PTSD 8 months after the earthquake, after which this group's PTSD prevalence fell gradually, to 42.8%, 42.8% and, finally, 39.4%. By contrast, only 8% of those without depression had probable PTSD 8 months after the earthquake, and this prevalence dropped dramatically to 3.6% at 44 months after the earthquake (Fig. B.1).

### 3.2. Regression analysis

Table C.1 presents the results of the multivariate logistic analysis assessing the relationship between the risk factors and PTSD. It shows that depression was significantly associated with probable PTSD across all waves, controlling for potential confounding variables. In other words, subjects with depression were more likely to also have PTSD (OR, 6.09–16.96, $P < 0.0001$). In addition, self-reported health status was significantly associated with probable

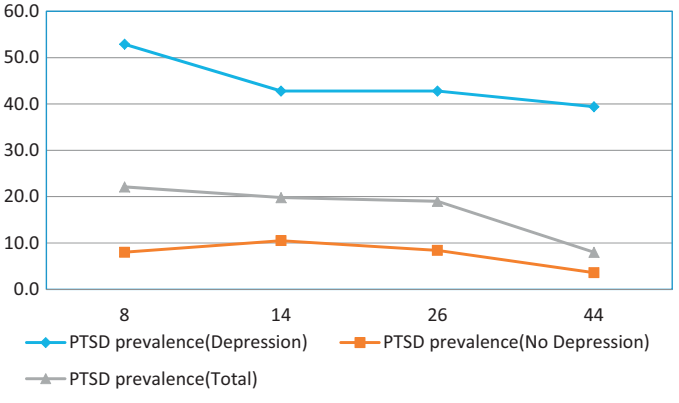


**Fig. B.1.** PTSD prevalence by depression, from the 4-wave survey among adults in the Wenchuan earthquake area in China.

PTSD during the first two years after earthquake, while drinking was negatively associated with PTSD only immediately after the earthquake.

Moreover, most results from the linear regression analysis were similar with to those of the logistic regression analysis, except with regard to gender. Female gender was significantly associated with probable PTSD across all waves in the linear regression results. This difference may be explained by the fact that dimensionally-based representations of PTSD can yield greater statistical power and construct validity relative to categorical ones.

## 4. Discussion

The present study sought to estimate the prevalence of probable PTSD and identify the factors associated with PTSD at different time points following an earthquake. It found that the prevalence of PTSD was at its highest immediately after the earthquake, among the adult survivors, and steadily declined thereafter. In addition, demographic and health related variables affected PTSD during the early period, while depression had a long-term impact on survivors' PTSD.

The study found that more than half of the participants had probable PTSD immediately after the earthquake, while 8% of survivors still had probable PTSD 44 months after the earthquake. The prevalence of PTSD from 3 to 20 months after the earthquake had been assessed in prior studies, but long-term follow-up results were lacking (Wu et al., 2006). In a study of survivors of the Chi-Chi earthquake, a PTSD prevalence of 4.4% was found 3 years after the earthquake (Wu et al., 2006). A community survey conducted following earthquakes in Turkey, however, estimated the prevalence of PTSD to be 11.7% even 3 years after the disaster (Onder, Tural, Aker, Kilic, & Erdogan, 2006). The present study demonstrates that the Wenchuan earthquake had long-lasting impacts on the psychological health of its survivors. Even after nearly 4 years had passed since the earthquake, its effects on the participants' mental health

**Table B.1**
Prevalence of PTSD by all factors of the 5-wave survey among adults in the Wenchuan earthquake area in China.

