



The impact of quarantine on mental health status among general population in China during the COVID-19 pandemic

Yunhe Wang^{1,2} · Le Shi³ · Jianyu Que³ · Qingdong Lu^{1,2} · Lin Liu^{1,2} · Zhengang Lu³ · Yingying Xu^{1,2} · Jiajia Liu³ · Yankun Sun³ · Shiqiu Meng¹ · Kai Yuan³ · Maosheng Ran⁴ · Lin Lu^{3,5} · Yanping Bao^{1,2} · Jie Shi¹

Received: 15 August 2020 / Revised: 21 December 2020 / Accepted: 7 January 2021 / Published online: 22 January 2021
© The Author(s), under exclusive licence to Springer Nature Limited 2021

Abstract

Quarantine and isolation measures urgently adopted to control the COVID-19 pandemic might potentially have negative psychological and social effects. We conducted this cross-sectional, nationwide study to ascertain the psychological effect of quarantine and identify factors associated with mental health outcomes among population quarantined to further inform interventions of mitigating mental health risk especially for vulnerable groups under pandemic conditions. Socio-demographic data, attitudes toward the COVID-19, and mental health measurements of 56,679 participants from 34 provinces in China were collected by an online survey from February 28 to March 11, 2020. Of the 56,679 participants included in the study (mean [SD] age, 36.0 [8.2] years), 27,149 (47.9%) were male and 16,454 (29.0%) ever experienced home confinement or centralized quarantine during COVID-19 outbreak. Compared those without quarantine and adjusted for potential confounders, quarantine measures were associated with increased risk of total psychological outcomes (prevalence, 34.1% vs 27.3%; odds ratio [OR], 1.34; 95% CI, 1.28–1.39; $P < 0.001$). Multivariable logistic regression analyses showed that vulnerable groups of the quarantined population included those with pre-existing mental disorders or chronic physical diseases, frontline workers, those in the most severely affected areas during outbreak, infected or suspected patients, and those who are less financially well-off. Complying with quarantine, being able to take part in usual work, and having adequate understanding of information related to the outbreak were associated with less mental health issues. These results suggest that quarantine measures during COVID-19 pandemic are associated with increased risk of experiencing mental health burden, especially for vulnerable groups. Further study is needed to establish interventions to reduce mental health consequences of quarantine and empower wellbeing especially in vulnerable groups under pandemic conditions.

Introduction

In early December, 2019, Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2) occurred and has now rapidly spread around the world. As of July 17, 2020, the

These authors contributed equally: Yunhe Wang, Le Shi, Jianyu Que

✉ Lin Lu
linlu@bjmu.edu.cn
✉ Yanping Bao
baoy@bjmu.edu.cn
✉ Jie Shi
shijie@bjmu.edu.cn

¹ National Institute on Drug Dependence, Peking University, Beijing 100191, China

² School of Public Health, Peking University, Beijing 100191, China

³ Institute of Mental Health, National Clinical Research Center for Mental Disorders, Key Laboratory of Mental Health and Peking University Sixth Hospital, Peking University, Beijing 100191, China

⁴ Department of Social Work and Social Administration, University of Hong Kong, Hong Kong, China

⁵ Peking-Tsinghua Center for Life Sciences and PKU-IDG/McGovern Institute for Brain Research, Peking University, Beijing 100191, China

COVID-19 outbreak has resulted in 13 million confirmed cases including with 58,5727 deaths globally [1]. A range of public health interventions including traffic restriction, social distancing, home confinement and centralized quarantine, and improvement of medical supplies have enormously contributed to the quick containment of the epidemic in China and set an encouraging example for other countries being affected [2]. However, quarantine and isolation measures urgently adopted to control the pandemic might potentially have negative psychological and social effects especially on those most vulnerable, such as front-line medical workers, children, and older adults [3–5]. Most of the anticipated direct consequences of quarantine and associated social and physical distancing, including financial insecurity, boredom, frustration, feeling a burden, loneliness, and fear, are risk factors for mental health issues including anxiety, depression, suicide, and self-harm [3]. In circumstances such as these, the caution and actions about protecting the mental health and boosting psychological wellbeing of population placed under quarantine are warranted [6].

Several cross-sectional studies have reported a high prevalence of symptoms of psychological distress during the outbreak, estimating that nearly half of health care workers exposed to COVID-19 experienced symptoms of depression and anxiety [7], and 20% of students restricted to home in Wuhan reported having anxiety and depressive symptoms [8]. Previous evidence also suggested that quarantine measures used in the outbreak of severe acute respiratory syndrome (SARS) and H1N1 influenza pandemic are associated with increased risk of psychological outcomes [9–11] and may have long-term consequences [3, 12]. However, to our knowledge, no study has yet investigated the association of quarantine measures with the mental health status among general population during the pandemic. Research is needed to ascertain the psychological effect of quarantine and identify factors associated with mental health outcomes among population quarantined to further inform interventions of mitigating mental health risk especially for vulnerable groups under pandemic conditions.

In this study, rates of depression, anxiety, insomnia, and acute stress symptoms were reported and compared for population quarantined with those not quarantined to evaluate the associations of quarantine measures and mental health outcomes during the outbreak of COVID-19, and factors associated with psychological symptoms among population quarantined were identified, which could serve as evidence base for policy makers to carefully weight against the potential psychological risks when develop protocols and implement quarantine, and to support psychological wellbeing especially in vulnerable groups.

