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Changing trends of mental and behavioral responses and associations during the COVID-19 epidemic in China: a panel study

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Abstract

This prospective observational study examined changing trends in mental and behavioral responses, and their association with perceived risk, severity, self-efficacy and isolation status during the Chinese COVID-19 epidemic. There were five waves of interviews. Descriptive statistics and non-parametric test methods were used for data analysis. Participants numbered 150 for the linkable baseline survey and 102 completed all 5 survey waves and were included in the analysis. Mental stress, emotional status and lifestyle manifested a statistically significant downwards trend across the total period of this panel study. The number of reported new confirmed patients perceived high risk and perceived severity were positively associated with mental stress, emotional status and lifestyle. Self-efficacy was negatively associated with each type of mental and behavioral response. The more time people were confined to their home, the more serious the emotional and lifestyle problems. Dose-response relationships were noted between the number of reported new confirmed patients and mental stress, emotional status and lifestyle during the five observation points. This study yielded new information about mental and behavioral responses among Chinese people during the COVID-19 epidemic. Policy changes and health education are essential for minimizing the adverse health effects of these responses.

Introduction

The COVID-19 pandemic represents a massive global health crisis [1]. The crisis has required large-scale mental and behavioral responses that may lead to significant mental disorders and other health problems. Given the salience of human mental and behavioral factors to disease prevention, it is crucial to evaluate their role in preventing health problems [2, 3]. According to the Stimulus, Cognition and Response (SCR) model, various stimuli (S) affect the internal states of people through cognition (C), which in turn elicits mental and behavioral responses (R) [4, 5]. COVID-19 is a strong stimulus that plausibly induces people to perceive high risk of infection with potentially severe health consequences. Studies have reported on mental and behavioral responses during an outbreak of an acute respiratory infection [6–8]. COVID-19 is a new disease, and the 2019 outbreak in Wuhan and elsewhere in China may have caused high levels of stress. An epidemic of a highly lethal disease can overwhelm people emotionally and physically, and induce strong mental and behavioral responses in

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both adults and children [9, 10]. A recent study revealed that individuals' perceived severity of the COVID-19 epidemic was related to undesirable emotional and behavioral outcomes among the Chinese public [6]. However, the above studies were all cross-sectional. Unlike cross-sectional studies, longitudinal observation studies can examine temporal trends in mental and behavioral responses as the epidemic progresses. This is of special significance to understand the impact of time and may assist in identifying behavioral measures to mitigate stress associated with the epidemic. Few previous empirical public health studies implemented longitudinal observation during an epidemic [11]. The main purpose of this research is to evaluate changing trends in mental and behavioral responses during the COVID-19 epidemic in China.

According to SCR theory, COVID-19 is a direct stimulus, which in turn may increase perceived risk and perceived severity of COVID-19 and ultimately impact people's mental and behavioral responses to the disease. Some studies have found an association between strong risk and threat perceptions and mental and behavioral responses during outbreaks of severe acute respiratory syndrome and Ebola [12–14]. A recent study revealed that individuals' perceived severity of the COVID-19 epidemic was related to undesirable emotional and behavioral outcomes among the Chinese public [6]. In this study, we will examine perceived risk and threat's influence on mental stress, emotional status and lifestyle. The Theory of Planed Behavior holds that self-efficacy is a key element in behavioral adaptation [5]. Thus, self-efficacy for preventing COVID-19 may have an important influence on mental and behavioral response during the epidemic. Studies have found that self-efficacy contributes to many health-related behaviors [15–17], but no empirical studies examined self-efficacy in relation to COVID-19 related behaviors. People quarantined at home or at another location may have experienced boredom, anger, fear and loneliness, which in turn can elicit a personal behavioral response [5, 18]. Some studies have examined isolation status and its role influencing infectious disease [19, 20]. Few empirical studies were conducted to examine mental and behavioral problems associated with isolation status [18]. This study will examine isolation status's influence on mental and behavioral responses.

This study may yield information important in formulating public health policy and health education initiatives aimed at mental and behavioral problems, with the goal of improving behavioral interventions for preventing and mitigating COVID-19.

Materials and methods

Study design

A prospective longitudinal observation study was designed to examine temporal trends and changes in mental and behavioral responses over a 5-week period of time, and their associations with selected stimulus and support variables during the COVID-19 epidemic in China.

