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Prevalence and associated factors of anxiety among 538,500 Chinese students during the outbreak of COVID-19: A web-based cross-sectional study

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ABSTRACT

This study was conducted on elementary school students in Henan Province, China, from February 4th to 11th, 2020, during the coronavirus disease 2019 (COVID-19) epidemic. The purpose of the study was to examine the prevalence of anxiety among students and identify the related risk factors contributing to anxiety. Demographic information and psychological status were assessed by using self-reported measures. The generalized anxiety disorder tool (GAD-7) and a multiple logistic regression model were used to assess anxiety and identify potential influencing factors. Cross-sectional data indicated that the overall anxiety prevalence was 13.4%. The prevalence of anxiety symptoms was highest among rural primary school students and lowest among city students. Three groups of students in different regions were surveyed, and the prevalence of anxiety symptoms was significantly higher among students with poor knowledge of COVID-19 than among students with good knowledge of COVID-19. After adjusting for potential confounding factors, it was found that location, knowledge, and practice were related to anxiety. This study showed that the prevalence of anxiety symptoms was higher among Chinese primary school students. The influencing factors found in this study may help relevant staff improve the mental health of children during the epidemic.

1. Introduction

The coronavirus is a pathogen causing respiratory illness that was first identified in the 1960s. Since December 2019, the COVID-19 outbreak has spread rapidly to become a global public health threat (Lai et al., 2020). The rapid spread of this severe acute respiratory syndrome has posed an enormous challenge to global health care systems, with a ripple effect on every known aspect of human life (Phelan et al., 2020). The high number of confirmed cases and deaths around the world have created fears of disease, as well as of an impending economic crisis and recession (Nicola et al., 2020). To prevent the continuous spread of the novel coronavirus, unparalleled strict isolation measures have been implemented by the Chinese government, such as social distancing, school closures, and home quarantine.

The current COVID-19 pandemic has resulted in an increase in negative emotions for people around the world (Goularte et al., 2021). Available research indicates that anxiety, depression and stress levels increased significantly in the 21–40 age group during the pandemic. The main reason for this increase appears to be concern in this age group about the future consequences and economic challenges of the epidemic or increased access to information through social media, which may also lead to stress (Salari et al., 2020). As the infection rates and mortality of children are lower than those of adults, less attention has been given to the mental health status of children, even though children have different physical and psychological characteristics from adults and are therefore more vulnerable to psychological effects (Ma et al., 2020). Previous studies have shown that children experience anxiety when faced with flexible and rapidly changing situations (Dalton et al., 2020; Danese

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et al., 2020). Therefore, special attention should be given to the anxiety state of children in the general population (Duan et al., 2020). Although online courses were offered to children to ensure that school learning was not largely disrupted, prolonged home quarantine might increase the anxiety status of children's mental health (Brooks et al., 2020). One of the most important issues in the Sustainable Development Goals (SDGs) is children's health, and an increasing number of studies have been identifying associations between adverse childhood experiences (ACEs) and ill health throughout the life course (Bellis et al., 2019). Some studies have shown that genetic susceptibility can be influenced by the environment. For example, children's experiences during a pandemic may affect learning capacities, adaptive behaviors, lifelong physical and mental health, and adult productivity (Hughes et al., 2017). Therefore, it is necessary to gain a timely understanding of anxiety status.

In addition to describing the anxiety status of children during the COVID-19 pandemic, key risk and protective factors need to be identified to determine which children fall into an at-risk group and measures that can be taken to protect these children from anxiety symptoms and improve their mental health. A systematic review of 24 studies found that restricting activity had significant psychological effects: for example, increased rates of common psychological symptoms, mood disorders, depression and anxiety were found in isolated populations (Brooks et al., 2020). Subsequent research has shown that close and open communication between parents and children during home isolation may protect children from experiencing anxiety to some extent (Tang et al., 2021). However, in previous studies, there has been little consideration and analysis of the influence of children's COVID-19 knowledge and protective behaviors on anxiety symptoms at the regional level.

To address these gaps in the literature, the present study was conducted on registered elementary school students in China during the COVID-19 epidemic to investigate the prevalence of anxiety and identify the associated risks and protective factors contributing to anxiety. The results of this study may help improve the mental health of students during the pandemic.

