



The Effect of COVID-19 on Youth Mental Health

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Abstract

The purposes of this study was to assess the youth mental health after the coronavirus disease 19 (COVID-19) occurred in China two weeks later, and to investigate factors of mental health among youth groups. A cross-sectional study was conducted two weeks after the occurrence of COVID-19 in China. A total of 584 youth enrolled in this study and completed the question about cognitive status of COVID-19, the General Health Questionnaire(GHQ-12), the PTSD Checklist-Civilian Version (PCL-C) and the Negative coping styles scale. Univariate analysis and univariate logistic regression were used to evaluate the effect of COVID-19 on youth mental health. The results of this cross-sectional study suggest that nearly 40.4% the sampled youth were found to be prone to psychological problems and 14.4% the sampled youth with Post-traumatic stress disorder (PTSD) symptoms. Univariate logistic regression revealed that youth mental health was significantly related to being less educated (OR = 8.71, 95%CI:1.97–38.43), being the enterprise employee (OR = 2.36, 95%CI:1.09–5.09), suffering from the PTSD symptom (OR = 1.05, 95%CI:1.03–1.07) and using negative coping styles (OR = 1.03, 95%CI:1.00–1.07). Results of this study suggest that nearly 40.4% of the youth group had a tendency to have psychological problems. Thus, this was a remarkable evidence that infectious diseases, such as COVID-19, may have an immense influence on youth mental health. Therefor, local governments should develop effective psychological interventions for youth groups, moreover, it is important to consider the educational level and occupation of the youth during the interventions.

Keywords Post-traumatic stress disorder · Mental health · Negative coping styles · COVID-19

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Introduction

In late December 2019, patients in Wuhan, China, reported having viral pneumonia due to an unknown microbial pathogen. A new coronavirus was subsequently identified as the pathogen and was temporarily named the 2019 new coronavirus (2019-nCoV) [1]. On January 30, 2020, the World Health Organization (WHO) announced that the emergence of a new coronavirus (2019-nCoV) was a public health emergency of international concern (PHEIC). Infectious diseases have become one of the major threats to global public health in the twenty-first century [2]; such diseases impact both physical health and mental health [3, 4]. As of February 18, 2020, 57805 people have been confirmed to be infected with COVID-19, leading to 2004 deaths across 31 provinces in mainland China [5]. The outbreak of COVID-19 in China caused public panic and mental health stress, with an increasing number of cases being diagnosed and some countries appearing to have confirmed cases and public concerns about infection [6].

Many studies have demonstrated the impact of infectious disease outbreaks on public mental health, such as severe acute respiratory syndrome (SARS) in 2003 [7, 8], and the 2009 novel influenza A (H1N1) epidemic [9, 10]. These types of epidemics lead the public to experience psychological problems such as post-traumatic stress disorder, psychological distress, depression and anxiety [11]. Some studies have shown that post-traumatic stress disorder is closely related to depression and other psychological problems [12]. According to a theoretical model developed by Ehlers and Clark [13], after experiencing a traumatic event, individuals may make a negative assessment of the trauma and its sequelae. In this way, they may easily to adopt maladaptive strategies to maintain PTSD symptoms such as invasion, arousal symptoms and strong negative emotions [14]. Therefore, this study assumes that youth groups may have a tendency to develop psychological problems after experiencing traumatic stress disorder.

Studies have shown that effective coping strategies can protect individuals from mental health problems when facing emergencies [15], but the coping styles can be divided into positive and negative subscales [16]. Multiple studies have shown that the relationship between negative coping styles and depression, such that the use of avoiding or negative coping styles is related to psychological problems such as depression [17, 18]. For example, the 5–8 weeks after September 11, 2001, 28.8% of respondents reported consuming more tobacco, alcohol and marijuana [19]. These negative responses were the main predictors of psychological distress, such as depression, anxiety and stress [20]. However, few studies have considered the psychological impact of a negative coping strategy on youth during public health emergencies (e.g., COVID-19).