Participants

Participants were recruited via a survey advertisement in the social media groups WeChat and Douban, two of the most popular social media platforms in China. Inclusion criteria were membership in a common community; being between 20 and 60 years of age; having access to a Smartphone; knowing the Chinese language; and willing to participate in the panel study and provide follow-up information at five scheduled observation points. Participants were excluded if they refused to provide this information or had a medical condition that could limit or preclude their participation. Within the registration system, potential participants were screened to ascertain eligibility. Upon consent, participants received an electronic questionnaire and instructions on how to proceed. After reading the instructions, they were asked to provide an e-consent by tapping the 'Confirmation and Authorization' button and then directed to the questionnaire. A special administrative WeChat group was established to manage the follow-up data collection, using a unique QR code for each respondent. The QR code was the vehicle, not only for identifying unique participants, but prohibiting

non-participants from taking the survey. After scanning the QR code, survey participants could enter the investigation group without further preconditions.

This panel study analyzed five waves of data collected over a 5-week period of time: Wave 1 (5 February 2020), Wave 2 (12 February 2020), Wave 3 (19 February 2020), Wave 4 (26 February 2020) and Wave 5 (4 March 2020). The entire observation period covered the peak and trough of the COVID-19 epidemic in China. The number of reported new confirmed patients in China, respectively, numbered 3887, 2015, 394, 433 and 133 at the time each wave was administered [21].

Data collection

Data were obtained by an online survey to ascertain mental and behavioral responses to COVID at that time. The online survey was implemented on *Wenjuanxing* (www.wjx.cn), a survey service website similar to Qualtrics or Surveymonkey, but tailored to Chinese users. Each wave of the survey had a dedicated electronic questionnaire access link. The online questionnaire link was posted to the respondent group, centrally managed in a WeChat group, and accessible every Wednesday from 10:30 a.m. to 4:30 p.m. Data were collected from 9.00 to 11.00 a.m. every Monday. Data collectors and facilitators were third-year doctoral students enrolled in a university public health program. All responses were anonymous. The questionnaire took ∼10 min to complete, and the same survey protocol was used for each wave of the survey to assure homogeneity of data administration and collection. As appropriate, a token of appreciation, 30 RMB (∼$5.00) was given to those participants who completed all 5 questionnaires.

Measurement

In this study, mental responses were measured via two variables. The first variable was mental stress. It was measured by the Perceived Stress Scale, Chinese version (CPSS). This scale comprises 14 items for assessing perceptions of stress during the previous month. Items are rated on a 5-point Likert-type scale, and range from 0 (never) to 4 (very often) [22]. This scale has proven to be valid and reliable [22] and has been widely used in Chinese field research [23–25]. Several studies have administered the CPSS online, especially during the COVID-19 epidemic. Using this scale, it was found that perceived stress can predict some mental and psychiatric problems [26–28], which supports the scale's validity. These studies, however, did not directivity report the validity and reliability coefficients. The internal reliability of the CPSS in this sample, measured by Cronbach's Alpha, ranged from 0.7216 to 0.7534 over the five time points. Factor analysis revealed two factor structures, perceived stress and out of control stress, which is consistent with that of on-site interviews [22]. This study found a statistically significant association between the number of reported new confirmed patients and mental stress. Overall, online administration of the CPSS has demonstrated acceptable levels of validity and reliability.

The second variable was emotional status, which was measured by a question, 'how is your current emotional status as compared to before COVID-19 epidemic?' Respondents were to select one of three options: 'same as before', 'less stable than before' or 'much less stable than before'. Behavioral response was measured by a question, 'how would you describe your regularity of lifestyle behaviors as compared to before COVID-19 epidemic?' Respondents again selected one of three options: 'same as before', 'less regular than before' and 'much less regular than before'.

Several independent variables were measured as part of this study. Perceived risk was measured by a question 'Do you always feel that you may be infected?' Responses were on a 5-point Likert-type from 'strongly disagree' to 'strongly agree'. Perceived severity was measured by the question 'If you were infected with COVID-19 it would be a serious misfortune'. Responses were again on a 5-point Likert-type scale ranging from 'strongly disagree' to 'strongly agree'. Isolation status was measured by asking 'How much time did you spend away from home each day in the past week?' Responses included 'completely kept in house', 'less 0.5 hour outside house', 'from 0.5 hour to less than 1 hour outside house', 'from

1 hour to less than 2 hours outside house', 'from 2 hour to less 4 hours outside house' and '4 hour or more outside house'. The options were coded from small to large according to the length of stay at home each day. Self-efficacy for preventing COVID-19 infection was measured by asking, 'Do you think that you can avoid the disease through your current prevention behaviors?' Responses were provided on a 5-point Likert-type scale ranging from 'no confidence I can avoid the disease' to 'much confidence I can avoid the disease'. Demographic information requested from participants in this study included age, gender, ethnicity, education level, marital status and occupation.