| | T1-PTSD % (*N*) | T2-PTSD % (*N*) | T3-PTSD % (*N*) | T4-PTSD % (*N*) | T5-PTSD % (*N*) |
|---|---|---|---|---|---|
| Total | 58.2 (620) | 22.1 (297) | 19.8 (239) | 19.0 (223) | 8.0 (102) |
| Town | | | | | |
| Anxian | 59.1 (247) | 14.6 (86) | 18.8 (108) | 16.7 (86) | 8.7 (55) |
| Guangji | 57.6 (373) | 27.9 (211)*** | 20.6 (131) | 20.8 (137) | 7.2 (47) |
| Gender | | | | | |
| Male | 44.0 (175) | 17.4 (84) | 15.5 (81) | 13.7 (68) | 7.1 (45) |
| Female | 66.6 (445)*** | 24.8 (213)** | 23.0 (158)*** | 22.9 (155)*** | 8.8 (57) |
| Ethnicity | | | | | |
| Han | 57.8 (598) | 22.4 (292) | 19.6 (231) | 19.1 (218) | 8.1 (100) |
| Minority | 68.8 (22) | 12.2 (5) | 25.0 (8) | 14.7 (5) | 4.8 (2) |
| Age | | | | | |
| 18–35 | 44.9 (66) | 10.6 (25) | 13.8 (22) | 12.3 (19) | 7.0 (13) |
| 35–55 | 61.6 (333) | 25.4 (160) | 20.3 (127) | 21.0 (118) | 7.6 (51) |
| >55 | 58.5 (221)*** | 23.5 (112)*** | 21.2 (90) | 18.9 (86)* | 9.0 (38) |
| Marital status | | | | | |
| Married | 60.1 (569) | 22.7 (274) | 20.3 (224) | 19.7 (205) | 8.2 (92) |
| Unmarried | 42.5 (51)*** | 17.0 (23) | 13.9 (15) | 13.4 (18) | 6.5 (10) |
| Education | | | | | |
| Primary school or below | 62.3 (483)*** | 24.8 (239)*** | 21.9 (192)** | 20.7 (178)* | 7.7 (70) |
| Middle school or above | 47.1 (137) | 15.2 (58) | 14.1 (47) | 14.2 (45) | 8.6 (32) |
| Income | | | | | |
| ≦USD 150 | 58.4 (394) | 24.8 (138) | 18.7 (55) | 18.2 (56) | 7.4 (18) |
| 150–300 | 57.7 (162) | 24.5 (109) | 18.7 (74) | 20.8 (71) | 9.4 (27) |
| ≧300 | 19 (59.4) | 14.6 (46)*** | 21.1 (105) | 16.4 (79) | 7.6 (52) |
| Smoke | | | | | |
| Yes | 50.3 (161)*** | 19.1 (71) | 17.2 (65) | 13.3 (50)*** | 7.7 (31) |
| No | 61.5 (453) | 23.1 (224) | 20.8 (173) | 21.6 (170) | 8.1 (70) |
| Drink | | | | | |
| Yes | 43.8 (134)*** | 16.7 (60)** | 14.7 (57)*** | 13.3 (46)** | 7.0 (26) |
| No | 63.9 (470) | 24.2 (233) | 22.7 (179) | 21.1 (166) | 8.5 (69) |
| Chronic | | | | | |
| Yes | 66.3 (269)*** | 29.1 (126)*** | 22.0 (116) | 19.7 (118) | 10.5 (54)** |
| No | 53.2 (340) | 18.7 (169) | 17.9 (121) | 18.3 (105) | 6.3 (48) |
| Two-weeks disease | | | | | |
| Yes | 63.1 (357)*** | 29.0 (135)*** | 27.6 (124)*** | 18.8 (96) | 11.1 (46)** |
| No | 52.6 (261) | 18.4 (160) | 15.1 (114) | 19.3 (127) | 6.4 (55) |
| Self-reported health | | | | | |
| Poor | 70.1 (263) | 43.3 (148) | 29.9 (81) | 21.5 (73) | 11.9 (43) |
| Fair | 54.5 (249) | 16.5 (113) | 19.3 (128) | 19.4 (114) | 6.7 (41) |
| Good | 45.5 (96)*** | 9.9 (29)*** | 11.4 (30)*** | 14.6 (35) | 5.9 (16)** |
| Depression | | | | | |
| Yes | | 52.9 (222)*** | 42.8 (149)*** | 42.8 (155)*** | 39.4 (61)*** |
| No | | 8.0 (74) | 10.5 (90) | 8.4 (68) | 3.6 (41) |

* $P<0.05$.
** $P<0.01$.
*** $P<0.001$.

were still being felt. Researchers, health care professionals, and the public should be aware that affected individuals may continue to present earthquake-related trauma symptoms long after the event; ongoing surveillance and services are needed. This is particularly important in light of previous findings indicating that little attention tends to be paid to earthquake victims two years post-event (Xiao et al., 2011).

Second, the findings indicate that gender is associated with PTSD risk among survivors. The effects of gender were found to be more robust than those of other demographic variables. Compared with men, women were more than twice as likely to have probable PTSD two months after the earthquake. Furthermore, the results of the linear regression analysis indicated that female gender can be a long-term risk factor for PTSD. This finding agrees with the conclusions of many studies of gender differences in the psychological effects of disasters (Zhang, Wang, Shi, Wang, & Zhang, 2012). Explanations reviewed within a psychobiological model of PTSD suggest that women's higher PTSD risk may be due to the type of trauma they experience, their younger age at the time of trauma exposure, their stronger perceptions of threat and loss of control, higher levels of peritraumatic dissociation, insufficient social support resources, and greater use of alcohol to manage trauma-related symptoms like intrusive memories and dissociation, as well as gender-specific acute psychobiological reactions to trauma (Gavranidou & Rosner, 2003; Olff, Langeland, Draijer, & Gersons, 2007). The Wenchuan earthquake was the second earthquake of this magnitude known to have hit China to date, and the results of this study have implications for policy and planning. Health care providers, researchers, and government officials need to continue to address the mental health needs of vulnerable subgroups of those affected, such as female survivors.