2. Methods

2.1. Study participants

A cross-sectional survey was conducted from 4 to 11 February 2020 by using an anonymous questionnaire through an online platform ("Survey Star", Changsha Ran Xing Science and Technology, Shanghai, China). A link to the survey was sent by using the cluster sampling method to teachers in charge of student affairs in schools in the cities of Zhengzhou, Xinyang, and Xinxiang in Henan Province, China. Then, students received the questionnaire through the social network group of the classes. The questionnaire could only be submitted once for each account after all questions had been answered. Both student assent and parental informed consent for the survey were obtained. A total of 616,995 subjects who consented to participate and submitted the questionnaire were included in the study. We excluded 78,495 individuals aged < 6 years or > 12 years according to the legal primary school age in China. Finally, data on 538,500 participants were used in the analysis. In this study, county-level cities were those that were originally counties and subsequently developed into cities with large populations or strong economies far away from prefecture-level city centers. Rural areas, population, and agricultural production in county-level cities account for a higher proportion of the national economy than prefecture-level cities. Children exhibiting anxiety symptoms after the study were offered psychological counseling. The study was approved by the Ethics Committee of Zhengzhou University.

2.2. Data collection

We prepared a self-reported questionnaire with 30 questions, which is provided in Supplementary Material A. The questionnaire consisted of four parts: (A) basic participants' information (grade, gender, age, location, etc.); (B) COVID-19 knowledge; (C) practices (lifestyle changes after finding out about the epidemic); and (D) attitudes (worry, fear, anxiety, confidence, etc.). Knowledge and practice scores for each respondent were determined from responses to 9 knowledge questions and 6 practice questions, respectively. Each question was scored out of 2. The total score for each correct answer for knowledge and practices was based on the number of correct answers to the individual questions. A cutoff of a cumulative frequency of approximately 50% was used for all the categories to distinguish between good and poor knowledge and practices (Paul et al., 2020). Allowed responses to questions regarding levels of worry, fear and self-reported anxiety were "very", "comparatively", "generally", "not very much" and "none" and were assigned a score to on a 5-point Likert scale corresponding to 5, 4, 3, 2, and 1, respectively. For the emotional levels, a score of 4,5 was considered high, a score of 3 was considered moderate, and a score of 1,2 was considered low or zero. This evaluation standard has been used in previous studies (Li et al., 2020). Anxiety was assessed by using the generalized anxiety disorder tool (GAD-7). The sensitivity and specificity of this tool were both greater than 80% on a cutoff point scale of 10 (Spitzer et al., 2006), and scores above 10 were categorized into three levels: low, moderate and high. A score of 10–13 was considered low, a score of 14–18 was considered moderate, and a score of 19–21 was considered high.

2.3. Statistical analysis

Categorical data were presented as frequencies (%), and chi-squared tests were used to describe the statistical differences between the two groups. Cramer's *V* values were used to present the correlation of categorical variables. A logistic regression model was used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) of the characteristics of the study participants. We adjusted for age, gender, knowledge, practices, worry level, fear level and the way of completion for this model. The abovementioned analyses were performed for different locations due to large divergences in economic and development levels among rural areas, county-level cities and cities. All statistical analyses were performed by using SPSS software, version 21.0 (SPSS Inc., Chicago). Two-tailed *P* values < 0.05 indicated a difference was statistically significant.

3. Results

3.1. Sociodemographic characteristics of the participants

Fig. 1 shows the overall anxiety prevalence among primary school students. The prevalence of anxiety among primary school students was 13.4% during the COVID-19 pandemic in China. Furthermore, a high proportion of these participants (7.3% of 13.4%) reported relatively low-level anxiety. The study participants' characteristics are summarized in Table 1. Among the 583,500 students included in the study, 72,276 students were found to exhibit anxiety symptoms during the COVID-19 epidemic in China. Table 1 shows the characteristics of the participants by anxiety status. Compared to participants without anxiety, participants with anxiety differed in terms of the proportion of gender, location, knowledge and practices of COVID-19, and the way of completion ($P < 0.001$ in all cases). Except for gender, the range of the Cramer's *V* values of these variables was 0.01–0.07 ($P < 0.001$ in all cases) (Supplementary Table 2). Notably, the gap in the boys/girls ratio was particularly small, although significant.