Data analysis

All data were entered into a database using Microsoft Excel. They were then imported into SAS (9.3version) for the statistical analysis. Across survey waves mean scores were calculated for mental stress, emotional status and lifestyle at different observation points. As most of the variables included in this study were not normally distributed, we used non-parametric testing methods to examine changing trends in mental and behavioral responses, and their associations. The Mann–Kendall test was used to assess changing trends across the five observation points [29]. The non-parametric linear mixed-effects model was used to examine the association between confirmed new patients, perceived disease risk and severity, self-efficacy and isolation status, with mental stress, emotion and lifestyle status [30]. Regression parameters in fixed effects were estimated using the Theil–Sen test [31, 32].

Results

A total of 150 participants were recruited at baseline. The baseline was linkable to 3 intermediate and a final observation point, with 102 participants completing all 5 waves of the survey and being included in the final analysis. Differentiated by region, 99 came from 24 provinces located across China. The remaining three were international students who were living in China. Of the study sample, 61.8% were female and 93.1% were Han Chinese. The average age of participants was 39.1 years (SD: 12.5), 43.1% were never married and 50.0% were married (Table I).

Table I. *Characteristics of sample (102)*

Group	*N*	%
Sex		
Male	39	38.2
Female	63	61.8
Age (years)		
<30	37	36.1
40–49	28	27.5
50+	37	36.9
Education		
High school or junior college	50	49.0
College and more	52	51.0
Ethnicity		
Han	95	93.1
Minority	7	6.9
Marital status		
Never married	44	43.1
Married	51	50.0
Divorce or widowed	7	6.9
Occupation		
Manager	34	33.3
Professional	40	39.2
Others	28	27.5

Table II. *Means and their change trend across time in mental stress, emotion and lifestyle*

Group	Mental stress	Emotion	Lifestyle
Time 1	27.60 (8.25)	1.48 (0.64)	1.45 (0.68)
Time 2	26.03 (8.63)	1.37 (0.61)	1.45 (0.65)
Time 3	24.92 (8.19	1.20 (0.51)	1.39 (0.650
Time 4	25.17 (7.91)	1.22 (0.46)	1.28 (0.51)
Time 5	24.57 (8.43)	1.16 (0.40)	1.25 (0.49)
Mann–Kendall test (*Z*)	-3.49^{**}	-4.02^{**}	-2.15^{*}

$^{*}p<0.05$; $^{**}p<0.01$.

The mean mental stress score at baseline was 27.60 and it declined to 24.57 at the end of the study. Emotional status had a baseline score of 1.48 and it dropped to 1.16 by study completion. Lifestyle had a mean score of 1.45 when the study was initiated and it was reduced to 1.25 by study completion. All of the reported changes for these variables were statistically significant (Table II). The mean of perceived risk and perceived severity showed a

Table III. *Means and their change trend across time of dependence variables*

Group	Confirmed new patients (number)	Perceived risk (SD)	Perceived severity (SD)	Self-efficacy (SD)	Isolation status (SD)
Time 1	3887	3.36 (1.68)	3.52 (1.24)	4.01 (0.97)	3.98 (2.52)
Time 2	2015	2.27 (1.05)	3.27 (1.25)	4.01 (0.82)	3.46 (2.47)
Time 3	394	2.18 (0.95)	3.31 (1.25)	3.99 (0.84)	3.09 (2.33)
Time 4	433	2.16 (0.93)	3.28 (1.18)	4.07 (0.76)	2.48 (2.06)
Time 5	139	2.11 (0.82)	3.22 (1.27)	4.05 (0.81)	1.98 (1.61)
Trend test (Z, P)	−908.800 (19.115)[a,**]	−6.23[**]	−1.73[*]	0.37	4.68[**]

[a]Trend test using repeated measures analysis of variance by GIM program (β, P).
*$p<0.05$; **$p<0.01$.