In this study, we aimed to examine the extent to which youth groups were prone to psychological problems due to COVID-19 and to explore the correlation between the GHQ-12, PTSD, negative coping styles and sociodemographic variables. In addition, we explored the factors affecting the mental health of youth groups and provided suggestions for intervention in the mental health of youth groups.

Methods

Participants

On January 30, 2020, approximately two weeks after the World Health Organization announced the emergence of a new coronavirus (2019-nCoV) as a public health emergency of

international concern (PHEIC), we conducted this cross-sectional study. We used a snowball sampling approach to distribute questionnaires online. The questionnaires were distributed to WeChat circles of friends, when a participant completed the questionnaire, they forwarded it to their own WeChat circle of friends to expand the sample size. The participants of this survey were mainly young people aged 14–35 who could complete the questionnaires without assistance. Approximately 610 questionnaires were completed. After deleting incomplete and random responses, a total of 584 valid questionnaires were analyzed in this study, thus, the valid response rate was 95.7%.

Measures

Knowledge about COVID-19

Five items were used to measure knowledge about COVID-19, such as “Do you know that 56° for 30 minutes, diethyl ether, 75% ethanol, peracetic acid and other lipid solvents can effectively kill the virus?”. Participants could select from 1 (did not have full knowledge) to 5 (full knowledge) to judge the participants’ knowledge about COVID-19.

The General Health Questionnaire Scale (GHQ-12)

Mental health was measured using the General Health Questionnaire (GHQ-12) [21], which is a self-assessment screening tool. This questionnaire has been successfully used in Chinese samples and has good psychometric properties [22]. The questionnaire consists of 12 items, and response options range from 0 (never) to 3 (usually). Total scores range from 0 to 36 with higher scores indicating higher degrees of disturbance of the general health status. A total score higher than 15 points indicates a tendency toward psychological problems [23]. In our study, the Cronbach’s alpha coefficient of the GHQ-12 was 0.793.

The PTSD Checklist-Civilian Version (PCL-C)

The PTSD Checklist-Civilian Version (PCL-C) [24] was used to measure post-traumatic stress symptoms with respect to COVID-19. Response options ranged from 1 (not at all) to 5 (seriously). The reliability and validity of this questionnaire have been previously assessed [25]. It consists of 17 items, and the total scores range from 17 to 85. Participants with a cut-off score of 38 or higher were classified as having PTSD symptoms [24, 26]. In this study, this scale presented good internal consistency, and the Cronbach’s alpha coefficient of the PCL-C was 0.943.

Simplified Coping Style Questionnaire (SCSQ)

Negative coping styles were measured by the Simplified Coping Style Questionnaire (SCSQ), which was originally developed for Chinese respondents and has been proven to be reliable and effective [16]. This questionnaire includes two subscales: active coping (12 items) and negative coping (8 items). Response options ranged from 0 (never) to 3 (very frequently). In the negative coping subscales, higher scores indicate more frequent use of negative coping strategies. The Cronbach’s alpha coefficient of the negative coping subscale was 0.834.

Data Analyses

All statistical analyses were performed using SPSS 24.0 (IBM Corp), with $P < 0.05$ as the level of statistical significance. Means (M) and standard deviation (SD) were used to describe the demographic data. One-way ANOVA and LSD post hoc comparisons were used to assess the associations between sociodemographic characteristics, GHQ-12, PTSD and negative coping style. In addition, we used univariate logistic regression analysis to explore the factors that influence mental health among the participants.

Results

Participant Characteristics

The demographic information for 584 participants (361 females and 223 males) is shown in Table 1. Their ages ranged from 14 to 35, and most of them were between 21 and 30 years old (74.6%). In addition, 77.9% of the participants had a bachelor's degree, and 13.5% had a master's degree or above. In addition, most of the participants were single, and 77.7% were students. More than half of the participants' (69.2%) had a monthly average disposable income less than 2000 RMB.

Regarding knowledge about COVID-19, 30.1% of the participants had full knowledge of the information presented in item 1, but 6.5% of the participants did not have full knowledge of the information. In addition, most of the participants had full knowledge of the information presented in items 2, 3 and 4. Approximately 5.0% of the participants did not fully understand that psychological balance can improve immunity. More information is provided in Table 2.