Prevalence of anxiety

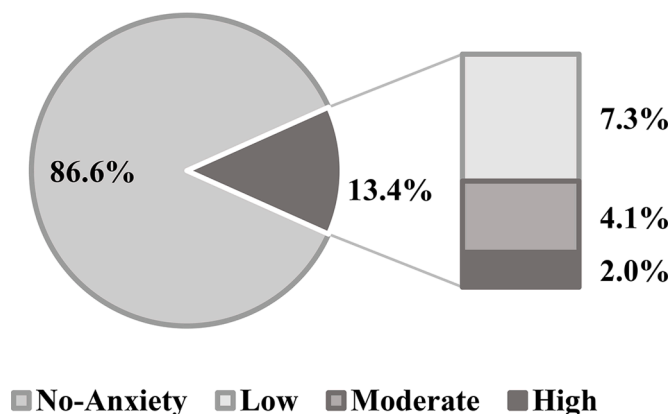


Fig. 1. The prevalence of anxiety symptoms in overall participants.

Table 1
Basic characteristics of the study population.

Variables	No-Anxiety	Anxiety	P-value
	n1 = 466,224	n2 = 72,276	
Gender, n (%)			
Boys	248,601 (53.3)	38,588 (53.4)	< 0.001
Girls	217,623 (46.7)	33,688 (46.6)	
School location, n (%)			< 0.001
Rural	180,026 (38.6)	35,315 (48.9)	
County-level city	83,552 (17.9)	11,834 (16.4)	
City	202,646 (43.5)	25,127 (34.8)	
Knowledge, n (%)			< 0.001
Poor	263,114 (56.4)	46,820 (64.8)	
Good	203,110 (43.6)	25,456 (35.2)	
Practices, n (%)			< 0.001
Poor	229,198 (49.2)	34,833 (48.2)	
Good	237,026 (50.8)	37,443 (51.8)	
Worried level, n (%)			< 0.001
Low	26,247(5.6)	577(0.8)	
Moderate	66,838(14.3)	1801(2.5)	
High	373,139(80.0)	69,898(96.7)	
Fear level, n (%)			< 0.001
Low	52,432(11.25)	1273(1.76)	
Moderate	133,941(28.73)	3799(5.26)	
High	279,851(60.03)	67,204(92.98)	
Way of completion, n (%)			< 0.001
With the help of parents	326,432 (70.0)	45,865 (63.5)	
On one's own	139,792 (30.0)	26,411 (36.5)	

Data were presented as numbers (percentages) for categorical variables; P values calculated using chi-square.

Compared with No-anxiety, P < 0.05.

3.2. Knowledge and preventative practices of COVID-19

The results for participants' knowledge of general information on COVID-19 and prevention behavior is shown in Supplementary Material B. In Supplementary Table 1, the frequency distribution for participants' responses to questions about COVID-19 demonstrated that the majority had accurate knowledge of COVID-19. As many as 99.4% of the participants identified COVID-19 as a disease that spreads from person to person. Regarding COVID-19 transmission routes, 95.0% of the participants knew that COVID-19 can spread through droplets, and 87.7% of the participants knew that COVID-19 can spread through contact. The participants had poor knowledge of COVID-19 symptoms (only 42.7% and 53.7% knew that a blocked or watery nose and a series of complications, respectively, were symptoms) but had sound knowledge of preventative measures. Knowledge of preventative options was ranked as follows: frequent hand washing (99.5%), indoor ventilation (92.9%),

wearing surgical masks (91.1%), wearing N95 or KN95 masks (93.2%), wearing a mask, keeping a safe distance, and going to the nearest designated hospital when infection is suspected (92.9%).

Regarding practices, a total of 99.0% of subjects reported not socializing with classmates, and 98.9% of subjects avoided crowded areas. Approximately 99% of the participants reported increased frequency of hand washing, 82% of participants gave up travel plans, and 97% of participants avoided dining together outside. However, only 65.8% of the participants reported a preference for wearing masks when going out.

