



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Factors related to perceived stress during the COVID-19 epidemic context among the general population in China: A cross-sectional nationwide study

Jiayao Xu^a, Xiaomin Wang^a, Ziming Xuan^b, Leesa Lin^{c,d}, Kai Sing Sun^e, Yiyi Zhou^f, Fangyuan Jiang^f, Weiqi Han^g, Xudong Zhou^{a,*}

^a Institute of Social Medicine, School of Medicine, Zhejiang University, Hangzhou, China

^b Department of Community Health Sciences, Boston University School of Public Health, Boston, United States

^c Department of Infectious Disease Epidemiology, London School of Hygiene and Tropical Medicine, London, United Kingdom

^d Laboratory of Data Discovery for Health (D24H), Hong Kong Science Park, Hong Kong, SAR, China

^e JC School of Public Health and Primary Care, The Chinese University of Hong Kong, Hong Kong, China

^f School of Medicine, Zhejiang University, Hangzhou, China

^g Faculty of Public Health and Policy, London School of Hygiene and Tropical Medicine, London, United Kingdom

ARTICLE INFO

Keywords:

COVID-19
Mental health
Stress
Risk factors
General population
China

ABSTRACT

Background: This study aimed to investigate factors related to high stress levels among the general population in China during the novel coronavirus disease (COVID-19) pandemic when its containment measures were in place and to identify the most stressed populations.

Methods: A nationwide study was conducted online among 5,039 adults in all 31 provinces in mainland China between March 1 and March 16, 2020. Bivariate analysis and multivariate logistic regressions were performed to explore the related factors of high perceived stress.

Results: Among all respondents, 36.0% reported a high level of stress. Respondents in Hubei province (the epicenter) were more likely to report high stress levels than those in low epidemic areas. Respondents who went outside every day or every other day reported greater odds of experiencing a high level of stress than those who went outside every 8–14 days. People with higher risk perceptions were more prone to report high stress levels. Respondents aged 16–35 were more likely to report high stress than respondents aged 46 or older. Lower household income and lower health literacy were related to increased odds of reporting high stress levels.

Limitations: We used a convenience sample and self-reported survey data.

Conclusions: We identified risk factors for high stress levels related to the epidemic (epidemic intensity in residential areas, risk perception, and frequency of going outside) and other vulnerabilities (younger age, low household income, low health literacy). Our findings can directly inform interventions and policies for mitigating stress among the general population for this or future epidemics.

Introduction

The novel coronavirus disease (COVID-19) was first reported in December 2019 in Wuhan, China, and subsequently spread across the country (Wang et al., 2020a). During the peak of the epidemic, the Chinese government adopted unprecedented containment measures to control COVID-19 transmission, including lockdown measures imposed in all cities in Hubei province (Tian et al., 2020), the partial suspension of public transportation, the closing of public spaces, the close management of communities, social distancing, and stay-at-home orders for the general population. These were subsequently adopted by other

worst-hit countries (CCDC, 2020; Teslya et al., 2020).

The pandemic, as well as its containment measures, brought about great challenges for the general population, which further developed into stresses (Brooks et al., 2020; Bruine de Bruin, 2020). Studies have reported a high prevalence of perceived stress (Yang et al., 2020; Yan et al., 2021) and elevated mental health problems (Li et al., 2020) among the general population in China during the epidemic. High stress can compromise the immune system, which, in turn, increases an individual's susceptibility to contracting infectious diseases (Fancourt & Steptoe, 2020; Pedersen et al., 2010), leading to mental health problems (Husky et al., 2020; Islam et al., 2020; Tang et al., 2020; Taylor et al.,

* Corresponding author.

E-mail address: zhouxudong@zju.edu.cn (X. Zhou).

<https://doi.org/10.1016/j.jad.2021.07.097>

Received 11 January 2021; Received in revised form 18 June 2021; Accepted 11 July 2021

Available online 29 July 2021

0165-0327/© 2021 Elsevier B.V. All rights reserved.

2020) and possibly even suicide (Elbogen et al., 2020). Investigating specific stressors during an infectious disease emergency can be instrumental in the success of targeted efforts aimed at providing better mental health services and the optimization of disease containment measures to mitigate mental health consequences. Several studies have investigated factors related to mental health among the general population in China and have identified a myriad of risk factors related to the epidemic itself (e.g., contact history of COVID-19, risk perception, exposure to COVID-19 at work) (Du et al., 2020; Wang et al., 2020c; Sun et al., 2021; Wang et al., 2021a) as well as psychosocial factors (e.g., resilience, coping style, social support) (Hou et al., 2021; Liu et al., 2021; Yan et al., 2021). In addition to environmental event stressors caused by the epidemic, several social event stressors were attributable to epidemic containment measures (Chu et al., 2020; Shaw, 2021; Shi et al., 2021; Wang, 2021b), such as economic challenges caused by business closures (Li et al., 2020; Zhou & Guo, 2021), interpersonal and social disturbances when practicing social distancing (Zhao et al., 2020; Zhu et al., 2021), and heightened information inequalities due to inadequate literacy (Chu et al., 2020). However, to our knowledge, few studies have systematically investigated stress-related factors resulting from social and environmental event stressors caused by the epidemic among the general population to whom mental health services are not regularly accessible during an epidemic or pandemic (COVID-19 Prevention and Control Team, 2020; Wang et al., 2020d).

The possibility of contracting COVID-19 challenged the entire general public in China during the epidemic. Living in high-risk regions (e.g., at the epicenter of the disease or in denser urban areas), a higher frequency of going outside, and a lack of protective resources (e.g., medical masks) could increase risk of exposure to COVID-19. Biologically vulnerable populations, such as older adults, also faced higher risks of contracting COVID-19 (Chen et al., 2020; WHO, 2020a). Additionally, some people (e.g., residents in epicenters, older people, those with low education levels) reported high levels of risk perception during the epidemic (Wang et al., 2020e), which may be another stress-related factor (Jia et al., 2020; C. Wang et al., 2020b; Wang et al., 2020c; Wu et al., 2009).

On the other hand, coping with the social consequences of epidemic control strategies could be challenging for certain populations. Large-scale work closures during the epidemic caused profound losses of income (Wang et al., 2020c), which further deteriorated low-income individuals' ability to pay for potential testing, COVID-19 treatment fees, or even daily expenses. A reduced frequency of going outside, either compulsorily or voluntarily (Liu et al., 2020) because of stay-at-home orders (CCDC, 2020), limited individuals' social interactions (Hawryluck et al., 2004; Vinck et al., 2019). In general, individuals with low health literacy (Sorensen et al., 2012; The Lancet, 2009) may have found it difficult to follow up with and understand epidemic information, due to encountering scientific words and information bombardment, which could exaggerate their fears and uncertainty regarding the epidemic. Thus, we were interested in studying whether such populations were more stressed during the epidemic.