Univariate Analysis

One-way ANOVA revealed significant differences in the GHQ-12, PTSD and negative coping between genders. However, age did not have a significant effect on any variable. In addition, this study found significant differences in the GHQ-12 and PTSD across education status and across marital status. However, occupation only had a significant effect on PTSD. The GHQ-12, PTSD, and negative coping also did not differ significantly between monthly average disposable income brackets (see Table 3).

To show which subcategories of the demographic variables were associated with GHQ-12, PTSD and negative coping, LSD post hoc comparisons were conducted, and the results are shown in Table 4. The LSD post hoc comparisons showed that participants with a junior high school education or below had significantly ($P < 0.05$) higher scores than the other three groups (high school or secondary school, undergraduate or college and master's degree or above) on the GHQ-12. For PTSD, participants with a junior high school education or below had significantly ($P < 0.05$) higher scores than the undergraduate or college group, and participants with a high school or secondary school education had significantly ($P < 0.05$) higher scores than the undergraduate or college and master's degree or above groups. Additionally, this study found that the divorced/widowed participants had significantly ($P < 0.05$) higher scores on the GHQ-12 and PTSD scales than the married/cohabitating and single participants, but there were no significant differences for the other groups. Note that the results of other subcategories of occupation were omitted here. We only list the business

Table 1 Demographic characteristics of the participants ($n = 584$)

Variable		Sample ($n = 584$)	Percentage (%)
Gender	Female	361	61.8
	Male	223	38.2
Age	14–20	130	22.3
	21–30	436	74.6
	31–35	18	3.1
Educational level	Junior high school or below	18	3.1
	High school or secondary school	32	5.5
	Undergraduate or college	455	77.9
	Master's degree or above	79	13.5
Marital status	Single	548	93.8
	Married/Cohabiting	32	5.5
	Divorced/widowed	4	0.7
Occupation	Student	454	77.7
	Medical staff	17	2.9
	Business	22	3.8
	Enterprise employee	72	12.3
	Other	19	3.3
Monthly average disposable income	<2000 RMB	404	69.2
	2001–3000 RMB	77	13.2
	3001–4000 RMB	45	7.7
	4001–5000 RMB	16	2.7
	>5001RMB	42	7.2

compared with other groups; we found that the business had significantly higher scores than the other group ($P < 0.05$).

Univariate Logistic

To determine the factors that predict psychiatric symptoms, univariate logistic regression was conducted. Since there were nominal (i.e., categorical) variables, it was necessary to recode them into dummy variables. The results showed that participants with a junior high school education or below (OR = 8.71, 95% CI: 1.97–38.43), enterprise employee (OR = 2.36, 95%

Table 2 Knowledge about COVID-19 ($n = 584$)

	Fully known (%)	Not known (%)
Item 1. Do you know that 56° for 30 min, diethyl ether, 75% ethanol, peracetic acid and other lipid solvents can effectively kill the virus?	176(30.1)	38(6.5)
Item 2. COVID-19's incubation period is generally 3–7 days, with a maximum of 14 days.	379(64.9)	23(3.9)
Item 3. COVID-19 is mainly transmitted through respiratory droplets and can also be transmitted through contact.	402(68.8)	20(3.4)
Item 4. The early general symptoms of COVID-19 are fever, fatigue, dry cough, and gradually dyspnea. Some patients have mild onset symptoms without fever. In severe cases, symptoms such as respiratory distress syndrome and septic shock occur, but most patients are mild to moderate with a good prognosis, but a few patients are in critical condition and even die.	332(56.8)	18(3.1)
Item 5. Do you know that psychological balance can improve the body's immunity?	216(37.0)	29(5.0)

Table 3 Demographic characteristics by the GHQ-12, PTSD and negative coping ($n = 584$)