3.3. Associations of demographic variables with anxiety

Fig. 2 shows the prevalence of anxiety among participants by location. Among students in the three location groups, the prevalence of anxiety was lowest (11.0%) among city students and highest (16.4%) among rural students. The results from the regression analyses are presented in Table 2. Girls had a lower risk of developing anxiety symptoms than boys for the three location groups. Among them, girls in cities were 4.3% less likely to suffer from anxiety symptoms (OR 0.957, 95%CI 0.932–0.983). Elementary school students with good knowledge of COVID-19 clearly had a lower risk of suffering from anxiety symptoms than those with poor knowledge. In county-level cities, students with good knowledge had a 2.13% lower risk of anxiety symptoms than students with poor knowledge (OR 0.787, 95%CI 0.755–0.819). Students with good knowledge of COVID-19 in rural areas and cities were 2.8% (OR 0.759, 95% CI 0.740–0.778) and 4.5% (OR 0.742, 95% CI 0.722–0.763) less likely to be anxious, respectively, than students in county-level areas. Prevention and control behaviors had a different influence on anxiety symptoms during the epidemic than knowledge. Compared to students with unhealthy practices, an increased risk of anxiety symptoms was found for students who took COVID-19 health precautions in the rural (OR 1.023, 95%CI 0.999–1.047), county-level (OR 1.039, 95%CI 0.998–1.081) and city (OR 1.043, 95%CI 1.015–1.071) groups.

3.4. Proportion of participants at each level of knowledge or practices in different locations

Table 3 is a comparison of two groups of good and poor knowledge and practices, showing that the proportion of respondents with good knowledge of COVID-19 was highest in cities (47.5%) and lowest in rural areas (36.3%). County-level cities had the largest number of elementary school students (52.6%) with good practices for COVID-19, and there was little difference between rural and urban areas for students with good practices for COVID-19.

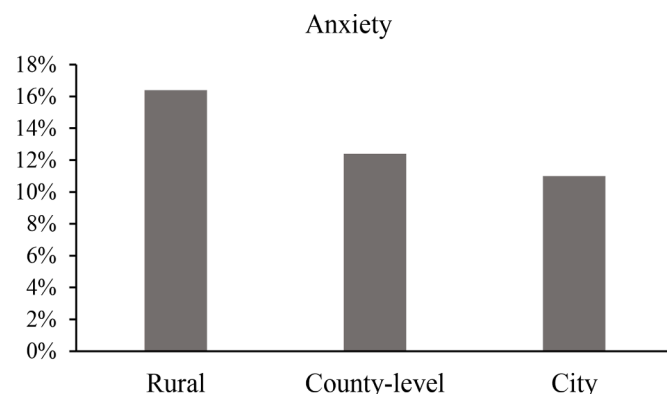


Fig. 2. Prevalence of anxiety symptoms in participants by different locations.

Table 2
Independent association of characteristics of study participants and anxiety during the COVID-19 epidemic in China.

		Rural	County-level city	City
Gender	Boys	Reference	Reference	Reference
	Girls	0.989(0.966, 1.013)	0.967(0.929, 1.006)	0.957(0.932, 0.983)
Knowledge	Poor	Reference	Reference	Reference
	Good	0.759(0.740, 0.778)	0.787(0.755, 0.819)	0.742(0.722, 0.763)
Practices	Poor	Reference	Reference	Reference
	Good	1.023(0.999, 1.047)	1.039(0.998, 1.081)	1.043(1.015, 1.071)

Adjusted for age, gender, knowledge, practices, worried level, fear level, way of completion.

Statistical significance is indicated in bold.

Table 3
Proportion of participants at each level of knowledge or practices in different locations.

Location	Knowledge		Practices	
	Good (%)	Poor (%)	Good (%)	Poor (%)
Rural	36.3	63.7	50.5	49.5
County-level city	44.2	55.8	52.6	47.4
City	47.5	52.5	50.8	49.2

3.5. Prevalence of anxiety among participants by location and knowledge or practices

Fig. 3 shows the prevalence of anxiety among the three location groups. The prevalence of anxiety was lowest among students with good knowledge of COVID-19 (13.5% in rural areas; 10.4% in county-level cities; and 9.0% in city areas). However, there was a very small difference in the prevalence of anxiety among students at different levels of epidemic prevention practice for the different locations.

4. Discussion

We conducted a study to assess the prevalence of anxiety symptoms among elementary school students under the ongoing nationwide quarantine during the COVID-19 outbreak. A meta-analysis of 41 studies conducted in 27 countries between 1985 and 2012 showed that anxiety

disorders in children and adolescents are the most common mental disorder, with a worldwide prevalence of 6.5% (95% CI 4.7–9.1) (Polanczyk et al., 2015). Similarly, an analysis of data from the 2016 National Child Health Survey (NSCH) showed a 6.6% prevalence of anxiety among U.S. children aged 6 to 11 (Ghandour et al., 2019). Data from a Brazilian survey on children aged 6–12 years showed that 19.4–21% suffered from anxiety (Garcia de Avila et al., 2020). In the present study, we found that the overall prevalence of anxiety in primary school students reached 13.4% during the COVID-19 epidemic (approximately 2.06 times higher than normal). This result indicated that primary school students might suffer considerable psychological impact from the epidemic (Duan et al., 2020; Zhao et al., 2012). The increased anxiety symptom prevalence could result in excessive consumption of medical resources during the COVID-19 epidemic (Asmundson and Taylor, 2020) and affect lifelong physical mental health later in life (Bellis et al., 2015).