In this study, we aimed to investigate potential risk factors for high stress in the COVID-19 epidemic context among the general adult population in China one month after the lockdown in Wuhan city, when the epidemic and its containment measures were in place. Evidence of risk factors from our study can help identify the most vulnerable populations under stress associated with COVID-19 and can create a greater potential to engage in better mental health assistance for these populations.

Methods

Study design and participants

National cross-sectional data was collected between March 1 and March 16, 2020, from all 31 provincial-level regions in mainland China (excluding Hong Kong, Macau, and Taiwan). The main inclusion

criterion was that participants must be community residents of Chinese nationality aged 16 years or older who could read Mandarin. The online questionnaire link was distributed, and the household member who matched the criteria and whose birth date was closest to the survey day was selected as the representative of the household. Detailed sampling size calculation, sampling strategy, and data collection were previously reported (Wang et al., 2020e). Among the 5,409 households contacted, 5,124 agreed to participate in our study (response rate 94.7%). Eighty-five questionnaires (1.7%) were excluded because of inconsistent answers to logic questions or due to respondents' being under 16 years old, resulting in 5,039 valid questionnaires in total. This sample included both Han people (non-minority) and ethnic minorities (Tibetan, Yi, Uyghur, etc.). Before their answering the questions, the questionnaire instructions informed all participants that their participation was voluntary and anonymous and that they could quit at any time. No compensation was provided. The study was reviewed and approved by the Ethics Committee of the School of Public Health at Zhejiang University (ZGL202002-3).

Measures

Perceived stress was assessed using a four-item version of the Perceived Stress Scale (PSS) (Cohen et al., 1983), rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often). The Chinese version of this scale was translated and validated by Tingzhong Yang, with Cronbach's alpha values of 0.90 (Yang & Huang, 2003). A computed score above 25 (out of a total possible range of 0 to 56) was interpreted as high perceived stress (Yang & Huang, 2003). The binary stress variable was used as the primary outcome.

Respondents were asked about their residential province and were categorized into three groups based on the cumulative number of confirmed cases reported in that province as of March 1, 2020, when the study was carried out. Hubei province, a statistical outlier (67,103 confirmed cases), was defined as the large number group. Of the 30 remaining provinces, we used a median split to define the first 15 provinces (≥ 296 confirmed cases) as the medium number group, and the last 15 provinces (≤ 252 confirmed cases) as the small number group. Respondents self-reported their residential area type with two options (1-urban area, 2-rural areas) and were grouped accordingly. Respondents' average frequency of going outside during the epidemic was also collected, and the options were coded as 1 (went outside every day or every other day), 2 (went outside every 3–7 days), 3 (went outside every 8–14 days), and 4 (went outside every 15 days or more). Among respondents who had tried to purchase masks (excluding individuals who chose "no"), individuals who chose "yes but cannot buy one" were grouped as experiencing an inadequate supply of masks, while those who responded "yes and bought successfully" were grouped as experiencing an adequate supply of masks. The respondents' ages were obtained, and they were further divided into four age groups (i.e., people aged 16–25 years, 26–35, 36–45, and ≥ 46).

Risk perception was measured by having the respondents use a 5-point Likert scale ranging from 1 (not worried at all) to 5 (very worried), to rank their perceived possibility of contracting COVID-19. Answers were then categorized as low (1–2), medium (3), and high (4–5), representing different risk perception groups.

Respondents were asked about their monthly household income, with the options of "less than ¥ 3,000," "¥ 3,000–¥ 5,000," "¥ 5,001–¥ 10,000," and "more than ¥ 10,000," and they were grouped accordingly. Health literacy was measured by two questions adapted from previous studies (Wang et al., 2018), concerning the ability to search for and understand COVID-19-related information, using a 5-point Likert scale ranging from 0 (strongly agree) to 4 (strongly disagree). Respondents were categorized into high or low health literacy groups based on the 50th percentile cutoff of health literacy scores (half of them scored higher than 4).

Respondents' ethnicity (e.g., Han, Tibetan, Yi, Uyghur, etc.) was

asked, and they were grouped into the Han (non-minority) group and the minority group. Respondents' gender (male/ female) and education level (middle school and under/ high school/ college and above) were also collected.

Statistical analyses

Descriptive analyses were conducted to describe the individual characteristics and perceived stress of respondents, and their associations were assessed using Chi-square tests, t-tests, and bivariate logistic regressions. Multivariate logistic regressions were performed to explore related factors of stress. To test whether associations were robust to the dichotomy we used, we did multiple linear regression with continuous perceived stress scores as the outcome, as a sensitivity analysis. All statistical analyses were performed using SPSS 24.0 with the statistical significance set at $p < 0.05$.

Results

Of the 5,039 respondents (Table 1), more than half were females (58.5%) aged 16–35 years (63.3%), and had a monthly income higher than ¥ 5,000 (53.7%). About half of the respondents resided in rural areas and had a college or above education level. A total of 598 (11.9%) respondents lived in Hubei province, and 805 (16.0%) were minorities. During the epidemic, 943 respondents (18.7%) never went outside, and 2,118 (42.0%) went out every eight days or more. Of the 4,921 respondents attempting to purchase masks, around one-fifth (21.7%) experienced an inadequate supply. Almost half (49.4%) of the respondents had high risk perceptions. There were 15.1% of respondents who reported it was difficult to understand COVID-19-related information, and 31.8% reported it was hard to find correct and comprehensive information.

Respondents reported an average score of 21.9 (SD = 8.3) for perceived stress, with over one-third (36.0%) experiencing a high level of stress (Table 1). The proportion of high stress was greatest among those who went out every day or every other day (38.2%), was less among those who went out every 3–7 days (35.6%), and further decreased among those who went out every 8–14 days (32.3%). However, it increased among those who only went out every 15 days or longer (36.3%) (Table 2). Further bivariate regression suggests that, when compared with those who went outside every day or every other day, respondents who went out every 8–14 days showed a lower proportion of stress ($p < 0.05$). The results also show that the proportion of respondents reporting high stress decreased with age. Those aged 16–25 years reported higher stress than those over 45 years old (38.2% vs. 31.8%, $p < 0.05$). Respondents with a higher risk perception, lower household income, and poorer health literacy also showed more stress ($p < 0.001$).