Variable		GHQ-12		PTSD		Negative Coping	
		M ± SD	<i>P</i>	M ± SD	<i>P</i>	M ± SD	<i>P</i>
Gender	Female	11.55 ± 6.14	<0.01	26.74 ± 8.89	<0.01	19.15 ± 5.00	<0.01
	Male	12.85 ± 6.66		29.27 ± 13.58		20.44 ± 6.05	
Age	14–20	12.45 ± 6.48	0.48	26.35 ± 9.96	0.28	19.73 ± 6.03	0.87
	21–30	11.99 ± 6.33		28.10 ± 11.37		19.59 ± 5.28	
	31–35	10.61 ± 6.75		28.06 ± 7.36		20.22 ± 5.54	
Educational Level			<0.001		<0.05		0.05
	Junior high school or below	18.39 ± 4.77		32.50 ± 15.08		17.06 ± 5.92	
	High school or secondary school	12.72 ± 5.37		32.75 ± 17.44		20.81 ± 6.29	
	Undergraduate or college	11.94 ± 6.32		27.16 ± 10.10		19.79 ± 5.29	
	Master's degree or above	10.92 ± 6.58		27.76 ± 10.90		18.87 ± 5.77	
Marital Status			<0.05		<0.01		0.42
	Single	12.00 ± 6.32		27.44 ± 10.63		19.57 ± 5.48	
	Married/Cohabiting	11.65 ± 6.51		30.28 ± 12.95		20.47 ± 4.90	
Occupation	Divorced/widowed	21.00 ± 8.29		44.75 ± 24.90		22.25 ± 5.91	
			0.40		<0.01		0.13
	Student	11.83 ± 6.27		27.18 ± 10.12		19.53 ± 5.36	
	Medical staff	9.70 ± 7.39		29.35 ± 7.59		18.64 ± 3.29	
	Business	13.77 ± 8.33		37.41 ± 20.51		21.68 ± 7.15	
	Enterprise employee	13.22 ± 6.08		27.70 ± 12.16		19.95 ± 5.73	
Monthly average disposable income	Other	12.78 ± 5.50		27.79 ± 8.77		19.68 ± 5.84	
			0.40		0.05		0.66
	<2000 RMB	11.85 ± 6.32		26.89 ± 9.69		19.57 ± 5.31	
	2001–3000 RMB	11.57 ± 6.09		29.75 ± 12.86		19.98 ± 5.63	
	3001–4000 RMB	12.98 ± 5.75		31.16 ± 14.64		19.91 ± 5.29	
	4001–5000 RMB	13.37 ± 7.33		28.19 ± 6.56		17.87 ± 6.46	
>5001 RMB	13.28 ± 7.25		28.00 ± 14.53		20.07 ± 6.33		

CI: 1.09–5.09), those who had PTSD symptoms (OR = 1.05, 95% CI: 1.03–1.07) and those who used adopted negative coping strategies (OR = 1.03, 95% CI: 1.00–1.07) were more likely to have psychological disorders (see Table 5).

Discussion

In this study, we investigated the factors that influence mental health problems among the youth approximately two weeks after the occurrence of COVID-19. Approximately 40.4% of the participants reported having psychological problems and 14.4% youth groups with PTSD symptoms. Having a junior high school education or below, being the enterprise employee, having PTSD symptoms and using negative coping measures were the factors associated with psychological disorders.

Table 4 The results of post-hoc analyses ($n = 584$)