Third, health behavior, physical illnesses and self-reported overall health were also found to be related to PTSD. This study found that, in the immediate post-disaster period, drinkers and smokers

**Table C.1**
Logistic regression results for risk factors of PTSD of the 5-wave survey among adults in the Wenchuan earthquake area in China[a,b].

| | T1-PTSD AOR (95%CI) | T2-PTSD AOR (95%CI) | T3-PTSD AOR (95%CI) | T4-PTSD AOR (95%CI) | T5-PTSD AOR (95%CI) |
|---|---|---|---|---|---|
| Town (Ref: Anxian) | | | | | |
| Guangji | 1.04 (0.78, 1.39) | 1.78 (1.26, 2.52) | 1.02 (0.73, 1.42) | 1.55 (1.06, 2.26) | 0.54 (0.52, 1.41) |
| *p*-Value | 0.794 | 0.001 | 0.909 | 0.023 | 0.537 |
| Gender (Ref: male) | | | | | |
| Female | 2.05 (1.41, 2.98) | 1.19 (0.78, 1.81) | 1.34 (0.88, 2.05) | 1.52 (0.97, 2.39) | 1.23 (0.68, 2.21) |
| *p*-Value | <0.0001 | 0.415 | 0.172 | 0.068 | 0.490 |
| Age (Ref: 16–35) | | | | | |
| 35–55 | 1.55 (0.97, 2.46) | 1.57 (0.88, 2.78) | 1.26 (0.69, 2.32) | 1.13 (0.60, 2.16) | 0.93 (0.40, 2.17) |
| >55 | 1.40 (0.85, 2.32) | 1.03 (0.54, 1.94) | 1.20 (0.62, 2.30) | 1.15 (0.57, 2.34) | 1.84 (0.71, 4.73) |
| *p*-Value | 0.179 | 0.044 | 0.741 | 0.921 | 0.093 |
| Marital status (Ref: unmarried) | | | | | |
| Married | 1.73 (1.09, 2.74) | 1.07 (0.61, 1.90) | 1.34 (0.71, 2.54) | 1.26 (0.69, 2.28) | 1.33 (0.55, 3.19) |
| *p*-Value | 0.021 | 0.810 | 0.373 | 0.450 | 0.528 |
| Education (Ref: middle school or above) | | | | | |
| Prim-school/below | 1.55 (1.10, 2.18) | 1.20 (0.78, 1.86) | 1.43 (0.93, 2.20) | 1.20 (0.75, 1.92) | 0.58 (0.32, 1.06) |
| *p*-Value | 0.013 | 0.404 | 0.105 | 0.441 | 0.077 |
| Income (Ref: ≧USD300) | | | | | |
| ≦150 | 0.72 (0.33, 1.58) | 1.15 (0.73, 1.81) | 0.61 (0.39, 0.95) | 0.91 (0.57, 1.45) | 0.62 (0.30, 1.28) |
| 150–300 | 0.74 (0.33, 1.67) | 1.31 (0.83, 2.08) | 0.84 (0.58, 1.22) | 1.29 (0.85, 1.95) | 1.00 (0.55, 1.82) |
| *p*-Value | 0.707 | 0.501 | 0.092 | 0.307 | 0.389 |
| Smoke (Ref: yes) | | | | | |
| No | 0.78 (0.53, 1.14) | 1.10 (0.70, 1.72) | 0.91 (0.59, 1.41) | 1.22 (0.76, 1.98) | 1.00 (0.54, 1.85) |
| *p*-Value | 0.203 | 0.690 | 0.681 | 0.407 | 0.998 |
| Drink (Ref: yes) | | | | | |
| No | 1.68 (1.18, 2.40) | 1.25 (0.80, 1.97) | 1.32 (0.86, 2.04) | 1.16 (0.72, 1.89) | 1.03 (0.54, 1.98) |
| *p*-Value | 0.004 | 0.329 | 0.210 | 0.545 | 0.921 |
| Self-report health (Ref: good) | | | | | |
| Poor | 2.42 (1.64, 3.58) | 3.15 (1.86, 5.33) | 2.62 (1.54, 4.46) | 0.73 (0.40, 1.33) | 1.45 (0.67, 3.13) |
| Fair | 1.36 (0.94, 1.96) | 1.18 (0.72, 1.94) | 1.63 (1.02, 2.61) | 0.90 (0.53, 1.52) | 1.10 (0.54, 2.23) |
| *p*-Value | <0.0001 | <0.0001 | 0.001 | 0.509 | 0.553 |
| Depression (Ref: no) | | | | | |
| Yes | | 9.55 (6.88, 13.27) | 6.09 (4.42, 8.38) | 8.76 (6.09, 12.62) | 16.96 (10.28, 27.99) |
| *p*-Value | | <0.0001 | <0.0001 | <0.0001 | <0.0001 |