The multivariate logistic regression model (Table 3) suggests that respondents residing in Hubei province (adjusted odds ratio [aOR] = 1.30, 95%CI [1.05, 1.60]) had higher adjusted odds of reporting high perceived stress, compared with those residing in provinces with a small number of confirmed cases. Respondents with a medium level (aOR = 1.34, 95%CI [1.11, 1.61]) and a high level (aOR = 1.91, 95%CI [1.61, 2.27]) of risk perceptions were more likely to report high stress than those with a low level of risk perceptions. Respondents who went outside every 8–14 days had lower odds of reporting high stress (aOR = 0.75, 95%CI [0.60, 0.95]) than those who went outside every day or every other day. Respondents in the age group of 16–25 years old (aOR = 1.51, 95%CI [1.25, 1.83]) and those in the 26–35 age group (aOR = 1.39, 95%CI [1.15, 1.69]) were more likely to report high stress than the older respondents (≥ 46 years).

Respondents with the lowest (aOR = 1.34, 95%CI [1.09, 1.65]) and medium (aOR = 1.29, 95%CI [1.08, 1.53]) household income status had greater odds of reporting high stress than those with the highest household income status. Respondents with lower health literacy were

Table 1

Sociodemographic characteristics, perceived stress, risk perception, health literacy, frequency of going outside, and inadequate supply of masks of respondents during the COVID-19 (n=5,039).

	n (%)
Sociodemographic characteristics	
Age	
≥46	1008 (20.0)
36–45	839 (16.7)
26–35	1174 (23.3)
16–25	2018 (40.0)
Gender	
Male	2090 (41.5)
Female	2949 (58.5)
Urbanicity	
Urban	2492 (49.5)
Rural	2547 (50.5)
Ethnicity	
Han (Non-minority)	4234 (84.0)
Minority	805 (16.0)
Education level	
College and above	2534 (50.3)
High school	1837 (36.5)
Middle school and under	668 (13.3)
Monthly household income	
> ¥ 10,000 (\$1,449)	1286 (25.5)
¥ 5001–¥ 10,000 (\$725–\$1,449)	1422 (28.2)
¥ 3,000–¥ 5,000 (\$435–\$725)	1485 (29.5)
< ¥ 3,000 (\$ 435)	846 (16.8)
Perceived stress	
In recent month, how often have you felt that you were unable to control the important things in your life?	
Never	1091 (21.7)
Almost never	1156 (22.9)
Sometimes	2351 (46.7)
Fairly often	367(7.3)
Very often	74(1.5)
In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	
Never	837 (16.6)
Almost never	1355 (26.9)
Sometimes	2258 (44.8)
Fairly often	492(9.8)
Very often	97(1.9)
In the last month, how often have you felt confident about your ability to handle your personal problems?	
Never	247(4.9)
Almost never	218(4.3)
Sometimes	1463 (29.0)
Fairly often	2649 (52.6)
Very often	462(9.2)

(continued on next page)

Table 1 (continued)

	n (%)
In the last month, how often have you felt that things are going your way?	
Never	355(7.0)
Almost never	538 (10.7)
Sometimes	2402 (47.7)
Fairly often	1518 (30.1)
Very often	226(4.5)
Perceived stress (continuous), Mean (SD)	21.9(8.3)
Perceived stress (categorical)	
High (>25)	1815 (36.0)
Low (≤25)	3224 (64.0)
Confirmed cases in residential province	
Small	2028 (40.2)
Medium	2413 (47.9)
Large (Hubei province)	598 (11.9)
Frequency of going outside	
Went outside every day or every other day	1059 (21.0)
Went outside every 3–7 days	1862 (37.0)
Went outside every 8–14 days	542 (10.8)
Went outside every 15 days or more	1576 (31.3)
Inadequate supply of masks (n=4,921)	
No (yes and bought successfully)	3855 (78.3)
Yes (yes but cannot buy one)	1066 (21.7)
Risk perception	
Are you worried about yourself contracting COVID-19?	
Low (no worried at all/ not worried)	1011 (20.1)
Medium (fair)	1539 (30.5)
High (worried/ very worried)	2489 (49.4)
Health literacy	
Hard to understand COVID-19 related knowledge and information	
Strongly disagree	348(6.9)
Disagree	2471 (49.0)
Fair	1461 (29.0)
Agree	587 (11.6)
Strongly agree	172(3.4)
Hard to find correct and comprehensive COVID-19 related information	
Strongly disagree	218(4.3)
Disagree	1541 (30.6)
Fair	1679 (33.3)
Agree	1230 (24.4)
Strongly agree	371(7.4)
Health literacy (continuous), Mean (SD)	4.4(1.7)
Health literacy (categorical)	
High (scores≥5)	2522 (50.0)
Low (scores≤4)	2517 (50.0)

2.48 times as likely to report high stress (95%CI [2.19, 2.81]) as those with high health literacy.

The linear regression model (Appendix Table A1) shows similar relationships and further indicates that an inadequate supply of masks (β

= 0.90, 95%CI [0.36, 1.44]), a lower education level (β = 0.89, 95%CI [0.14, 1.64]), and a minority status (β = 0.88, 95%CI [0.22, 1.53]) were associated with higher stress scores.

Discussion

To our knowledge, this study is the first to investigate factors related to perceived stress among the nationwide general population during the COVID-19 epidemic in China when its containment measures were in place. Among all respondents, 36.0% reported a high level of stress. Living in Hubei province, having higher risk perceptions, being of a younger age, earning a lower household income, and having lower health literacy were related to increased odds of reporting high stress levels. In addition, going outside every 8–14 days was related to lower stress levels, compared with going outside every day or every other day.

Despite a considerable proportion of respondents in non-endemic provinces reporting high stress levels, residents in Hubei province reported even higher levels of stress, corresponding to data from other comparative studies in China (Qiu et al., 2020; Wang et al., 2020d). Residents in Hubei province reported greater difficulties during the epidemic, as they experienced higher risks of contracting the virus, strict lockdown policies, and discrimination, and reported higher risk perceptions (Gao et al., 2020; Yuan et al., 2020). All findings suggest that timely mental health aid for residents in epicenters should be implemented during and after an epidemic, as these residents suffer the most during an outbreak.