Methods

Participants

The study was approved by the ethics committee of Peking University Sixth Hospital (Institute of Mental Health). Written informed consent was received online before the respondents began the questionnaire. This study follows the American Association for Public Opinion Research reporting guideline.

This is a cross-sectional, nationwide study conducted via an online survey from February 28 to March 11, 2020. During this period, following massive city lockdown with traffic restriction and quarantine implemented since early February, the COVID-19 outbreak in China was temporally controlled. A self-report questionnaire was designed to investigate mental health status of general population during the outbreak and delivered through an online crowdsourcing platform (<http://www.jd.com/>), as detailed elsewhere [13]. Joybuy platform is a large e-commerce and information service corporation with 0.44 billion active users by 2020 in China. Briefly, 71,227 people clicked on the survey page and 56,932 participants submitted the questionnaire voluntarily in 12 days, with a participation rate of 79.9%. After the quality control, 56,679 participants from 34 provinces in China were included, with an effective rate of 99.6%.

Outcomes and covariates

Data on demographic characteristics (e.g., age, sex, educational attainment, income level, occupation, marital status, geographic location, and living area), medical comorbidities (e.g., chronic disease and mental disorder), and information related to COVID-19 (e.g., infection status of participants and their relatives, condition of contact with infected or suspected patients, attitude and respond toward the epidemic, whether participant in frontline work related to COVID-19 including medical care, scientific research, disease control and management, and supply support, status of work or school resumption, risk of expose to patients due to occupational reasons, fear of infection, experience of public health interventions including quarantine, traffic restriction and community confinement were collected via questionnaire).

The primary psychological outcomes included symptoms of depression, anxiety, insomnia, and acute stress measured by the 9-item Patient Health Questionnaire (PHQ-9) [14], the 7-item Generalized Anxiety Disorder (GAD-7) scale [15], the 7-item Insomnia Severity Index (ISI) [16], and the Acute Stress Disorder scale (ASDS) [17], respectively. All measures were validated for use in Chinese [14–16]. Severity categories of mental health status were divided according to the total scores of measures: PHQ-9, normal

(0–4), mild (5–9), moderate (10–14), and severe (≥ 15) depression; GAD-7, normal (0–4), mild (5–9), moderate (10–14), and severe (≥ 15) anxiety; ISI, normal (0–7), sub-threshold (8–14), moderate (15–21), and severe (≥ 22) insomnia; and a score for dissociative cluster of ASDS ≥ 9 and a score for re-experiencing, avoidance and arousal cluster of ASDS ≥ 28 indicate the symptom of acute stress. The cutoff points for detecting symptoms of major depression, anxiety, and insomnia were 10, 10, and 15, respectively. Scores of participants greater than the cutoff threshold indicate potential psychological issues.

Statistical analysis

All analyses were conducted using SAS software, version 9.4 (SAS Institute, Inc), and two-sided $P < 0.05$ indicated significance. The scores of measure tools not normally distributed are presented as medians with interquartile ranges (IQRs) and categorical variables are presented as numbers and percentages. The Mann–Whitney U test was used to compare continuous variables not normally distributed between two groups.

Multivariable logistic regression analysis was performed to calculate the odds ratios (ORs) and 95% CI of risk of experiencing mental health issues, after adjusting potential confounders, including age, sex, educational attainment, income level, occupation, marital status, geographic location, living area, comorbidity of chronic diseases, history of mental disorders, infection status of COVID-19, experience of traffic restriction and community containment, and participation of frontline work related to the outbreak, status of work or school resumption, risk of expose to patients due to occupational reasons, and fear of infection.

Results

Demographic characteristics

In this cross-sectional, nationwide study, a total of 56,679 participants from 34 provinces in China completed the survey. Of the participants included (mean [SD] age, 36.0 [8.2] years), 27,149 (47.9%) were male and 16,454 (29.0%) ever experienced home confinement or centralized quarantine during COVID-19 outbreak. The basic characteristics of participants by quarantine condition are shown in Table 1. Most participants were aged 18–40 years (42,966 [75.8%]), were married (45,033 [79.4%]), had an educational level of college/undergraduate or less (50,311 [88.8%]), and lived in urban areas (52,839 [93.2%]). A total of 9725 participants (17.2%) participated in frontline work related to COVID-19 and participants (36745 [65.1%]) have returned to work or were constantly working. A

Table 1 Demographic characteristics of responders by quarantine condition.