To identify factors associated with anxiety in children during the COVID-19 outbreak, demographic variables related to the psychological status of elementary school students in China were explored in this study. Consistent with several previous studies, our results suggested that gender, worry and fear levels, the way of completion and location contributed to the prevalence of anxiety (Li et al., 2020). Among these factors, location performance had the most noticeable effect. The detection rate of anxiety was higher among residents in rural areas than those in cities (16.4% vs. 11.0%). There have been similar reports of a higher incidence of anxiety in rural areas than in the general population (Zhang et al., 2020). During the epidemic situation, more than 220 million children and adolescents were confined to their homes and informed to postpone the start of the spring semester until further notice in order to effectively cooperate with the government’s prevention and control efforts (Wang et al., 2019). As families with higher income likely have more savings and resources to cope with the increasing stress brought about by changes in life and work (Brooks et al., 2020), rural parents’ negative emotions caused by large-scale shutdown or unmarketable agricultural products may be transferred to the children also stay at home. Moreover, many online mental health services can’t provide help for primary students with imperfect coverage of network in rural areas. These above factors all may contribute to a higher prevalence of anxiety symptoms. Thus, the government should provide more economic and medical support to remove this barrier. This support would also help address inequalities in regard to mental health educational support for low-income families.

In addition, clear differences were found in the status of psychological distress between students with poor and good knowledge by location. Students with good knowledge of COVID-19 clearly had a

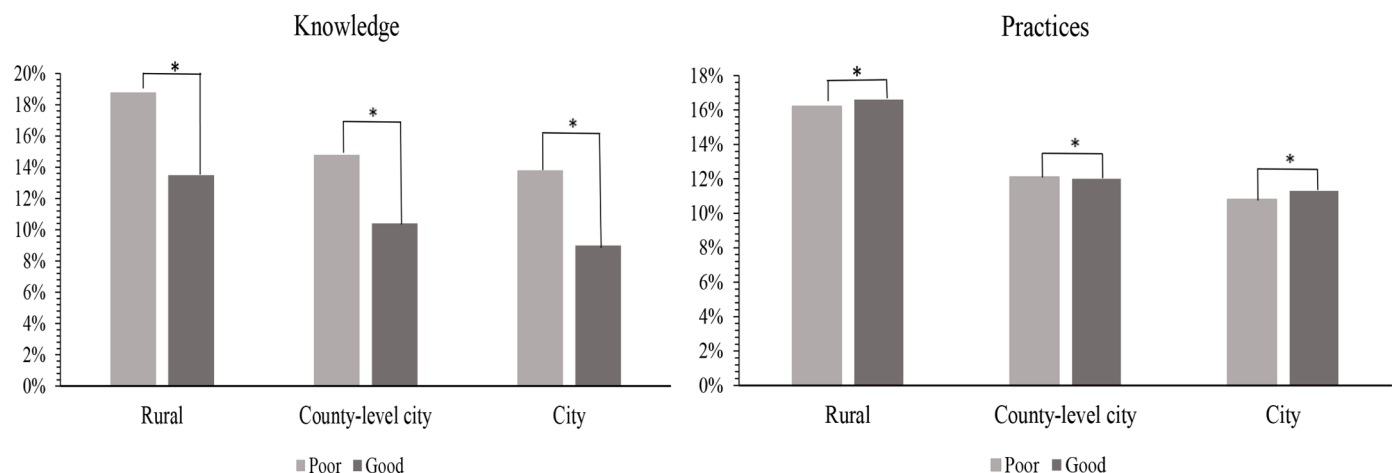


Fig. 3. Prevalence of anxiety symptoms in participants by location and knowledge or practices. Good group compared with poor group, * $P < 0.05$.