A reduced frequency of going outside could lower the likelihood of contracting COVID-19 during the epidemic; however, the lack of social interaction may affect interpersonal relationships and mental health. Thus, the associations between the frequency of going outside and perceived stress may be complicated. Participants who went outside most frequently reported the highest stress levels, while those who went outside every 8–14 days reported lower stress levels, which demonstrates a beneficial mental effect of social distancing behaviors during the epidemic. Considering the Chinese population’s overall adherence to social distancing behaviors during the epidemic (Liu et al., 2020), people in our study who went outside frequently (81.6% of whom were aged 21–50 years) may have needed to do so for mandatory reasons (e.g., duty or for work), despite facing the increased risk of contracting the virus and, in turn, increased stress levels. For example, bus drivers continued working to maintain necessary public transportation, even at the peak of the epidemic, which elevated their risk of contracting COVID-19. Thus, the mental health status of those performing essential duties during an epidemic should be given special attention. Surprisingly, participants who substantially reduced their frequency of going outside (i.e., those who went outside every 15 days or more) reported slightly increased stress, notwithstanding the lack of social interaction and the sedentary lifestyle induced by excessive durations of staying at home (Brooks et al., 2020; Hawryluck et al., 2004). These slight mental effects could be attributed to the robust function of online systems allowing for socialization, which compensated for changes to normal life. However, we only captured the stress levels of the general population one month after the social distancing orders; thus, the long-term impact of a reduced frequency of going outside remains unclear. Studies and reviews have revealed that experiences of long quarantine duration during epidemics are related to psychological distress (Brooks et al., 2020; Hawryluck et al., 2004). Governments should maintain a balance between controlling the spread of COVID-19 through social distancing and maintaining public mental health. Advocating for an adequate frequency of going outside despite social distancing orders might be beneficial in reducing public stress levels.

Masks are personal protective equipment designed to reduce the transmission of respiratory infectious disease, the lack of which leads to higher risks of contracting the virus, especially for those who go out frequently during epidemics. At the beginning of the epidemic, the demand for protective equipment far exceeded supply, which was then

Table 2

Association of sociodemographic characteristics, risk perception, health literacy, frequency of going outside, inadequate supply of masks with perceived stress (n=5,039).

	High Perceived Stress* n (%)	χ^2/t	p	Bivariate regression OR(95%CI)	P
Sociodemographic characteristics					
Age		14.113	0.003	Ref	
≥46	321(31.8)				
36–45	285(34.0)			1.10(0.91,1.34)	0.333
26–35	439(37.4)			1.28(1.07,1.53)	0.007
16–25	770(38.2)			1.32(1.13,1.55)	0.001
Gender		1.308	0.253	Ref	
Male	772(36.9)				
Female	1043(35.4)			0.93(0.83,1.05)	0.253
Urbanicity		5.960	0.015	Ref	
Urban	856(34.3)				
Rural	959(37.7)			1.15(1.03,1.30)	0.015
Ethnicity		4.025	0.045	Ref	
Han (Non-minority)	1500(35.4)				
Minority	315(39.1)			1.17(1.004,1.37)	0.045
Education level		12.886	0.002	Ref	
College and above	856(33.8)				
High school	689(37.5)			1.18(1.04,1.33)	0.011
Middle school and under	270(40.4)			1.33(1.12,1.58)	0.001
Monthly household income		35.466	<0.0001	Ref	
> ¥ 10,000 (\$1,449)	396(30.8)				
¥ 5,001–¥ 10,000 (\$725–\$1,449)	489(34.4)			1.18(1.003,1.38)	0.046
¥ 3,000–¥ 5,000 (\$435–\$725)	572(38.5)			1.41(1.20,1.65)	<0.0001
< ¥ 3,000 (\$ 435)	358(42.3)			1.65(1.38,1.98)	<0.0001
Confirmed cases in residential province		2.374	0.305	Ref	
Small	728(35.9)				
Medium	855(35.4)			0.98(0.87,1.11)	0.748
Large (Hubei province)	232(38.8)			1.13(0.94,1.37)	0.196
Frequency of going outside		5.738	0.125	Ref	
Went outside every day or every other day	405(38.2)				
Went outside every 3–7 days	663(35.6)			0.89(0.76,1.04)	0.155
Went outside every 8–14 days	175(32.3)			0.77(0.62,0.96)	0.019
Went outside every 15 days or more	572(36.3)			0.92(0.78,1.08)	0.310
Inadequate supply of masks (n=4,921)		1.472	0.225	Ref	
No (yes and bought successfully)	1376(35.7)				
Yes (yes but cannot buy one)	402(37.7)			1.09(0.95,1.26)	0.225
Risk perception		91.657	<0.0001	Ref	
Low (no worried at all/ not worried)	262(25.9)				
Medium (fair)	505(32.8)			1.40(1.17,1.67)	0.0002
High (worried/ very worried)	1048(42.1)			2.08(1.77,2.44)	<0.0001
Health literacy		308.402	<0.0001	Ref	
Hard to understand COVID-19 related knowledge and information					
No (disagree/ strongly disagree)	726(25.8)				
Fair	674(46.1)			2.27(1.95,2.63)	<0.0001
Yes (agree/ strongly agree)	415(54.7)			2.92(2.52,3.39)	<0.0001
Hard to find correct and comprehensive COVID-19 related information		218.668	<0.0001	Ref	
No (disagree/ strongly disagree)	401(22.8)				
Fair	673(40.1)			2.47(2.16,2.82)	<0.0001
Yes (agree/ strongly agree)	741(46.3)			3.48(2.95,4.11)	<0.0001
Health literacy (continuous), Mean (SD)	3.90(1.69)	17.681	<0.0001	0.74(0.71,0.76)	<0.0001
Health literacy (categorical)		276.652	<0.0001	Ref	
High (scores≥5)	625(24.8)				
Low (scores≤4)	1190(47.3)			2.72(2.42,3.07)	<0.0001

* respondents with scores higher than 25

accompanied by panic purchasing. Individuals in our study who had trouble obtaining medical masks reported higher stress scores. Governments should consider that an inadequate supply of personal protective resources will not only impede disease control but also will worsen public mental health. Thus, timely resource production and allocation policies should be a priority.

Not all factors that increase the possibility of contracting COVID-19 are related to higher stress levels. Despite older people’s higher vulnerability (Chen et al., 2020; WHO, 2020a), higher risk perception (Bruine de Bruin, 2020), and lower health literacy (Greenhalgh, 2015), they showed lower stress levels than their younger counterpart; this indicated that older age is an important protective factor for lower stress levels. Similarly, Cai et al. (2020) found that COVID-19 survivors aged 60 or above reported less severe stress response symptoms. Lower stress

levels among older adults could partly be due to better stress coping capacities and richer life experience (e.g. living through past epidemics or pandemics) (Neubauer et al., 2019; Yang & Huang, 2003), whereas younger adults may be more worried about disruptions to their academic, social, occupational, and economic activities caused by the epidemic (Nwachukwu et al., 2020).

We found that personal risk perceptions, which could be influenced by environmental risk levels, standards of acceptable risk, and exposure to risk communication (Marshall et al., 2007), were positively associated with higher stress levels, which corresponded with findings among residents in the U.K. (Jia et al., 2020). Maintaining assuring and effective communications between authorities and the general public may be an efficient way to lessen stress by enhancing safety and reducing excessive risk perceptions among the public.