Characteristic	Total, No. (%)	Quarantine condition, No. (%)	
		Quarantine	Without quarantine
Overall	56,679 (100.0)	16,454 (29.0)	40,225 (71.0)
Sex			
Male	27,149 (47.9)	8008 (48.7)	19,141 (47.6)
Female	29,530 (52.1)	8446 (51.3)	21,084 (52.4)
Age, y			
18–40	42,966 (75.8)	13,440 (81.7)	29,526 (73.4)
41–60	13,248 (23.4)	2932 (17.8)	10,316 (25.7)
>60	465 (0.8)	82 (0.5)	383 (0.9)
Marriage status			
Unmarried	11,646 (20.5)	3826 (23.2)	7820 (19.4)
Married ^a	45,033 (79.5)	12,628 (76.8)	32,405 (80.6)
Education attainment			
≤College/undergraduate	50,311 (88.8)	14,474 (88.0)	35,837 (89.1)
≥Postgraduate	6368 (11.2)	1980 (12.0)	4388 (10.9)
Living areas			
Urban	52,839 (93.2)	15,046 (91.4)	37,793 (94.0)
Rural	3840 (6.8)	1408 (8.6)	2432 (6.0)
Having chronic diseases			
No or unknown	53,405 (94.2)	15,726 (95.6)	37,679 (93.7)
Yes	3274 (5.8)	728 (4.4)	2546 (6.3)
History of mental illnesses			
No or unknown	56,518 (99.7)	16,407 (99.7)	40,111 (99.7)
Yes	161 (0.3)	47 (0.3)	114 (0.3)
Infection status of COVID-19			
Diagnosed or suspected	100 (0.2)	57 (0.3)	43 (0.1)
Uninfected	56,579 (99.8)	16,397 (99.7)	40,182 (99.9)
Experience of traffic restriction			
No	11,917 (21.0)	2237 (13.6)	9680 (24.1)
Yes	44,762 (79.0)	14,217 (86.4)	30,545 (75.9)
Experience of community containment			
No	3603 (6.4)	702 (4.3)	2901 (7.2)
Yes	53,076 (93.6)	15,752 (95.7)	37,324 (92.8)
Participation of frontline work related to the outbreak			
No	46,954 (82.8)	14,049 (85.4)	32,905 (81.8)
Yes	9725 (17.2)	2405 (14.6)	7320 (18.2)
Mental health issues			
No	40,096 (70.7)	10,835 (65.9)	29,261 (72.7)
Yes	16,583 (29.3)	5619 (34.1)	10,964 (27.3)

COVID-19 coronavirus disease 2019.

^aThe married category included separate, divorced, and widowed participants.

considerable proportion of participants reported experiencing symptoms of depression (15,802 [27.9%]), anxiety (17,897 [31.6%]), insomnia (16,564 [29.2%]), and acute stress (13,817 [24.4%]). Sixteen thousand, five hundred eighty-three participants (29.2%) reported having one of the moderate to severe mental health issues including symptoms of depression, anxiety, insomnia, and acute stress.

Table 2 Severity categories of depression, anxiety, insomnia, and acute stress symptoms by quarantine condition.

Characteristic	Total, No. (%)	Quarantine condition, No. (%)	
		Quarantine	Without quarantine
PHQ-9, depression symptoms			
Normal	40,877 (72.1)	11,048 (67.1)	29,829 (74.2)
Mild	9688 (17.1)	3163 (19.2)	6525 (16.2)
Moderate	2805 (4.9)	1010 (6.1)	1795 (4.5)
Severe	3309 (5.8)	1233 (7.5)	2076 (5.2)
GAD-7, anxiety symptoms			
Normal	38,782 (68.4)	10,435 (63.4)	28,347 (70.5)
Mild	12,026 (21.2)	3831 (23.3)	8195 (20.4)
Moderate	4308 (7.6)	1572 (9.6)	2736 (6.8)
Severe	1563 (2.8)	616 (3.7)	947 (2.4)
ISI, insomnia symptoms			
Absence	40,115 (70.8)	10,984 (66.8)	29,131 (72.4)
Subthreshold	13,308 (23.5)	4278 (26.0)	9030 (22.4)
Moderate	2746 (4.8)	990 (6.0)	1756 (4.4)
Severe	510 (0.9)	202 (1.2)	308 (0.8)
ASDS, acute stress symptoms			
No	42,862 (75.6)	11,752 (71.4)	31,110 (77.3)
Yes	13817 (24.4)	4702 (28.6)	9115 (22.7)

GAD-7 7-item Generalized Anxiety Disorder, ISI 7-item Insomnia Severity Index, PHQ-9 9-item Patient Health Questionnaire, ASDS Acute Stress Disorder Scale.

The psychological impact of quarantine

Participants who experienced quarantine measures reported higher prevalence rates of moderate-to-severe symptoms of depression (2243 [13.6%] vs 3871 [9.6%]; $P < 0.001$), anxiety (2188 [13.3%] vs 3683 [9.2%]; $P < .001$), insomnia (1192 [7.2%] vs 2064 [5.1%]; $P < .001$), and acute stress (4702 [28.6%] vs 9115 [22.7%]; $P < .001$) than those who were not quarantined (Table 2). Regarding total mental health issues, 34.1% of participants quarantined reported one of the psychological symptoms, compared with 27.3% in the population without quarantine ($P < 0.001$).

The median (IQR) scores on the PHQ-9, the GAD-7, the ISI, and the ASDS for all participants were 0.0 (0.0–6.0) for depression, 1.0 (0.0–7.0) for anxiety, 4.0 (1.0–8.0) for insomnia, and 23.0 (19.0–38.0) for acute stress. Participants who had been quarantined reported higher scores in scales measuring symptoms of depression (median [IQR] PHQ-9 score: 1.0 [0.0–8.0] vs 0.0 [0.0–5.0]; $P < .001$), anxiety (median [IQR] GAD-7 score: 2.0 [0.0–7.0] vs 1.0 [0.0–6.0]; $P < .001$), insomnia (median [IQR] ISI score: 5.0 [1.0–9.0] vs 4.0 [1.0–8.0]; $P < .001$) and acute stress (median [IQR] ASDS score: 25.0 [19.0–38.0] vs 23.0 [19.0–37.0]; $P < .001$) than those who were not quarantined (Table 3).