Table IV. *Factors associated with for mental stress, emotion status and lifestyle*

Group	Mental stress (β, SE)	Emotion (β, SE) (q16emotion)	Lifestyle (β, SE) (q17life)
Confirmed new patients	0.0076 (0.0024)[**]	0.0093 (0.003)[**]	0.0062 (0.002)[*]
Perceived risk	2.3409 (0.0018)[**]	0.15332 (0.02332)[**]	0.04330 (0.02018)[*]
Perceived severity	0.9724 (0.2513)[**]	0.8199 (0.2513)[**]	1.9026 (0.3198)[**]
Self-efficacy	−2.1833 (0.3080)[**]	−0.1909 (0.02826)[**]	−0.1100 (0.03235)[**]
Isolation status	0.07131 (0.14304)	0.02651 (0.01021)[*]	0.02428 (0.01134)[*]

*$p<0.05$; **$p<0.01$.

statistically significant downwards trend across the total observation period with a Z value in the former of −6.23 and −1.73 in the latter (statistically significant at 0.01 and 0.05 level). Simultaneously, there was a statistically significant downwards trend in isolation status [Z value 4.68, statistically significant at 0.01 level (Table III)].

Table IV indicates that the number of reported new confirmed patients in China, perceived high risk and perceived severity for contracting COVID-19 were positively associated with mental stress, emotion status and lifestyle during COVID-19 epidemic, with a β of 0.008 ($P<0.01$), 0.009 ($P<0.01$) and 0.006 ($P<0.05$), respectively. Perceived high risk was associated with mental stress, emotion status and lifestyle [β=2.341 ($P<0.01$), 0.153 ($P<0.01$) and 0.043 ($P<0.05$), respectively]. The β was 0.972 ($P<0.01$), 0.820 ($P<0.01$) and 1.903 ($P<0.01$) for perceived severity. Self-efficacy was negatively associated with mental and behavioral responses [β=−2.183 ($P<0.01$), −0.191 ($P<0.01$) and −0.110 ($P<0.01$)]. The more time people were confined to their homes, the worse was their emotional and lifestyle status [β=0.027 ($P<0.05$) and 0.024 ($P<0.05$)].

Significant positive correlations were found between the number of reported new confirmed patients in China and mental stress, emotion status and lifestyle level over five observation points. Pearson correlation coefficients (r) were 0.99 ($P<0.0001$), 0.99 ($P<0.0001$) and 0.78 ($P<0.0001$), respectively. Fig. 1 shows that mental stress, emotional status and lifestyle level changed with the number of reported new confirmed patients in China over the five observation points.

Discussion

Addressing a gap in the literature, this Chinese study found temporal trends in mental and behavioral responses during the COVID-19 epidemic. Mental stress declined over the observation period, a trend consistent with the decline in the actual risk of infection. New confirmed patients with COVID-19 in China across the 5 observation points were 3887,

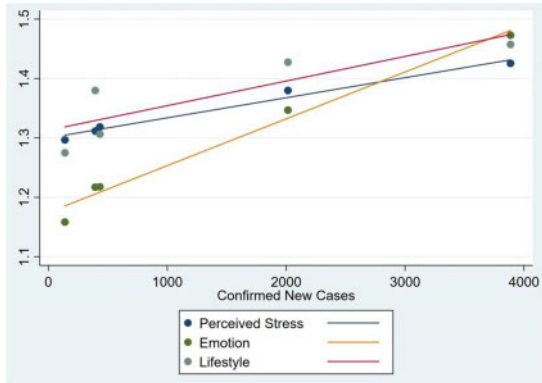

Fig. 1. Relevant scatter plot between the number of reported new confirmed patients in China and perceived stress, emotion and lifestyle.

2015, 394, 433 and 139, respectively [21]. The baseline observed in this study is the peak of the disease epidemic, and 72.5% of the respondents reported high levels of stress. This indicates that COVID-19 produced a great psychological challenge to people's mental health. Even at the last point of observation, when the outbreak numbers had dropped to a low point, 58.8% of respondents still were reporting high levels of stress. This percentage is higher than that reported prior to COVID-19 (44.5%, 95% CI: 46.1%, 42.9%) [22]. Emotional status and lifestyle problems also demonstrated similar declining trends with mental stress over the observation period. Moreover, there are dose–response relationships between the number of reported new confirmed patients in China and mental stress, emotion and lifestyle. Viewed as a stimulus, this disease overwhelms people and elicits strong mental and behavioral responses. COVID-19, as a global pandemic, presents a great threat to people's normal life and health. It generates negative mental and behavioral outcomes [9, 10, 32].