Variable		GHQ-12		PTSD	
I	J	Mean Difference (I-J)	<i>P</i>	Mean Difference (I-J)	<i>P</i>
Education level					
Junior high school or below	High school or secondary school	5.67	<0.01	-0.25	0.93
	Undergraduate or college	6.45	<0.001	5.33	<0.05
	Master's degree or above	7.46	<0.001	4.74	0.09
High school or secondary school	Junior high school or below	-5.67	<0.01	0.25	0.93
	Undergraduate or college	0.77	0.49	5.58	<0.01
	Master's degree or above	1.79	0.17	4.99	<0.05
Undergraduate or college	Junior high school or below	-6.45	<0.001	-5.33	<0.05
	High school or secondary school	-0.77	0.49	-5.58	<0.01
	Master's degree or above	1.01	0.18	-0.59	0.65
Master's degree or above	Junior high school or below	-7.46	<0.001	-4.74	0.09
	High school or secondary school	-1.79	0.17	-4.99	<0.05
	Undergraduate or college	-1.01	0.18	0.59	0.65
Marital status					
Single	Married/Cohabiting	0.34	0.76	-2.84	0.15
	Divorced/widowed	-8.99	<0.01	-17.31	<0.01
Married/Cohabiting	Single	-0.34	0.76	2.84	0.15
	Divorced/widowed	-9.34	<0.01	-14.46	<0.05
Divorced/widowed	Single	8.99	<0.01	17.31	<0.01
	Married/Cohabiting	9.34	<0.01	14.46	<0.05
Occupation					
Business	Student	-	-	10.23	<0.01
	Medical staff	-	-	8.05	<0.05
	Enterprise employee	-	-	9.70	<0.01
	Other	-	-	9.62	<0.01

“-”: There was no significant difference in one-way ANOVA.

In this survey, it was found that there were more young people with a tendency toward psychological problems, which was higher than the ratio of psychological problems in other studies [3, 27, 28]. For example, some studies during the SARS period found that 26.2% of participants had a tendency to have psychological problems [29] and 14.1% youth groups with PTSD symptoms at three years after the 2013 earthquake in Lushan, China [30]. This finding was most likely because this study was a survey conducted two weeks after the COVID-19, while other surveys started one month or even a year after the emergencies occurred and previous studies showed a decrease in PTSD cases with time [31]. In addition, COVID-19 seems to spread via human-to-human transmission, and a first-level response to public health emergencies has been initiated in some provinces in China, which raising concerns about the infection.

It was found that most of the participants had some knowledge about COVID-19, but a few participants had no knowledge. Studies have shown that the ability of the public to understand and respond to the information obtained played a key role in stopping the spread of SARS [32]. Therefore, during this epidemic, public media education should be carried out, including

Table 5 Factors associated with psychological disorder (GHQ-12 score>15)

	Variable	OR(95%CI)	P
Education status	Master's degree or above	1.00 (reference)	
	Undergraduate or college	1.10(0.58-1.77)	0.95
	High school or secondary school	0.79(0.28-2.26)	0.67
	Junior high school or below	8.71(1.97-38.43)	<0.01
Occupation	Student	1.00 (reference)	
	Medical staff	1.14(0.34–3.85)	0.83
	Business	1.18(0.50–6.63)	0.36
	Enterprise employee	2.36(1.09–5.09)	<0.05
	Other	1.67(0.57–4.93)	0.35
PTSD		1.05(1.03–1.07)	<0.001
Negative Coping		1.03(1.00–1.07)	<0.05

using the media for the prevention and control of the epidemic [33], so that young people can learn about the COVID-19 and take action to protect themselves and others.

This study found that compared to women, men scored significantly higher on the GHQ-12, PTSD and negative coping scales, which is inconsistent with other research results [34, 35]. The difference may be due to different coping styles and social roles. Women were more likely to show symptoms of PTSD during the COVID-19 outbreak, which may reduce the incidence of PTSD [36], but men may take more responsibility leading to stress, PTSD symptoms and psychological distress symptoms [37]. Regarding factors of educational level, participants with a lower education were more likely to show PTSD symptoms and psychological distress, which is consistent with other research results [38]. In this study, LSD post-hoc comparisons were used to discover differences between different educational levels. The participants with junior high school or below educational level had higher PTSD and GHQ-12 scores than other groups, which may be because a higher level of education can improve one's understanding of issues related to post-traumatic stress disorder and psychological distress, leading one to take positive measures to prevent related symptoms from appearing and increasing confidence in mental health recovery [39]. In terms of marital status, the LSD post-hoc comparisons revealed that the divorced/widowed participants had significantly higher PTSD and GHQ-12 scores than single and married/cohabitating participants; this difference may be due to family financial loss, a lack of support against negative emotions or depression symptoms [40, 41] and a lack of opportunities to communicate with family members leading to psychological problems such as depression and anxiety, which highlight the importance of family support during this emergency [12]. In the professional dimension, this study found that business groups have significantly higher PTSD scores than the other four groups, which may be because during the occurrence of COVID-19, compared to other professions, the businessman who needed to trade with others were worried about being infected and had some PTSD symptoms.