Compared those without quarantine and adjusted for potential confounders, home confinement and centralized quarantine were associated with increased risk of total psychological outcomes (prevalence, 34.1% vs 27.3%; OR, 1.34; 95% CI, 1.28–1.39; $P < .001$), and of having moderate-to-severe symptoms of depression (prevalence, 13.6% vs 9.6%; OR, 1.42; 95% CI, 1.34–1.50; $P < .001$), anxiety (prevalence, 13.3% vs 9.2%; OR, 1.48; 95% CI, 1.40–1.57; $P < .001$), insomnia (prevalence, 7.2% vs 5.1%; OR, 1.44; 95% CI, 1.34–1.55; $P < .001$), and acute stress (prevalence, 28.6% vs 22.7%; OR, 1.34; 95% CI, 1.28–1.40; $P < .001$) (Table 4).

Associated factors of mental health status for population quarantined

Multivariable logistic regression analyses showed that, after adjusting for potential confounders, male (OR, 1.27; 95% CI, 1.18–1.36; $P < 0.001$), those having a household income less than 5000 RMB per month (OR, 1.12; 95% CI, 1.03–1.21; $P = 0.005$), those with history of mental disorders (OR, 2.03; 95% CI, 1.46–2.82; $P < 0.001$) or having chronic physical diseases (OR, 1.26; 95% CI, 1.10–1.43; $P = 0.001$), those who were infected or suspected of COVID-19 (OR, 3.74; 95% CI, 1.80–7.76; $P < 0.001$) and those having suspected or infected relatives and friends (OR, 1.81; 95% CI, 1.39–2.36; $P < 0.001$), those who experienced fear of infection (e.g., worried vs not worried: OR, 2.05; 95% CI, 1.85–2.27; $P = 0.005$), those who are in Wuhan (OR, 1.50; 95% CI, 1.23–1.84; $P = 0.002$), frontline workers (OR, 1.16; 95% CI, 1.06–1.28; $P = 0.002$), and those who were exposed to patients with general diseases except COVID-19 (OR, 1.28; 95% CI, 1.04–1.58; $P = .043$), or to suspected or diagnosed COVID-19 patients because of occupational condition (OR, 1.44; 95% CI, 1.24–1.69; $P < 0.001$) had significantly higher risk of total psychological outcomes including moderate-to-severe symptoms of depression, anxiety, insomnia, and acute stress. Compared with those who lack of clarity about information related to the COVID-19, participants who have a good understanding of the information on the outbreak reported lower risk of psychological symptoms (basically understand, OR, 0.61; 95% CI, 0.48–0.78; $P < 0.001$; very understand, OR 0.46; 95% CI, 0.36–0.59; $P < 0.001$). Work resumption or working persistently (OR, 0.88; 95% CI, 0.82–0.95; $P = 0.001$), complying with quarantine protocol (OR, 0.47; 95% CI, 0.37–0.61; $P < 0.001$), occupational exposure to general population (OR, 0.78; 95% CI, 0.71–0.85; $P < 0.001$), and experience of community containment (OR, 0.77; 95% CI, 0.64–0.91; $P = 0.003$) were associated with lower risk of psychological outcomes (Table 5).

Table 3 Scores of depression, anxiety, insomnia and acute stress symptoms by quarantine condition.

	Total, Median (IQR)	Quarantine condition, Median (IQR)		
		Quarantine	Without quarantine	<i>P</i> value
PHQ-9, depression symptoms	0.0 (0.0–6.0)	1.0 (0.0–8.0)	0.0 (0.0–5.0)	<0.001
GAD-7, anxiety symptoms	1.0 (0.0–7.0)	2.0 (0.0–7.0)	1.0 (0.0–6.0)	<0.001
ISI, insomnia symptoms	4.0 (1.0–8.0)	5.0 (1.0–9.0)	4.0 (1.0–8.0)	<0.001
ASDS, acute stress symptoms	23.0 (19.0–38.0)	25.0 (19.0–38.0)	23.0 (19.0–37.0)	<0.001

GAD-7 7-item Generalized Anxiety Disorder, *ISI* 7-item Insomnia Severity Index, *PHQ-9* 9-item Patient Health Questionnaire.

Table 4 The impact of quarantine on mental health issues.

	Quarantine condition, OR (95% CI) ^a			
	Without quarantine	<i>P</i> value	Quarantine	<i>P</i> value
Total mental health issues				
Cases/participants (%)	10,964/40,225 (27.3)		5619/16,454 (34.1)	
Unadjusted	1 [Reference]	NA	1.38 (1.33–1.44)	<0.001
Multivariable adjusted	1 [Reference]	NA	1.34 (1.28–1.39)	<0.001
Depression symptoms				
Cases/participants (%)	3871/40,225 (9.6)		2243/16,454 (13.6)	
Unadjusted	1 [Reference]	NA	1.48 (1.40–1.57)	<0.001
Multivariable adjusted	1 [Reference]	NA	1.42 (1.34–1.50)	<0.001
Anxiety symptoms				
Cases/participants (%)	3683/40,225 (9.2)		2188/16,454 (13.3)	
Unadjusted	1 [Reference]	NA	1.52 (1.44–1.61)	<0.001
Multivariable adjusted	1 [Reference]	NA	1.48 (1.40–1.57)	<0.001
Insomnia symptoms				
Cases/participants (%)	2064/40,225 (5.1)		1192/16,454 (7.2)	
Unadjusted	1 [Reference]	NA	1.44 (1.34–1.56)	<0.001
Multivariable adjusted	1 [Reference]	NA	1.44 (1.34–1.55)	<0.001
Acute stress symptoms				
Cases/participants (%)	9115/40,225 (22.7)		4702/16,454 (28.6)	
Unadjusted	1 [Reference]	NA	1.37 (1.31–1.42)	<0.001
Multivariable adjusted	1 [Reference]	NA	1.34 (1.28–1.40)	<0.001

OR odds ratio, NA not applicable.