Table 3

Logistic multivariate models for the association between sociodemographic characteristics, risk perception, health literacy, frequency of going outside, inadequate supply of masks, and perceived stress (n=4,921).

	Perceived Stress aOR (95%CI)	p
Sociodemographic characteristics		
Age		
≥46	Ref	
36–45	1.17(0.95,1.44)	0.143
26–35	1.39(1.15,1.69)	0.001
16–25	1.51(1.25,1.83)	<0.0001
Gender		
Male	Ref	
Female	0.96(0.84,1.08)	0.480
Urbanicity		
Urban	Ref	
Rural	1.00(0.87,1.14)	0.970
Ethnicity		
Han (Non-minority)	Ref	
Minority	1.09(0.91,1.30)	0.350
Education level		
College and above	Ref	
High school	1.03(0.89,1.20)	0.699
Middle school and under	1.06(0.86,1.30)	0.575
Monthly household income		
> ¥ 10,000 (\$1,449)	Ref	
¥ 5,001–¥ 10,000 (\$725–\$1,449)	1.16(0.98,1.38)	0.090
¥ 3,000–¥ 5,000 (\$435–\$725)	1.29(1.08,1.53)	0.005
< ¥ 3,000 (\$ 435)	1.34(1.09,1.65)	0.006
Confirmed cases in residential province		
Small	Ref	
Medium	1.09(0.95,1.26)	0.219
Large (Hubei province)	1.30(1.05,1.60)	0.018
Frequency of going outside		
Went outside every day or every other day	Ref	
Went outside every 3–7 days	0.90(0.76,1.06)	0.214
Went outside every 8–14 days	0.75(0.60,0.95)	0.017
Went outside every 15 days or more	0.88(0.73,1.05)	0.155
Inadequate supply of masks		
No (yes and bought successfully)	Ref	
Yes (yes but cannot buy one)	1.10(0.95,1.28)	0.206
Risk perception		
Low (no worried at all/ not worried)	Ref	
Medium (fair)	1.34(1.11,1.61)	0.002
High (worried/ very worried)	1.91(1.61,2.27)	<0.0001
Health literacy		
High (≥5)	Ref	
Low (≤4)	2.48(2.19,2.81)	<0.0001

Respondents of low household income status reported high stress levels, which corresponded with findings in Austria (Pieh et al., 2020). During the COVID-19 epidemic, more than a quarter of people in China reported a significant reduction in household income (Wang et al., 2020c). Studies in the U.S. showed that those of a lower household income status suffered more profound economic impacts from the epidemic (Sánchez et al., 2020), and were more prone to work outside due to financial distress (Weill et al., 2020). Our results showed that this population was also more likely to experience shortages of masks. Additionally, low household income is itself a chronic stressor (Wethington et al., 2015). The confluence of these factors exacerbated already high stress levels among poor individuals and demonstrated that income gaps can lead to mental health disparities. Thus, providing financial security for low-income households during epidemics is recommended.

Participants with lower health literacy showed higher stress levels, the negative mental effects of which were overlooked in previous studies in epidemic contexts; this result is consistent with findings among Japanese workers in their daily lives (Tohmiya et al., 2018). The marginal populations, such as low-income and minority ethnic groups and those with low education levels, who reported higher stress scores in our study, also typically possesses low health literacy levels (Greenhalgh,

Table A1

Linear multivariate models for the association between sociodemographic characteristics, risk perception, health literacy, frequency of going outside, inadequate supply of masks, and perceived stress (n=4,921).

	Perceived Stress β (95%CI)	p
Sociodemographic characteristics		
Age		
≥46	Ref	
36–45	0.20(-0.53,0.94)	0.593
26–35	0.72(0.03,1.41)	0.042
16–25	1.10(0.42,1.78)	0.001
Gender		
Male	Ref	
Female	0.05(-0.41,0.50)	0.843
Urbanicity		
Urban	Ref	
Rural	-0.03(-0.51,0.44)	0.889
Ethnicity		
Han (Non-minority)	Ref	
Minority	0.88(0.22,1.53)	0.009
Education level		
College and above	Ref	
High school	-0.05(-0.59,0.49)	0.856
Middle school and under	0.89(0.14,1.64)	0.020
Monthly household income		
> ¥ 10,000 (\$1,449)	Ref	
¥ 5,001–¥ 10,000 (\$725–\$1,449)	0.78(0.18,1.39)	0.011
¥ 3,000–¥ 5,000 (\$435–\$725)	0.89(0.26,1.52)	0.005
< ¥ 3,000 (\$ 435)	0.96(0.19,1.72)	0.014
Confirmed cases in residential province		
Small	Ref	
Medium	0.06(-0.44,0.57)	0.810
Large (Hubei province)	1.80(1.02,2.58)	<0.0001
Frequency of going outside		
Went outside every day or every other day	Ref	
Went outside every 3–7 days	0.18(-0.42,0.79)	0.557
Went outside every 8–14 days	-0.56(-1.40,0.27)	0.188
Went outside every 15 days or more	-0.17(-0.83,0.48)	0.606
Inadequate supply of masks		
No (yes and bought successfully)	Ref	
Yes (yes but cannot buy one)	0.90(0.36,1.44)	0.001
Risk perception		
Low (no worried at all/ not worried)	Ref	
Medium (fair)	2.03(1.39,2.67)	<0.0001
High (worried/ very worried)	3.58(2.99,4.18)	<0.0001
Health literacy		
High (≥5)	Ref	
Low (≤4)	3.70(3.25,4.15)	<0.0001

DW=1.966; F=28.810, p < 0.001; R²=0.102

2015), which further caused their feelings of helplessness during an epidemic. To address this, more accessible, straight-forward, and comprehensible information about epidemics is needed to reduce public panic, especially for disadvantaged populations, and health education aimed at elevating public health literacy is needed both during and after an epidemic.

In addition, sensitivity analyses based on linear regression suggested that an inadequate supply of masks, lower education levels, and minority status were associated with higher stress scores, even though these factors were not significantly associated with high stress based on results of the logistic regression. These variables were potential risk factors for increased stress. The impact of these additional risk factors warrants further investigation, with particular attention paid to those experiencing an inadequate supply of masks, people with low education levels, and ethnic minorities, in addition to the vulnerable populations mentioned above. Though the logistic regression showed lower odds of reporting high stress levels among those who went outside every 8–14 days than those who went outside every day or every other day, the linear regression indicated no differences in stress scores between these two populations. The mental effects of the frequency of going outside during epidemics deserve further investigation.