The risk of disease and the severity of outcomes are crucial predictors of individual behaviors. This study adds new evidence that perceived risk of contracting COVID-19 and perception of the severity of its consequences are associated with mental stress, poor emotional status and poor lifestyle. These findings are generally compatible with those from some other studies [3, 6, 12]. This phenomenon may be explained by SCR theory. COVID-19 infection is a strong stress stimuli, which induces high levels of perceived risk and perceived severity, which in turn elicits negative mental and behavioral responses in people. Excessive strong mental and behavioral responses are harmful to health and well-being.

This study found perceived self-efficacy was positively associated with each of the measured mental and behavioral responses. This finding is consistent with results from previous studies [15–17]. This phenomenon can also be explained by the Theory of Planned Behavior. It can be seen that self-efficacy mobilizes people's inner power, and is responsible for preventing the mental and behavioral damage caused by fears of COVID-19. This study found that the more time people remained at home, the more intense the resulting mental, emotional and lifestyle problems. This is probably because people quarantined at home or at another location may have experienced boredom, fear, anger and loneliness, which in turn elicited negative mental and behavioral responses [5, 18]. This indicates that appropriate isolation measures should only be employed for COVID-19 and any future epidemics when absolutely necessary.

There are limitations to this study. First, sample size was small. Nevertheless, the sample was comprised of individuals from 24 provinces covering diverse regions of China and a wide array of demographic characteristics. Second, sample

attrition may introduce a 'cluster' bias since many longitudinal studies over-represent some characteristics, such as high educational attainment. A more sophisticated design and representative sample would be necessary to resolve this problem. Third, we measured the total level of 'emotional status' and 'lifestyle' change before and after the COVID-19 epidemic. It should be noted that emotional status and lifestyle could actually improve during the COVID-19 epidemic. COVID restrictions could potentially improve family relationships and stabilize a chaotic lifestyle. Time spent at home might be more restful and peaceful than one's regular work schedule. The measures used for emotional status and lifestyle change in this article only allowed participants to respond that these factors were the same as before COVID or were worse since COVID. There was no opportunity for respondents to indicate that their emotional status or lifestyle behaviors had actually improved. Therefore, the ratings for these questions have the potential to produce biased responses as they are one sided (i.e. only allowing people to report feeling the same or worse).

This study provides new information on temporal trends of mental and behavioral responses and other related factors during the epidemic. As the pandemic continues with predictions of potential spikes and second waves around the globe, it is likely that more restrictive measures as those implemented during the first spike will be again needed. Findings from this study could guide future COVID responses in both less and more developed countries. The findings highlight implications for understanding change and trends in mental and behavioral responses during the COVID-19 global pandemic.

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Conflict of interest statement

None declared.

References

1. World Health Organization. Mental Health and Psychosocial Considerations during the COVID-19 Outbreak. 2020. Available at: https://www.who.int/publications-detail/mental-health-and-psychosocial-considerations-during-the-covid-19-outbreak. Accessed: 10 May 2020.
2. Bish A, Michie S. Demographic and attitudinal determinants of protective behaviours during a pandemic: a review. *Br J Health Psychol* 2010; **15**: 797–824.
3. Wise T, Zbozinek TD, Michelini G *et al. Changes in Risk Perception and Protective Behavior during the First Week of the COVID-19 Pandemic in the United States*. 2020. Available at: https://psyarxiv.com/dz428. Accessed: 15 May 2020.
4. Mehrabian & Russell. *An Approach to Environmental Psychology*. Cambridge, MA: MIT Press, 1974.
5. Yang T. *Health Research: Social and Behavioral Theory and Methods*. Beijing: People's Medical Publishing House, 2018.
6. Li JB, Yang A, Dou K *et al. Chinese Public's Knowledge, Perceived Severity, and Perceived Controllability of the COVID-19 and Their Associations with Emotional and Behavioural Reactions, Social Participation, and Precautionary Behaviour: A National Survey*. 2020. Available at: https://psyarxiv.com/5tmsh/. Accessed: 15 May 2020.
7. Sørensen MD, Sørensen B, Gonzalez-Dosal R *et al*. Severe acute respiratory syndrome (SARS): a year in review. *Ann N Y Acad Sci* 2010; **1067**: 500–5.
8. LV S, Tian B, Yang T. Study on health-related behavior during and after the Sars epidemic. *Chin J Public Health* 2008; **24**: 960–1.
9. Greenberg N, Docherty M, Gnanapragasam S *et al*. Managing mental health challenges faced by healthcare workers during covid-19 pandemic. *BMJ* 2020; **368**: m1211.
10. Cullen W, Gulati G, Kelly BD. Mental health in the Covid-19 pandemic. *QJM* 2020; **113**: 311–2.
11. Fridman A, Gershon R, Gneezy A. *A COVID-19 and Vaccine Hesitancy: A Longitudinal Study*. Social Science Electronic Publishing. 2020.Available at: https://ssrn.com/abstract=3644775. Accessed: 30 October 2020.
12. Dorfan NM, Woody SR. Danger appraisals as prospective predictors of disgust and avoidance of contaminants. *J Soc Clin Psychol* 2011; **30**: 105–32.
13. Vartti AM, Oenema A, Schreck M *et al*. SARS knowledge, perceptions, and behaviors: a comparison between Finns and the Dutch during the SARS Outbreak in 2003. *Int J Behav Med* 2009; **16**: 41–8.
14. Yang JZ, Chu HR. Who is afraid of the Ebola outbreak? The influence of discrete emotions on risk perception. *J Risk Res* 2018; **21**: 834–53.
15. Taylor KM, Betz NE. Applications of self-efficacy theory to the understanding and treatment of career indecision. *J Vocat Behav* 1983; **22**: 63–81.
16. Kim Y, Chung S, So J. Success expectancy: a mediator of the effects of source similarity and self-efficacy on health behavior intention. *Health Commun* 2020; **35**: 1063–7.
17. Kawamura A, Inagaki J, Umemoto S *et al*. Dietary adherence, self-efficacy, and health behavior change of WASHOKU-modified DASH diet: a sub-analysis of the DASH-JUMP study. *Curr Hypertens Rev* 2020; **16**: 128–37.