^aAdjusted for sex, age, marriage, education attainment, location, living area, comorbidity of chronic diseases, history of mental disorders, infection status of COVID-19, experience of traffic restriction, experience of community containment, and participation of work related to the outbreak.

Discussion

In this nationwide survey study, 34.1% of participants with an experience of quarantine during COVID-19 outbreak reported having at least one of the psychological symptoms including anxiety, depression, insomnia, and acute stress, which is higher than those who were not quarantined (27.3%), indicating that the pandemic and quarantine measures related to COVID-19 are having adverse effects on mental health. Quarantine measures were associated with increased risk of experiencing mental health burden, especially for vulnerable groups including people with pre-existing mental or physical illnesses, frontline workers,

those in Wuhan, those who are infected or at risk of infection, those who are less financially well-off, and those who experienced fear of infection. Complying with quarantine, being able to take part in usual work, and having adequate understanding of information related to the outbreak were associated with less mental health issues. Health officials and policy makers should take supportive measures, such as providing sufficient and transparent information on the condition of outbreak in question, and advising possible activities (such as resuming usual work or study through internet and telephone when applicable) for people who are quarantined to reduce boredom and improve connection with others, to achieve an optimal balance

Table 5 Risk factors for mental health issues in quarantine population.

Variable	No. of mental health cases/ No. of quarantine participants (%)	Adjusted OR (95% CI) ^a	P value	
			Category	Overall
Sex				
Female	2712/8446 (32.1)	1 [Reference]	NA	<0.001
Male	2907/8008 (36.3)	1.27 (1.18–1.36)	<0.001	
Household income				
≥5000 RMB/month	4036/12,339 (32.7)	1 [Reference]	NA	0.005
<5000 RMB/month	15,83/4115 (38.5)	1.12 (1.03–1.21)	0.005	
History of mental illnesses				
No or unknown	5595/16,407 (34.1)	1 [Reference]	NA	<0.001
Yes	26/47 (55.3)	2.03 (1.46–2.82)	<0.001	
Having chronic diseases				
No or unknown	5347/15,726 (34.0)	1 [Reference]	NA	.001
Yes	272/728 (37.4)	1.26 (1.10–1.43)	0.001	
Infection status of COVID-19				
Uninfected	5573/16,397 (34.0)	1 [Reference]	NA	<0.001
Suspected or diagnosed	46/57 (80.7)	3.74 (1.80–7.76)	<0.001	
Having relatives and friends who are infected or suspected of COVID-19				
No	5456/16,160 (33.8)	1 [Reference]	NA	<0.001
Yes	163/294 (55.4)	1.81 (1.39–2.36)	<0.001	
Fears of infection				
Not worried	776/3444 (20.9)	1 [Reference]	NA	
Less worried	1134/3705 (30.6)	1.52 (1.37–1.70)	<0.001	
Worried	1726/4684 (36.8)	2.05 (1.85–2.27)	0.005	<0.001
More worried	1151/2847 (40.4)	2.39 (2.13–2.67)	<0.001	
Very worried	832/1774 (46.9)	3.18 (2.80–3.61)	<0.001	
Understanding of information related to the COVID-19 outbreak				
Do not understand	175/316 (55.4)	1 [Reference]	NA	<0.001
Basically understand	1904/5140 (37.0)	0.61 (0.48–0.78)	<0.001	
Very understand	3540/10,998 (32.2)	0.47 (0.36–0.59)	<0.001	
Experience of community containment				
No	307/702 (43.7)	1 [Reference]	NA	0.003
Yes	5312/15,752 (33.7)	0.77 (0.64–0.91)	0.003	
Complying with quarantine protocol				
No	177/293 (60.4)	1 [Reference]	NA	<0.001
Yes	5442/16,161 (33.7)	0.47 (0.36–0.61)	<0.001	
Participation of frontline work related to the outbreak				
No	4683/14,049 (33.3)	1 [Reference]	NA	0.002
Yes	936/2405 (38.9)	1.16 (1.06–1.28)	0.002	
Status of work resumption				
Unemployed or no	2273/6404 (35.5)	1 [Reference]	NA	0.001
Yes or work persistently	3346/10,050 (33.3)	0.88(0.82–0.95)	0.001	
Location				
Outside Hubei province	5076/15,155 (33.5)	1 [Reference]	NA	<0.001
Hubei province outside Wuhan	321/826 (38.9)	1.15 (0.98–1.35)	0.495	
Wuhan	222/473 (46.9)	1.50 (1.23–1.84)	0.002	

Table 5 (continued)

Variable	No. of mental health cases/ No. of quarantine participants (%)	Adjusted OR (95% CI) ^a	P value	
			Category	Overall
Condition of occupational exposure				
Without occupational exposure	3558/10,153 (35.0)	1 [Reference]	NA	<0.001
Exposed to the general public	1463/4996 (29.3)	0.78 (0.71–0.85)	<0.001	
Exposed to patients with general diseases except COVID-19	190/425 (44.7)	1.28 (1.04–1.58)	0.043	
Exposed to suspected or diagnosed COVID-19 patients	408/880 (46.4)	1.44 (1.24–1.69)	<0.001	

COVID-19 coronavirus disease 2019, OR odds ratio, NA not applicable.