[a] Analyses were conducted separately for each data collection wave.
[b] The results are similar to those of the linear regression analysis except with regard to gender, which was significantly associated with probable PTSD across all waves in that analysis.

tend to have lower prevalence of PTSD compared to abstainers. Even with potential confounders controlled for, drink still emerged as a protective factor against PTSD two months after the earthquake. This finding may have to do with specific characteristics of the local culture of this rural area, where people who like to drink a little bit every day tend to have more positive attitudes toward life. From previous studies, it was evident that the relationship between alcohol use and PTSD was a complex one (North, Ringwalt, Downs, Derzon, & Galvin, 2011). Two primary pathways have been described to explain these high rates of comorbidity: substance abuse precedes PTSD and vice versa (Jacobsen et al., 2001). Future research is needed to better understand the interrelationships among these variables, including predictors, moderators, and mechanisms of action. In addition, according to the bivariate analyses, current physical illness, chronic illness and worse self-perceived health all increased an individual's risk of probable PTSD. Individuals with poor self-perceived health were more than twice as likely to have probable PTSD even two years after the earthquake. Previous large-scale studies also have found PTSD to be related to increases in self-reported health symptoms, objectively measured medical morbidity, and increased health service utilization (Calhoun, Wiley, Dennis, & Beckham, 2009).The results of this study provide evidence that health behavior, physical health and self-perceived health status should be taken into consideration when targeting interventions or developing mental health preparedness protocols to mitigate stress reactions after earthquake.

Finally, the results of the multiple regression analysis in the present study indicated that depression was a robust predictor of probable PTSD at every wave of the study. Depressed adults were more likely to have PTSD (OR = 9.55, 6.09, 8.76 and 16.96, respectively). The results are consistent with the high correlation between PTSD and depression found in previous studies (Roussos et al., 2005). It is possible that factors strongly associated with depression drive the development or persistence of post-traumatic distress (Merriman, Norman, & Barton, 2007). In addition, it may be explained by that depression symptoms tend to persist longer and co-occur with PTSD symptoms after disasters. Three hypotheses have been offered to explain the co-morbidity between PTSD and depression. The first potential explanation is that post-traumatic stress and depression vary synchronously over time. Synchronous change may occur as a result of a third factor or factors that are causally related to both conditions and contribute to their simultaneous changes. The second hypothesis supposes that PTSD symptoms serve as a risk factor which increases the severity of depression. In contrast, a further hypothesis suggests that PTSD symptoms are themselves a consequence of depression rather than a causal factor. These explanations offer us important insights into the development and maintenance of PTSD and depressive symptoms (Schindel-Allon, Aderka, Shahar, Stein, & Gilboa-Schechtman, 2010; Ying, Wu, & Lin, 2012). Our study, being a repeated cross-sectional study, allowed us to learn more about the psychological sequelae associated with a large-scale disaster in a developing

country. However, the specifics of the longitudinal relationship between PTSD and depression require further study.

## 5. Limitations

The present study has several limitations that should be mentioned. First, as a repeated cross-sectional study, it supplied us with information concerning changes in prevalence of PTSD over time; this information is insufficient, however, for describing trajectories of PTSD over time at the individual level. Moreover, it is hard to determine the direction of the relationship between PTSD and risk factors, which assumed to affect the long-term course of PTSD such as depression, health behavior, and health status, also could service as outcomes and/or comorbidities of PTSD. Future studies using longitudinal data may be able to explore trends and risk factors of PTSD in more depth. Second, not all potential confounding factors were measured and adjusted for in the analysis. Details concerning the respondents' exposures to the earthquake, such as injuries to family members, damage to houses, etc., were not assessed in this study. Third, sampling was not completely random. The inclusion of persons for whom participation was convenient raises the possibility of self-selection bias, and there was a degree of overlap among the samples over time. Finally, the IES-R is a screening tool, rather than a clinical diagnostic method; thus, prevalence of PTSD was probably somewhat overestimated in our study. Future research should, if possible, emphasize the role of clinical diagnostic measurements when exploring similar topics, so as to increase the credibility of the findings among clinicians. Despite these limitations, to the authors' knowledge, this study is among the first investigations of mental health among survivors of the earthquake 4 years later, and is also one of a handful of studies of the psychological sequelae of catastrophic natural disasters among non-Western populations.

## 6. Conclusions

The results of this study indicate that PTSD symptom levels among survivors of the Wenchuan earthquake fell gradually during the four years following the earthquake. Gender, health behavior, health related variables and depression were associated with PTSD at various time points after the earthquake. These findings may have implications for further mental health interventions for adults after earthquakes.

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