Mental health services and related policies should focus more on residents in epicenters, younger adults, minority populations, and those from lower-income households, which is in accordance with the approach of psychological first aid (WHO, 2011). Governments should account for mental health disparities when implementing policies or measures to address both public mental health and epidemic control strategies, as there is a wide range of stress levels among the general population. Considering that we may be living with the pandemic for a while and may confront other infectious diseases emergencies in the near future, programs aimed to improve public health literacy may be an efficient way to relieve stress among the general population. WHO created a specific webpage to inform people on how to confront the “infodemic” situation during the pandemic (WHO, 2020b). This information is helpful for those who are stressed from information overload. However, offline health education about COVID-19 is necessary, aimed at the disadvantaged population, who are stressed but unable to access updated information due to a lack of electronic devices and/or low health literacy.

Limitations

Our study has several limitations. First, convenience sampling methods limited the representativeness of our sample. However, we maintained balanced sociodemographic distributions in this convenience sample and used provinces as stratifiers to improve representativeness. Second, the cross-sectional nature of this study limited the ability to determine causality. Only a limited set of covariates was accounted for in the adjusted analysis; therefore, residual confounding exists among detected associations. Last, self-reported questionnaires could induce recall bias and social desirability, even though we asked participants to recall their experience in recent months and answer all questions truthfully.

Conclusion

Our study identified factors related to high perceived stress levels (i.e., epidemic intensity in residential areas, frequency of outside activities, risk perception) and the most vulnerable populations (i.e., younger people, people from poor families, people with low health literacy) due to the stress during the COVID-19 epidemic among the general population in China. These findings can directly inform interventions and policies aimed at mitigating epidemic-related mental health impacts during this outbreak or future outbreaks. The evidence from this large survey is also valuable for international comparisons to understand the global impact of COVID-19 on mental health and related stressors.

Contributors

XZ, XW conceptualized the study design. XW, JX, LL, YZ, and FJ design the questionnaire. XW, JX, YZ, and FJ collected the data. XJ, XZ, XW, ZX, and KS contributed to the data interpretation. JX drafted the manuscript while XZ, XW, LL, KS, and WH revising the paper critically for important intellectual content. All authors contributed to and have approved the final manuscript.

Role of the Funding Source

This work was supported by the Chinese National Office for Philosophy and Social Sciences [grant number 20VYJ063] and Zhejiang University Special Scientific Research Fund for COVID-19 Prevention and Control [grant number 2020XGZX045]. Leesa Lin was supported by the UK Foreign, Commonwealth and Development Office and Wellcome [grant number 215373/A/19/Z]. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Declaration of Competing Interest

None

Acknowledgements

We thank Tianyu Jiang, Yuling Wan, Yanzheng Pan for their great assistance in this study. We greatly appreciate all respondents for their participation in this study.

Appendix

Table A1

References

- Brooks, SK, Webster, RK, Smith, LE, Woodland, L, Wessely, S, Greenberg, N, et al., 2020. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet* 395, 912–920. [https://doi.org/10.1016/s0140-6736\(20\)30460-8](https://doi.org/10.1016/s0140-6736(20)30460-8).
- Bruine de Bruin, W, 2020. Age differences in COVID-19 risk perceptions and mental health: Evidence from a national US survey conducted in March 2020. *J. Gerontol. B Psychol. Sci. Soc. Sci.* <https://doi.org/10.1093/geronb/gbaa074>.
- Cai, X, Hu, X, Ekumi, IO, Wang, J, An, Y, Li, Z, et al., 2020. Psychological Distress and Its Correlates Among COVID-19 Survivors During Early Convalescence Across Age Groups. *Am. J. Geriatr. Psychiatry* 28, 1030–1039. <https://doi.org/10.1016/j.jagp.2020.07.003>.
- China CDC, 2020. Guides for the public to prevent COVID-19. http://www.chinacdc.cn/jkzt/crb/zl/szkb_11803/jszl_2275/202001/t20200125_211447.html (accessed 16 June 2021).
- Chen, N, Zhou, M, Dong, X, Qu, J, Gong, F, Han, Y, et al., 2020. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* 395, 507–513. [https://doi.org/10.1016/S0140-6736\(20\)30211-7](https://doi.org/10.1016/S0140-6736(20)30211-7).
- Chu, IY, Alam, P, Larson, HJ, Lin, L, 2020. Social consequences of mass quarantine during epidemics: a systematic review with implications for the COVID-19 response. *J. Travel Med.* 27, taaa192. <https://doi.org/10.1093/jtm/taaa192>.
- Cohen, S, Kamarck, T, Mermelstein, R, 1983. A global measure of perceived stress. *J. Health Soc. Behav.* 24, 385–396.
- COVID-19 Prevention and Control Team, 2020. Psychological Counseling Work Plan for The Novel Coronavirus Disease. http://www.gov.cn/xinwen/2020-03/19/content_5493051.htm (accessed 16 June 2021).
- Du, J, Mayer, G, Hummel, S, Oetjen, N, Gronewold, N, Zafar, A, et al., 2020. Mental Health Burden in Different Professions During the Final Stage of the COVID-19 Lockdown in China: Cross-sectional Survey Study. *J. Med. Internet Res.* 22, e24240. <https://doi.org/10.2196/24240>.
- Elbogen, EB, Lanier, M, Montgomery, AE, Strickland, S, Wagner, HR, Tsai, J, 2020. Respond to “Stressors and Suicide Attempts in a Time of COVID-19”. *Am. J. Epidemiol.* 189, 1278–1279. <https://doi.org/10.1093/aje/kwaa149>.
- Fancourt, D, Steptoe, A, 2020. The longitudinal relationship between changes in wellbeing and inflammatory markers: Are associations independent of depression? *Brain Behav. Immun.* 83, 146–152. <https://doi.org/10.1016/j.bbi.2019.10.004>.
- Gao, H, Zou, Y, Chen, X, 2020. A Comparative Study of Residents’ Responses Between the Epicenter and the Surrounding Areas in Hubei Province During the COVID-19 Outbreak. *Asia Pacific J. Public Health.* <https://doi.org/10.1177/1010539520956440>.
- Greenhalgh, T, 2015. Health literacy: towards system level solutions. *BMJ* 350, h1026. <https://doi.org/10.1136/bmj.h1026>.
- Hawryluck, L, Gold, WL, Robinson, S, Pogorski, S, Galea, S, Styr, R, 2004. SARS control and psychological effects of quarantine, Toronto, Canada. *Emerg. Infect. Dis.* 10, 1206–1212. <https://doi.org/10.3201/eid1007.030703>.
- Hou, WK, Tong, H, Liang, L, Li, TW, Liu, H, Ben-Ezra, M, et al., 2021. Probable anxiety and components of psychological resilience amid COVID-19: A population-based study. *J. Affect. Disord.* 282, 594–601. <https://doi.org/10.1016/j.jad.2020.12.127>.
- Husky, MM, Kovess-Masfety, V, Swendsen, JD, 2020. Stress and anxiety among university students in France during Covid-19 mandatory confinement. *Compr. Psychiatry* 102, 152191. <https://doi.org/10.1016/j.comppsych.2020.152191>.
- Islam, MS, Ferdous, MZ, Potenza, MN, 2020. Panic and generalized anxiety during the COVID-19 pandemic among Bangladeshi people: An online pilot survey early in the outbreak. *J. Affect. Disord.* 276, 30–37. <https://doi.org/10.1016/j.jad.2020.06.049>.
- Jia, R, Ayling, K, Chalder, T, Massey, A, Broadbent, E, Coupland, C, et al., 2020. Mental health in the UK during the COVID-19 pandemic: cross-sectional analyses from a community cohort study. *BMJ Open* 10, e040620. <https://doi.org/10.1136/bmjopen-2020-040620>.
- Liu, C, Huang, N, Fu, M, Zhang, H, Feng, XL, Guo, J, 2021. Relationship Between Risk Perception, Social Support, and Mental Health Among General Chinese Population During the COVID-19 Pandemic. *Risk Manag. Healthc. Policy* 14, 1843–1853. <https://doi.org/10.2147/RMHP.S302521>.
- Li, J, Yang, Z, Qiu, H, Wang, Y, Jian, L, Ji, J, et al., 2020. Anxiety and depression among general population in China at the peak of the COVID-19 epidemic. *World Psychiatry* 19, 249–250. <https://doi.org/10.1002/wps.20758>.