^aAdjusted for sex, age, marriage, education attainment, location, living area, comorbidity of chronic diseases, history of mental disorders, infection status of COVID-19, experience of traffic restriction, experience of community containment, and participation of work related to the outbreak.

between the possible costs of mental health and containment of the outbreak when implementing quarantine and lockdown strategy. Interventions to reduce mental health consequences of quarantine and empower wellbeing especially in vulnerable groups under pandemic conditions need to be urgently identified and informed.

The psychological impact of quarantine measures

This study is, to our knowledge, the first to systematically explore the likely impacts of quarantine measures during the COVID-19 pandemic on mental health in general population, and the associated factors that may contribute to, or mitigate these effects. Recently published epidemiological studies during the outbreak investigating the effect of COVID-19 on mental health were restricted to the rate of anxiety, depression, insomnia, psychological distress, and other mental health issues in general population [18] or vulnerable groups such as medical care workers [7] or children [8], failing to consider the potential consequences of COVID-19 quarantine measures on mental health, which are one of the important research priorities for informing management of COVID-19 [4]. This study found that 29.2% of general population reported mental health issues, which is comparable with another investigation showing that 35% of the general population in China experienced psychological distress [18]. Against the backdrop of expected rise in psychological symptoms during these extraordinary circumstances, our findings suggest that quarantine measures used to manage the COVID-19 pandemic have negative effects on mental health and psychological wellbeing as previous quarantine and lockdown measures do during the outbreak of SARS and H1N1 influenza [19, 20]. Most of the adverse effects on mental health might come from the potential fallout of quarantine [3, 21–24], such as increased social isolation and loneliness, lack of belongingness, feeling a burden, financial insecurity,

restriction of liberty, and fear of infection, which are associated with increased risk of mental health issues across the lifespan [4]. Given the evolving situation with coronavirus and related public health interventions, specific attention is required regarding the mental health status during and after quarantine for those who undergo it. In addition, effective interventions should be put in place as part of science-based quarantine strategy to mitigate mental health consequences and sustain containment of COVID-19.

Vulnerable groups of population quarantined

Our findings suggest that quarantine measures might disproportionately affect those most vulnerable and exacerbate health inequalities within populations. People with pre-existing mental health issues or chronic diseases, suspected or infected patients, frontline workers especially those who are exposed to patients with general diseases and COVID-19, those who are less financially well-off, and those in the most severely affected areas in China should be particularly considered and given extra support during and after quarantine. Having a history of psychiatric illness is associated with psychological distress after experiencing traumatic events [25, 26], which might be exacerbated by lack of access to mental health support and services during COVID-19 mass quarantine. People with chronic diseases might be affected psychologically by isolation, loneliness, and lack of routine health care. For frontline workers vulnerable to high risk of infection, they might be affected by fear of infection and transmitting the virus to others, stigmatizing attitudes from others, and work stress [27–29]. Suspected or diagnosed patients of COVID-19 quarantined in dedicated facility or hospital may be affected by worry about physical symptoms that may related to the infection [30], fear of the consequences of infection when exposed to a potentially fatal infectious disease [24], and concern about infecting family members and friends [25, 31]. Furthermore,

adverse effect of treatment for COVID-19, such as insomnia caused by corticosteroids, and symptoms of the infection such as fever and hypoxia, might increase vulnerability during quarantine. People in Wuhan, the area most severely affected by COVID-19 in China, might be most and directly affected by experiencing major public health emergency and the earliest public transport lockdown [7], alongside inadequate supplies such as food and medical resource, fearing the worst due to lack of clarity about the new virus in the early phase of the outbreak, stigma, and guilty. Those who are less financially well-off might be affected by the socioeconomic effect of quarantine including increased unemployment and financial insecurity [32, 33].

What can be done to mitigate the mental health risk?

Our study found that complying with quarantine, being able to take part in usual work, and having adequate understanding of information related to the outbreak were associated with less mental health issues. In addition, we found that experiencing community confinement (only residents of the community are allowed to access) was associated with less psychological symptoms. Further study is needed to investigate whether other public health interventions such as social distancing and community confinement might be more favorable. Previous evidence suggests that disruptions of usual daily activities and social networks could cause a feeling of isolation, boredom and frustration, that is often distressing to those under quarantine [21, 22]. As such, participating in daily routine when possible and keeping in touch with others via the internet and mobile phone to activate the social network could reduce the sense of isolation and distress. There is also the evidence that mental health support services using online applications and phone lines specifically for those under quarantine would help reassure people and make them feel connected to others [34]. Lack of transparency and accessible information about the situation of the outbreak, and difficulty with complying with quarantine protocols were associated with post-traumatic stress symptoms during the SARS epidemic [24]. Ensuring that people under quarantine have a good understanding of the severity of the outbreak and receive adequate information related to the disease and the reasons for quarantine from health and government authorities, should be encouraged. Regarding compliance with quarantine measures, having a sense of altruism, as well as feeling that quarantine is helping to keep others safe and epidemic control are likely to increase adherence and make stressful experiences easier to bear [10]. Informing the public about the benefits of quarantine for protecting or restoring public health and controlling epidemic, while making every effort to ensure that the burden quarantine is

bearable for people, should be priorities to alleviate mental health issues and prevent long-term consequences.