This study suggested that participants with junior high school or below education had significantly higher scores on the GHQ-12. These groups may experience long-term mental health problems because they lack the ability to recover from emergencies [8]. The government and relevant psychological institutions should take relevant psychological counseling measures to help this group recover from the impact of COVID-19. In addition, it also found that the enterprise employees may occurrence to the tendency of psychological distress, because during the occurrence of COVID-19, the working style of employees has changed.

Faced with the sudden change of working style, they may not be able to adapt to this changes in a short time and cause certain psychological pressure. However, the specific reasons need to be further confirmed in the future. Using negative coping was also a predictive factor for the tendency of psychological distress, and studies showed that negative coping styles were linked to mental health issues [42]. These group used negative, avoidance-focused coping as a risk factor for post-traumatic symptoms [43]. Furthermore, post-traumatic symptoms were a strong predictor of psychological distress [12]. Thus, PTSD symptoms and negative coping styles were strong predictors of youth mental health with respect to COVID-19.

Conclusion

In summary, this study found that mental health problems remain serious among the most of youth group during public health emergency. This study also indicated that low education level, enterprise employee, PTSD symptom and negative coping styles were the influence factors of youth mental health. These results highlight the need for local governments to take appropriate mental health interventions based on the characteristics of youth groups. The future research should moved beyond the cross-sectional design of the present study to explore the other factors affecting the youth mental health in public health emergency.

Limitations and Future Research Directions

Certain limitations of this study should be recognized. The main limitation was that our study used a cross-sectional design, which cannot provide strong evidence for causality. Thus, further research should use a longitudinal design. Second, this study used self-reported questionnaires, which have issues with subjectivity and reliability. In addition, because of the limited sample size and snowball sampling approach, these findings may not represent the entire youth population. Therefore, a larger sample size might be needed. Finally, other variables affecting youth mental health with respect to COVID-19 should be examined.

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Compliance with Ethical Standards

Ethical Approval This study has received approval from the Research Ethical Committee of Jilin University and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. In addition, we obtained verbal consent from participants before data collection.

Conflict of Interest The authors declare that they have no conflict of interest.

Informed Consent During the research process, informed consent was obtained from all individual participants all. The invited participants were voluntary and guaranteed confidentially.