18. Severance EG, Dickerson FB, Viscidi RP *et al*. Coronavirus immunoreactivity in individuals with a recent onset of psychotic symptoms. *Schizophr Bull* 2011; **37**: 101–7.
19. Audet CM, McGowan CC, Wallston KA *et al*. Relationship between HIV stigma and self-isolation among people living with HIV in Tennessee. *PLoS One* 2013; **8**: e69564.
20. Zhang Q, Wang D. Assessing the role of voluntary self-isolation in the control of pandemic influenza using a household epidemic model. *Int J Environ Res Public Health* 2015; **12**: 9750–67.
21. National Health Commission of People's Republic of China. Epidemic Situation. Available at: http://www.nhc.gov.cn/xcs/yqfkdt/gzbd_index.shtml. Accessed: 18 May 2020.
22. Yang T, Huang H. An epidemiological study on stress among urban residents in social transition period. *Chin J Epidemiol* 2003; **9**: 11–5.
23. Jiang H, Jin L, Qian X. *Evidence of Accessing Antenatal Care Information via Social Media Platforms Supports Mental Wellbeing in COVID-19 Epidemic*. Bull World Health Organ. 2020.Available at: http://doi.org/10.2471/BLT.20.255489. Accessed: 10 May 2020.
24. Li J, Rose N. Urban social exclusion and mental health of China's rural-urban migrants: a review and call for research. *Health Place* 2017; **48**: 20–30.
25. Yang T, Rockett IR, Yang X *et al*. Patterns and correlates of stress among rural Chinese males: a four region study. *Public Health* 2009; **123**: 694–8.
26. Zhan Y, Liu Y, Liu H *et al*. Factors associated with insomnia among Chinese front-line nurses fighting against COVID-19 in Wuhan: a cross-sectional survey. *J Nurs Manag* 2020; **28**: 1525–1535.
27. Zhang Y, Gao Y, Tang Y *et al*. The role of workplace social capital on the relationship between perceived stress and professional identity among clinical nurses during the COVID-19 outbreak. *Jpn J Nurs Sci* 2021; **18**: e12376.
28. Xu C, Xu Y, Xu S *et al*. Cognitive reappraisal and the association between perceived stress and anxiety symptoms in COVID-19 isolated people. *Front Psychiatry* 2020; **11**: 858.
29. Kendall MG. *Rank Correlation Methods*, 4th edn. London: Griffin, 1975.
30. Trong DD, Phuong CX, Viet TQ. Nonparametric estimation of random effects densities in a linear mixed-effects model with Fourier-oscillating noise density. *Commun Stat Theory Methods* 2019; **1**: 28.
31. Fernandes R, Leblanc SG. Parametric (modified least squares) and non-parametric (Theil–Sen) linear regressions for predicting biophysical parameters in the presence of measurement errors. *Remote Sens Environ* 2005; **95**: 303–16.
32. Yang Q. *Nonparamethric Theil-Sen Method for Linear Mixed Model*. Xiamen: Xiamen University, 2008.