Implications and recommendations

In light of our findings and previous evidence, we make recommendations that may help mitigate the impact of COVID-19 quarantine on mental health to inform optimal quarantine strategies and further interventions to promote wellbeing. First, at the early stage where quarantine measures are deemed necessary, reminding public about the necessity and benefit of quarantine measures, providing clear guidelines of quarantine, and ensuring adequate support of supply especially for people on low income and financial insecurity, could be helpful to increase compliance and reduce harmful effects of quarantine. Preventive measures such as online psychoeducational sessions and easy access to digital mental health care could be helpful. Second, effective and timely mental health and social support, including counseling services provided by hotline and online applications, population-level policies and guidelines, and remotely delivered psychological interventions, should be informed and provided to people under quarantine, especially those might be disproportionately affected such as people with a history of mental illness, suspected or diagnosed patients, and frontline workers. Providing clear communication with regular and transparent updates about the COVID-19 outbreak, advising people activating their social network to improve connection with others and maintaining usual daily routine when applicable, and ensuring basic supplies could be helpful to alleviate the feelings of isolation and boredom. Third, it is likely that quarantine measures might have long-term effects on mental health after quarantine. Regular screening for psychological symptoms especially for vulnerable groups after quarantine are needed to prevent long-term consequences and protect mental health wellbeing. Further evaluations are also needed to develop and inform population-level approaches for the prevention and treatment of mental health symptoms targeting at factors that are causally related to poor psychological outcomes and modifiable by interventions.

Strengths and limitations

Strengths of this study is using a large, nationwide population-based survey to investigate the psychological effect of quarantine measures and the associated factors that may contribute to, or mitigate these effects during the COVID-19 pandemic. We also adjusted for several socio-demographic variables, comorbidities, and variables related to the COVID-19 outbreak and additional public health interventions such as traffic restriction and community

confinement, to reduce residual confounding. Several limitations of this study are worth noting. Current study with a cross-sectional design could not evaluate whether COVID-19 quarantine measures have long-term consequences on mental health. Further longitudinal studies are needed to clarify whether these outcomes will be long-lasting after the COVID-19 outbreak. In addition, psychological outcomes were measured in an online survey and defined by symptom scales rather than clinical diagnosis. However, the diagnosis of mental disorders by psychiatrists may not be feasible in a large general population under pandemic conditions. The use of clinical interviews should be encouraged in future study to improve the understanding about the psychological effect of COVID-19 and related interventions. Finally, although the response rate and completeness rate of the survey were 80.0% and 99.7%, our results might be subject to potential bias if the nonparticipants were too distressed to participate or were those with poor access to internet resources.

Conclusions

Quarantine measures during COVID-19 pandemic are associated with increased risk of experiencing mental health burden, especially for vulnerable groups including people with pre-existing mental or physical illnesses, frontline workers, those in the most severely affected area, and those who are less financially well-off. Reminding public about the necessity and benefit of quarantine measures, providing clear communication with regular and transparent updates about the COVID-19 outbreak, and advising people activating their social network to improve connection with others and maintaining usual daily routine when applicable, might be helpful to alleviate psychological distress. Achieving the appropriate balance between infection control and mitigation of the potential adverse psychological effects when implementing quarantine measures are crucial and immediate priorities for policy makers in health response to the COVID-19 outbreak. Further study is needed to establish interventions to reduce psychological effect of quarantine and empower wellbeing especially in vulnerable groups under pandemic conditions, and investigate the potential long-term consequences of COVID-19 quarantine and lockdown on mental health.

Acknowledgements LL was supported by grant BMU2020H-KYZX008 from the Special Research Fund of PKUHSC for Prevention and Control of COVID-19 and the Fundamental Research Funds for the Central Universities, grant 81761128036 from the National Natural Science Foundation of China–Canadian Institutes of Health Research Joint Health Research Program, grant 2019YFA0706200 from the National Key Research and Development Program of China,

grant U180220091 from the National Natural Science Foundation of China. We thank all the authors made contributions to this study.

Compliance with ethical standards

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

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

1. World Health Organization. Coronavirus disease 2019 (COVID-19) situation report-179. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200629-covid-19-sitrep-161.pdf?sfvrsn=74fde64e_2, Accessed 17 July 2020.
2. Pan A, Liu L, Wang C, Guo H, Hao X, Wang Q, et al. Association of public health interventions with the epidemiology of the COVID-19 outbreak in Wuhan, China. *JAMA*. 2020;323:1915–23.
3. Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet*. 2020;395:912–20.
4. Holmes EA, O'Connor RC, Perry VH, Tracey I, Wessely S, Arseneault L, et al. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. *Lancet Psychiatry*. 2020;7:547–60.
5. Liu JJ, Bao Y, Huang X, Shi J, Lu L. Mental health considerations for children quarantined because of COVID-19. *Lancet Child Adolesc Health*. 2020;4:347–9.
6. Bao Y, Sun Y, Meng S, Shi J, Lu L. 2019-nCoV epidemic: address mental health care to empower society. *Lancet*. 2020;395:e37–e38.
7. Lai J, Ma S, Wang Y, Cai Z, Hu J, Wei N, et al. Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019. *JAMA Netw Open*. 2020;3:e203976.
8. Xie X, Xue Q, Zhou Y, Zhu K, Liu Q, Zhang J, et al. Mental health status among children in home confinement during the coronavirus disease 2019 outbreak in Hubei Province, China. *JAMA Pediatr*. 2020;174:898–900.
9. Liu X, Kakade M, Fuller CJ, Fan B, Fang Y, Kong J, et al. Depression after exposure to stressful events: lessons learned from the severe acute respiratory syndrome epidemic. *Compr Psychiatry*. 2012;53:15–23.
10. Wu P, Fang Y, Guan Z, Fan B, Kong J, Yao Z, et al. The psychological impact of the SARS epidemic on hospital employees in China: exposure, risk perception, and altruistic acceptance of risk. *Can J Psychiatry*. 2009;54:302–11.
11. Wang Y, Xu B, Zhao G, Cao R, He X, Fu S. Is quarantine related to immediate negative psychological consequences during the 2009 H1N1 epidemic? *Gen Hosp Psychiatry*. 2011;33:75–77.
12. Cava MA, Fay KE, Beanlands HJ, McCay EA, Wignall R. The experience of quarantine for individuals affected by SARS in Toronto. *Public Health Nurs*. 2005;22:398–406.
13. Shi L, Lu ZA, Que JY, Huang XL, Liu L, Ran MS, et al. Prevalence of and risk factors associated with mental health symptoms among the general population in China during the coronavirus disease 2019 Pandemic. *JAMA Netw Open*. 2020;3:e2014053–e2014053.
14. Zhang YL, Liang W, Chen ZM, Zhang HM, Zhang JH, Weng XQ, et al. Validity and reliability of Patient Health Questionnaire-9 and Patient Health Questionnaire-2 to screen for depression