- Liu, X., Luo, WT., Li, Y., Li, CN., Hong, ZS., Chen, HL., et al., 2020. Psychological status and behavior changes of the public during the COVID-19 epidemic in China. *Infect. Dis. Poverty* 9, 58. <https://doi.org/10.1186/s40249-020-00678-3>.
- Marshall, RD., Bryant, RA., Amsel, L., Suh, EJ., Cook, JM., Neria, Y., 2007. The psychology of ongoing threat: relative risk appraisal, the September 11 attacks, and terrorism-related fears. *Am. Psychol.* 62, 304–316. <https://doi.org/10.1037/0003-066X.62.4.304>.
- Neubauer, AB., Smyth, JM., Sliwinski, MJ., 2019. Age Differences in Proactive Coping With Minor Hassles in Daily Life. *J. Gerontol. B Psychol. Sci. Soc. Sci.* 74, 7–16. <https://doi.org/10.1093/geronb/gby061>.
- Nwachukwu, I., Nkire, N., Shalaby, R., Hrabok, M., Vuong, W., Gusnowski, A., et al., 2020. COVID-19 Pandemic: Age-Related Differences in Measures of Stress, Anxiety and Depression in Canada. *Int. J. Environ. Res. Public Health* 17, 6366. <https://doi.org/10.3390/ijerph17176366>.
- Pedersen, A., Zachariae, R., Bovbjerg, DH., 2010. Influence of psychological stress on upper respiratory infection—a meta-analysis of prospective studies. *Psychosom. Med.* 72, 823–832. <https://doi.org/10.1097/PSY.0b013e3181f1d003>.
- Piehl, C., Budimir, S., Probst, T., 2020. The effect of age, gender, income, work, and physical activity on mental health during coronavirus disease (COVID-19) lockdown in Austria. *J. Psychosom. Res.* 136, 110186. <https://doi.org/10.1016/j.jpsychores.2020.110186>.
- Qiu, J., Shen, B., Zhao, M., Wang, Z., Xie, B., Xu, Y., 2020. A nationwide survey of psychological distress among Chinese people in the COVID-19 epidemic: implications and policy recommendations. *Gen. Psychiatr.* 33, e100213. <https://doi.org/10.1136/gpsych-2020-100213>.
- Sánchez J., Mather R., Athreya K., Mustre-del-Río J., 2020. How Will COVID-19 Affect the Spending of Financially Distressed Households. <https://www.stlouisfed.org/on-the-economy/2020/april/covid-19-spending-affect-financially-distressed-households> (accessed 16 June 2021).
- Shaw, A., 2021. Potential Mechanisms of COVID-19-Related Psychological Problems and Mental Disorders. *Adv. Exp. Med. Biol.* 1318, 727–735. https://doi.org/10.1007/978-3-030-63761-3_40.
- Shi, L., Que, JY., Lu, ZA., Gong, YM., Liu, L., Wang, YH., et al., 2021. Prevalence and correlates of suicidal ideation among the general population in China during the COVID-19 pandemic. *Eur. Psychiatry* 64, e18. <https://doi.org/10.1192/j.eurpsy.2021.5>.
- Sorensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J., Slonska, Z., et al., 2012. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health* 12, 80. <https://doi.org/10.1186/1471-2458-12-80>.
- Sun, L., Sun, Z., Wu, L., Zhu, Z., Zhang, F., Shang, Z., et al., 2021. Prevalence and risk factors for acute posttraumatic stress disorder during the COVID-19 outbreak. *J. Affect. Disord.* 283, 123–129. <https://doi.org/10.1016/j.jad.2021.01.050>.
- Tang, W., Hu, T., Hu, B., Jin, C., Wang, G., Xie, C., et al., 2020. Prevalence and correlates of PTSD and depressive symptoms one month after the outbreak of the COVID-19 epidemic in a sample of home-quarantined Chinese university students. *J. Affect. Disord.* 274, 1–7. <https://doi.org/10.1016/j.jad.2020.05.009>.
- Taylor, S., Landry, CA., Paluszek, MM., Fergus, TA., McKay, D., Asmundson, GJG., 2020. COVID stress syndrome: Concept, structure, and correlates. *Depress. Anxiety* 37, 706–714. <https://doi.org/10.1002/da.23071>.
- Teslya, A., Pham, TM., Godijk, NG., Kretschmar, ME., Bootsma, MCJ., Rozhnova, G., 2020. Impact of self-imposed prevention measures and short-term government-imposed social distancing on mitigating and delaying a COVID-19 epidemic: A modelling study. *PLoS Med.* 17, e1003166. <https://doi.org/10.1371/journal.pmed.1003166>.
- The Lancet, 2009. The health illiteracy problem in the USA. *Lancet.* 374, 2028. [https://doi.org/10.1016/S0140-6736\(09\)62137-1](https://doi.org/10.1016/S0140-6736(09)62137-1).
- Tian, H., Liu, Y., Li, Y., Wu, CH., Chen, B., Kraemer, MUG., et al., 2020. An investigation of transmission control measures during the first 50 days of the COVID-19 epidemic in China. *Science* 368, 638–642. <https://doi.org/10.1126/science.abb6105>.
- Tohmiya, N., Tadaka, E., Arimoto, A., 2018. Cross-sectional study of cognitive stress appraisal and related factors among workers in metropolitan areas of Japan. *BMJ Open* 8, e019404. <https://doi.org/10.1136/bmjopen-2017-019404>.
- Vinck, P., Pham, PN., Bindu, KK., Bedford, J., Nilles, EJ., 2019. Institutional trust and misinformation in the response to the 2018–19 Ebola outbreak in North Kivu, DR Congo: a population-based survey. *Lancet Infect. Dis.* 19, 529–536. [https://doi.org/10.1016/S1473-3099\(19\)30063-5](https://doi.org/10.1016/S1473-3099(19)30063-5).
- Wang, C., Horby, PW., Hayden, FG., Gao, GF., 2020a. A novel coronavirus outbreak of global health concern. *The Lancet* 395, 470–473. [https://doi.org/10.1016/S0140-6736\(20\)30185-9](https://doi.org/10.1016/S0140-6736(20)30185-9).
- Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, CS., et al., 2020b. Immediate Psychological Responses and Associated Factors during the Initial Stage of the 2019 Coronavirus Disease (COVID-19) Epidemic among the General Population in China. *Int. J. Environ. Res. Public Health* 17, 1729. <https://doi.org/10.3390/ijerph17051729>.
- Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, RS., et al., 2020c. A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain Behav. Immun.* 87, 40–48. <https://doi.org/10.1016/j.bbi.2020.04.028>.
- Wang, M., Zhao, Q., Hu, C., Wang, Y., Cao, J., Huang, S., et al., 2021a. Prevalence of psychological disorders in the COVID-19 epidemic in China: A real world cross-sectional study. *J. Affect. Disord.* 281, 312–320. <https://doi.org/10.1016/j.jad.2020.11.118>.
- Wang, S., Zhang, Y., Ding, W., Meng, Y., Hu, H., Liu, Z., et al., 2020d. Psychological distress and sleep problems when people are under interpersonal isolation during an epidemic: A nationwide multicenter cross-sectional study. *Eur. Psychiatry* 63, e77. <https://doi.org/10.1192/j.eurpsy.2020.78>.
- Wang, X., Lin, L., Xuan, Z., Xu, J., Wan, Y., Zhou, X., 2020e. Risk communication on behavioral responses during COVID-19 among general population in China: a rapid national study. *J. Infect.* <https://doi.org/10.1016/j.jinf.2020.10.031>.
- Wang, X., Zhou, X., Lin, L., Mantwill, S., 2018. The Effect of Vaccine Literacy on Parental Trust and Intention to Vaccinate after a Major Vaccine Scandal. *J. Health Commun.* 23, 413–421. <https://doi.org/10.1080/10810730.2018.1455771>.
- Wang, Y., Shi, L., Que, J., Lu, Q., Liu, L., Lu, Z., et al., 2021b. The impact of quarantine on mental health status among general population in China during the COVID-19 pandemic. *Mol. Psychiatry* 1–10. <https://doi.org/10.1038/s41380-021-01019-y>.
- Weill, JA., Stigler, M., Deschenes, O., Springborn, MR., 2020. Social distancing responses to COVID-19 emergency declarations strongly differentiated by income. *Proc. Natl. Acad. Sci. U. S. A.* 117, 19658–19660. <https://doi.org/10.1073/pnas.2009412117>.
- Wethington, E., Glanz, K., Schwartz, MD., 2015. Stress, Coping, and Health Behavior. editor. In: Glanz, K., Rimer, BK., Viswanath, K. (Eds.), *Health Behavior: Theory, Research, and Practice*. Jossey-Bass Public Health, pp. 223–235.
- WHO, 2011. Psychological first aid: guide for field workers. https://apps.who.int/iris/bitstream/handle/10665/44615/9789241548205_eng.pdf;sequence=1 (accessed 16 June 2021).
- WHO, 2020a. Coronavirus disease (COVID-19) pandemic. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019> (accessed 16 June 2021).
- WHO, 2020b. Let's flatten the infodemic curve. <https://www.who.int/news-room/spotlight/let-s-flatten-the-infodemic-curve> (accessed 16 June 2021).
- Wu, P., Fang, Y., Guan, Z., Fan, B., Kong, J., Yao, Z., et al., 2009. The psychological impact of the SARS epidemic on hospital employees in China: exposure, risk perception, and altruistic acceptance of risk. *Can. J. Psychiatry* 54, 302–311. <https://doi.org/10.1177/070674370905400504>.
- Yan, L., Gan, Y., Ding, X., Wu, J., Duan, H., 2021. The relationship between perceived stress and emotional distress during the COVID-19 outbreak: Effects of boredom proneness and coping style. *J. Anxiety Disord.* 77, 102328. <https://doi.org/10.1016/j.janxdis.2020.102328>.
- Yang, T., Huang, H., 2003. An epidemiological study on the psychological stress of urban residents. *Chinese J. Epidemiol.* 24, 760–764.
- Yang, X., Xiong, Z., Li, Z., Li, X., Xiang, W., Yuan, Y., et al., 2020. Perceived psychological stress and associated factors in the early stages of the coronavirus disease 2019 (COVID-19) epidemic: Evidence from the general Chinese population. *PLoS One* 15, e0243605. <https://doi.org/10.1371/journal.pone.0243605>.
- Yuan, S., Liao, Z., Huang, H., Jiang, B., Zhang, X., Wang, Y., et al., 2020. Comparison of the Indicators of Psychological Stress in the Population of Hubei Province and Non-Endemic Provinces in China During Two Weeks During the Coronavirus Disease 2019 (COVID-19) Outbreak in February 2020. *Med. Sci. Monit.* 26, e923767. <https://doi.org/10.12659/MSM.923767>.
- Zhao, SZ., Wong, JYH., Wu, Y., Choi, EPH., Wang, MP., Lam, TH., 2020. Social Distancing Compliance under COVID-19 Pandemic and Mental Health Impacts: A Population-Based Study. *Int. J. Environ. Res. Public Health* 17, 6692. <https://doi.org/10.3390/ijerph17186692>.
- Zhou, M., Guo, W., 2021. Subjective Distress about COVID-19 and Its Social Correlates: Empirical Evidence from Hubei Province of China. *J. Affect. Disord.* 289, 46–54. <https://doi.org/10.1016/j.jad.2021.04.026>.
- Zhu, Y., Zhang, L., Zhou, X., Li, C., Yang, D., 2021. The impact of social distancing during COVID-19: A conditional process model of negative emotions, alienation, affective disorders, and post-traumatic stress disorder. *J. Affect. Disord.* 281, 131–137. <https://doi.org/10.1016/j.jad.2020.12.004>.