lower prevalence of anxiety in all regions ($P < 0.001$). Students with limited understanding of the outbreak and access to coping strategies may not be able to process the information they have access to and communicate their feelings properly (Imran et al., 2020). During the home isolation period, parents are the people children have the most contact with. Effective parent-child communication can provide children with more knowledge of COVID-19 to reduce anxiety symptoms (Tang et al., 2021). We unexpectedly found a statistically significant, but very small, effect for preventive behavior. That is, engaging in effective preventive behavior produced almost no increase in the anxiety level. Therefore, to bring an early end to the epidemic, effective preventive behaviors, such as frequent hand washing, few or no visits to crowded places, and wearing masks in public places should be encouraged (Wang et al., 2020). Furthermore, we found that city students made up the largest proportion of groups with good knowledge. Generally, compared with students in rural areas, students in cities have access to a wealth of educational resources and parents with a higher education level and can therefore generally obtain more and accurate epidemic information more easily (Caleo et al., 2018; Ghosh et al., 2020). As good knowledge is associated with a lower prevalence of anxiety (Chang et al., 2020), it is understandable that urban children were found to have lower levels of anxiety symptoms than rural children in this study. Thus, we recognize the influence of rural factors on anxiety. It is therefore suggested that health-service decision-makers give more attention to the anxiety burden of rural individuals, especially during disease outbreaks.

A strength of this study is the large sample size used to investigate the prevalence of anxiety in primary school students. We excluded participants who did not meet the requirements of this study to obtain more realistic results. Our results suggest that primary school students are most likely to need psychosocial support and provide a basis for policy implementation. However, this study also has several limitations. First, data was collected by sending questionnaires to children online. Our results and the conclusions drawn from the survey might be influenced by the level of understanding and cooperation of the respondents, especially younger children who needed the help of guardians. Second, our study was designed as a cross-sectional survey, which did not establish a causal relationship. Third, the presence of anxiety symptoms was determined by the

GAD-7, a highly effective self-assessment tool for anxiety symptoms. However, the screening tool did not fully guarantee the reliability and validity of the study due to the relatively young age of the research subjects. Fourth, as the large-scale network-based cross-sectional survey was conducted in a relatively short period of time, the characteristics of those who did not submit the questionnaire and the response rate of each cluster were not accurately determined, and there could be some degree of self-selection biases. In addition, as the research subjects of this study were only from three areas, generalization of the research results is limited. However, Henan Province had the largest school population in China adjacent to the most severely affected areas at the beginning of the COVID-19 outbreak. Thus, this survey had practical significance. Finally, surgical diseases and other psychiatric problems were not ruled out, which may affect the validity of the study.

The COVID-19 epidemic has had an enormous impact on people's lives and psychology. The prevalence of anxiety symptoms among primary school students in China was high during the outbreak. This phenomenon was specific to the population for a specific time, and more attention from health care providers to this problem is needed. Risks and positive factors for mental health were also identified in this study that may help improve the mental health of students during the pandemic. However, due to the limitations of this research study, more studies need to be performed to address this problem in detail.

Supplementary materials

Supplementary materials A Questionnaire for this study.

Supplementary materials B Supplementary Table 1 Frequency

distribution of the responses to questions of knowledge and practices of novel coronavirus. **Supplementary Table 2** The Cramer 'V' of the variables.

CRediT authorship contribution statement

Juan Wang: Visualization, Formal analysis, Writing – original draft, Writing – review & editing. **Zhenxing Mao:** Visualization, Writing – original draft, Writing – review & editing. **Dandan Wei:** Data curation, Writing – review & editing. **Pengling Liu:** Writing – original draft, Writing – review & editing. **Keliang Fan:** Writing – original draft, Writing – review & editing. **Qingqing Xu:** Data curation, Writing – review & editing. **Lulu Wang:** Writing – original draft, Writing – review & editing. **Xian Wang:** Data curation, Writing – review & editing. **Xiaomin Lou:** Data curation, Writing – review & editing. **Hualiang Lin:** Data curation, Writing – review & editing. **Chunyang Sun:** Data curation, Writing – review & editing. **Chongjian Wang:** Data curation, Writing – review & editing. **Cuiping Wu:** Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

Acknowledgments

Juan Wang and Zhenxing Mao designed research; Hualiang Lin, Chunyang Sun, Xian Wang, Xiaomin Lou, Chongjian Wang, Dandan Wei and Qingqing Xu collected the data; Juan Wang analyzed the data and drafted the manuscript; Zhenxing Mao, Cuiping Wu, Pengling Liu, Keliang Fan and Lulu Wang revised the manuscript. Cuiping Wu had primary responsibility for final content. All authors read and approved the final manuscript.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2021.114251.

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