References

1. Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. *Lancet*. 2020;395:565–74.
2. Mak W, Chu CM, Pan PC, Yiu MG, Ho SC, Chan VL. Risk factors for chronic post-traumatic stress disorder (PTSD) in SARS survivors. *Gen Hosp Psychiat*. 2010;32:590–8.
3. Lau JT, Griffiths S, Choi KC, Tsui HY. Avoidance behaviors and negative psychological responses in the general population in the initial stage of the H1N1 pandemic in Hong Kong. *BMC Infect Dis*. 2010;10:139.
4. Xiang YT, Yu X, Ungvari GS, Correl CU, Chiu HF. Outcomes of SARS survivors in China: not only physical and psychiatric co-morbidities. *East Asian Arch Psychiatry*. 2014;24:37–8.
5. National Health Commission of the People's Republic of China. Update on epidemic situation of novel coronavirus-infected pneumonia by 24:00 on Feb 18, 2020. <http://www.nhc.gov.cn/xcs/s3574/202002/2db5729cfb674b37b48820a098c8bf88.shtml>. Accessed 18 Feb 2020.
6. Bao Y, Sun Y, Meng S, Correl CU, Chiu HF. 2019-nCoV epidemic: address mental health care to empower society. *Lancet*. 2020;395:e37–8.
7. Ko CH, Yen CF, Yen JY, Yang MJ. Psychosocial impact among the public of the severe acute respiratory syndrome epidemic in Taiwan. *Psychiat Clin Neuros*. 2006;60:397–403.
8. Peng EYC, Lee MB, Tsai ST, Yang CC, Morisky DE, Tsai LT, et al. Population-based post-crisis psychological distress: an example from the SARS outbreak in Taiwan. *J Formos Med Assoc*. 2010;109:524–32.
9. Yeung NCY, Lau JTF, Choi KC, Griffiths S. Population responses during the pandemic phase of the influenza a(H1N1)pdm09 epidemic, Hong Kong. *China Emerg Infect Dis*. 2017;23:813–5.
10. Taha SA, Matheson K, Anisman H. H1N1 was not all that scary: uncertainty and stressor appraisals predict anxiety related to a coming viral threat. *Stress Health*. 2014;30:149–57.
11. Shultz JM, Baingana F, Neria Y. The 2014 Ebola outbreak and mental health: current status and recommended response. *JAMA*. 2015;313:567–8.
12. Qu Z, Wang CW, Zhang X, Ho AH, Wang X. Prevalence and determinants of depression among survivors 8 months after the Wenchuan earthquake. *J Nerv Ment Dis*. 2014;202:275–9.
13. Ehlers A, Clark DM. A cognitive model of posttraumatic stress disorder. *Behav Res Ther*. 2000;38:319–45.
14. Xu W, Fu G, An Y, Yuan G, Ding X, Zhou Y. Mindfulness, posttraumatic stress symptoms, depression, and social functioning impairment in Chinese adolescents following a tornado: mediation of posttraumatic cognitive change. *Psychiatry Res*. 2018;259:345–9.
15. Xu JP, He Y. Psychological health and coping strategy among survivors in the year following the 2008 Wenchuan earthquake. *Psychiat Clin Neuros*. 2012;66:210–9.
16. Xie YN. The initial exploration of reliability and validity of simplified coping styles questionnaire. *Chin J Clin Psych*. 1998;6:114–5.
17. Guardino CM, Schetter CD. Coping during pregnancy: a systematic review and recommendations. *Health Psychol Rev*. 2014;8:70–94.
18. Tychev C, Spitz E, Briancon S, Lighezzolo J, Girvan F, Rosati A, et al. Pre- and postnatal depression and coping: a comparative approach. *J Affect Disorders*. 2005;85:323–6.
19. Vlahov D, Galea S, Resnick H, Ahem J, Boscarino JA, Bucuvalas M, et al. Increased use of cigarettes, alcohol, and marijuana among Manhattan, New York, residents after the September 11th terrorist attacks. *Am J Epidemiol*. 2002;155:988–96.
20. Mahmoud JS, Staten R, Hall LA, Lennie TA. The relationship among young adult college students' depression, anxiety, stress, demographics, life satisfaction, and coping styles. *Issues Ment Health N*. 2012;33:149–56.
21. Goldberg DP, Gater R, Sartorius N, Ustun TB, Piccinelli M, Gureje O, et al. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychol Med*. 1997;27:191–7.
22. Fares J, Saadeddin Z, Al Tabosh H, Aridi H, El Mouhassar C, Koleilat MK, et al. Extracurricular activities associated with stress and burnout in preclinical medical students. *J Epidemiol Glob Health*. 2016;6:177–85.
23. Saravanan P, Chau WF, Roberts N, Vedhara K, Greenwood R, Dayan CM. Psychological well-being in patients on “adequate” doses of L-thyroxine: results of a large, controlled community-based questionnaire study. *Clin Endocrinol*. 2002;57:577–85.
24. Weathers FW, Litz BT, Herman DS, Husha JA, Keane TM. The PTSD checklist: reliability, validity, and diagnostic utility. *Int Soc Trauma Stress Stud*. 1993;2:90–2.
25. Zhang Z, Shi Z, Wang L, Liu M. One year later: mental health problems among survivors in hard-hit areas of the Wenchuan earthquake. *Public Health*. 2011;125:293–300.
26. Grubaugh AL, Elhai JD, Cusack KJ, Wells C, Frueh BC. Frueh screening for PTSD in public-sector mental health settings: the diagnostic utility of the PTSD checklist. *Depress Anxiety*. 2007;24:124–9.