- among college students in China. *Asia Pac Psychiatry*. 2013;5:268–75.
15. He XY, Li C, Qian J, Cui HS, Wu WY. Reliability and validity of a generalized anxiety scale in general hospital outpatients. *Shanghai Arch Psychiatry*. 2010;22:200–3.
 16. Yu DSF. Insomnia Severity Index: psychometric properties with Chinese community-dwelling older people. *J Adv Nurs*. 2010;66:2350–9.
 17. Bryant RA, Moulds ML, Guthrie RM. Acute Stress Disorder Scale: a self-report measure of acute stress disorder. *Psychol Assess*. 2000;12:61–68.
 18. Qiu J, Shen B, Zhao M, Wang Z, Xie B, Xu Y. A nationwide survey of psychological distress among Chinese people in the COVID-19 epidemic: implications and policy recommendations. *Gen Psychiatry*. 2020;33:e100213.
 19. Bai Y, Lin CC, Lin CY, Chen JY, Chue CM, Chou P. Survey of stress reactions among health care workers involved with the SARS outbreak. *Psychiatr Serv*. 2004;55:1055–7.
 20. Robertson E, Hershenfield K, Grace SL, Stewart DE. The psychosocial effects of being quarantined following exposure to SARS: a qualitative study of Toronto health care workers. *Can J Psychiatry*. 2004;49:403–7.
 21. Blendon RJ, Benson JM, DesRoches CM, Raleigh E, Taylor-Clark K. The public's response to severe acute respiratory syndrome in Toronto and the United States. *Clin Infect Dis*. 2004;38:925–31.
 22. Braunack-Mayer A, Tooher R, Collins JE, Street JM, Marshall H. Understanding the school community's response to school closures during the H1N1 2009 influenza pandemic. *BMC Public Health*. 2013;13:344.
 23. Cava MA, Fay KE, Beanlands HJ, McCay EA, Wignall R. The experience of quarantine for individuals affected by SARS in Toronto. *Public Health Nurs*. 2005;22:398–406.
 24. Reynolds DL, Garay JR, Deamond SL, Moran MK, Gold W, Styra R. Understanding, compliance and psychological impact of the SARS quarantine experience. *Epidemiol Infect*. 2008;136:997–1007.
 25. Jeong H, Yim HW, Song YJ, Ki M, Min JA, Cho J, et al. Mental health status of people isolated due to Middle East Respiratory Syndrome. *Epidemiol Health*. 2016;38:e2016048.
 26. Kessler RC, Aguilar-Gaxiola S, Alonso J, Bromet EJ, Gureje O, Karam EG, et al. The associations of earlier trauma exposures and history of mental disorders with PTSD after subsequent traumas. *Mol Psychiatry*. 2018;23:1892–9.
 27. Li Z, Ge J, Yang M, Feng J, Qiao M, Jiang R, et al. Vicarious traumatization in the general public, members, and non-members of medical teams aiding in COVID-19 control. *Brain Behav Immun*. 2020;88:916–9.
 28. Zhang WR, Wang K, Yin L, Zhao WF, Xue Q, Peng M, et al. Mental health and psychosocial problems of medical health workers during the COVID-19 epidemic in China. *Psychother Psychosom*. 2020;89:242–50.
 29. Que J, Shi L, Deng J, Liu J, Zhang L, Wu S, et al. Psychological impact of the COVID-19 pandemic on healthcare workers: a cross-sectional study in China. *Gen Psychiatry*. 2020;33:e100259.
 30. Desclaux A, Badji D, Ndione AG, Sow K. Accepted monitoring or endured quarantine? Ebola contacts' perceptions in Senegal. *Soc Sci Med (1982)*. 2017;178:38–45.
 31. Hawryluck L, Gold WL, Robinson S, Pogorski S, Galea S, Styra R. SARS control and psychological effects of quarantine, Toronto, Canada. *Emerg Infect Dis*. 2004;10:1206–12.
 32. Mihashi M, Otsubo Y, Yinjuan X, Nagatomi K, Hoshiko M, Ishitake T. Predictive factors of psychological disorder development during recovery following SARS outbreak. *Health Psychol*. 2009;28:91–100.
 33. Frاسquilho D, Matos MG, Salonna F, Guerreiro D, Storti CC, Gaspar T, et al. Mental health outcomes in times of economic recession: a systematic literature review. *BMC Public Health*. 2016;16:115.
 34. Pan JD, Chang SH, Yu YY. A support group for home-quarantined college students exposed to SARS. *J Specialists Group Work*. 2005;30:363–74.