27. Maya-Mondragón J, Sánchez-Román FR, Palma-Zarco A, Aguilar-Soto M, Borja-Aburto VH, Aguilar-Soto M, et al. Prevalence of post-traumatic stress disorder and depression after the September 19th, 2017 earthquake in Mexico. *Arch Med Res.* 2017;50:502–8.
28. Wang Y, Xu J, Lu Y. Associations among trauma exposure, post-traumatic stress disorder, and depression symptoms in adolescent survivors of the 2013 Lushan earthquake. *J Affect Disorders.* 2020;264:407–13.
29. Mihashi M, Otsubo Y, Yinjuan X, Nagatomi K, Hoshiko M, Ishitake T. Predictive factors of psychological disorder development during recovery following SARS outbreak. *Health Psychol.* 2009;28:91–100.
30. Xu J, Wang Y, Tang W. Posttraumatic stress disorder in Longmenshan adolescents at three years after the 2013 Lushan earthquake. *Gen Hosp Psychiat.* 2018;54:45–51.
31. Sahin NH, Batigün AD, Yilmaz B. Psychological symptoms of Turkish children and adolescents after the 1999 earthquake: exposure, gender, location, and time duration. *J Trauma Stress.* 2007;20:335–45.
32. Slaughter L, Keselman A, Kushniruk A, Patal VL. A framework for capturing the interactions between laypersons' understanding of disease, information gathering behaviors, and actions taken during an epidemic. *J Biomed Inform.* 2005;38:298–313.
33. Kim L, Fast SM, Markuzon N. Incorporating media data into a model of infectious disease transmission. *PLoS One.* 2019;14:e0197646.
34. Carmassi C, Corsi M, Bertelloni CA, Carpita B, Gesi C, Pedrinelli V, et al. Mothers and fathers of children with epilepsy: gender differences in post-traumatic stress symptoms and correlations with mood spectrum symptoms. *Neuropsychiatr Dis Treat.* 2018;14:1371–9.
35. Jin Y, Deng H, An J, Xu J. The prevalence of PTSD symptoms and depressive symptoms and related predictors in children and adolescents 3 years after the ya'an earthquake. *Child Psychiatry Hum Dev.* 2018;50:300–7.
36. Du B, Ma X, Ou X, Jin Y, Ren P, Li J. The prevalence of posttraumatic stress in adolescents eight years after the Wenchuan earthquake. *Psychiatry Res.* 2018;262:262–9.
37. Guo J, Fu MQ, Xing J, Qu ZY, Wang XU. Coping style and posttraumatic growth among adult survivors 8 years after the 2008 Wenchuan earthquake in China. *Pers Individ Differ.* 2017;111:31–6.
38. Peng EYC, Lee MB, Tsai ST, Yang CC, Morisky DE, Tsai LT, et al. Population-based post-crisis psychological distress: an example from the SARS outbreak in Taiwan. *J Formos Med Assoc.* 2010;109:524–32.
39. Baral IA, Bhagawati KC. Post traumatic stress disorder and coping strategies among adult survivors of earthquake, Nepal. *BMC Psychiatry.* 2019;19:118.
40. Choul FH, Chou P, Lin C, Su TT, Ou-Yang WC, Chien IC, et al. The relationship between quality of life and psychiatric impairment for a Taiwanese community post-earthquake. *Qual Life Res.* 2004;13:1089–97.
41. Guo J, He H, Qu Z, Wang X, Liu C. Post-traumatic stress disorder and depression among adult survivors 8 years after the 2008 Wenchuan earthquake in China. *J Affect Disorders.* 2017;210:27–34.
42. Wright M, Banerjee R, Hoek W. Depression and social anxiety in children:differential links with coping strategies. *J Abnorm Child Psych.* 2010;38:405–19.
43. Pina AA, Villalta IK, Ortiz CD, Gottschall AC, Costa NM, Weems CF. Social support, discrimination, and coping as predictors of posttraumatic stress reactions in youth survivors of hurricane Katrina. *J Clin Child Adolesc.* 2008;37:564–74.

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