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RESEARCH ARTICLE

WILEY

Geographical distribution and prevalence of mental disorders among healthcare workers in China: A cross-sectional country-wide survey

A cross-sectional study to assess mental disorders of healthcare workers in China

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Abstract

Background: Reliable and detailed nationwide data on the prevalence and distribution of mental disorders among healthcare workers in China during the coronavirus disease 2019 (COVID-19) outbreak are scarce.

Methods: We did a cross-sectional online survey from March 2 to 2 April 2020 and a total of 19,379 healthcare workers from 25 provinces participated. Depression, anxiety and post-traumatic stress disorder (PTSD) were assessed by the Patient Health Questionnaire (PHQ-9), Generalized Anxiety Disorder Scale (GAD-7) and PTSD Checklist for DSM-5 (PCL-5), respectively.

Results: The age-standardized prevalence of depression, anxiety and PTSD was 15.5%, 12.7% and 5.2%, respectively. Frontline workers had higher prevalence estimates than non-frontline workers (depression: 18.2% vs. 13.9%; anxiety: 14.7% vs. 11.6%; PTSD: 6.1% vs. 4.6%). Subgroups who were nurses, were married or had dependent children reported higher prevalence of depression, anxiety and PTSD. Despite of the large variations, the prevalence of

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mental disorders was lowest in East China, followed by Middle China, and highest in West China.

Conclusion: Healthcare workers faced enormous stress not only from the direct risk presented by the COVID-19 outbreak, but also from the profound changes in their professional practice. Prevalence of adverse psychological outcomes has a significant association with geographically distribution of health resources and regional economic level. Sufficient medical resource may be a protective factor to mental health condition of healthcare personnel when such a public health emergency happened.

KEYWORDS

anxiety, depression, frontline, healthcare worker, pandemic, post-traumatic stress disorder, social disparity

1 | INTRODUCTION

Since 29 December 2019, when the first four cases of unexplained pneumonia were reported in Wuhan, the National Healthcare Service in China, has faced unprecedented pressure, with more than 83,418 cases and 4634 deaths due to coronavirus disease 2019 (COVID-19) as of 22 Jun 2020.¹ To fight with this unexpected and devastating disease, China has adopted extensive and stringent measures, and has for now succeeded in prevention and control of the virus. Healthcare workers, the professional who normally work under high pressure, were facing additional risks and stressors to various degrees at different stages of fighting the epidemic. In initial stage of the COVID-19 outbreak, they faced a high risk of viral exposure, extreme workloads, moral dilemmas, and a rapidly evolving practice environment that differs greatly from what they were familiar with.² They may also experience fear of contagion and of spreading the virus to their families, friends, or colleagues.³ In the post COVID-19 world, healthcare workers are also grappling with questions about how to resume work and provide normal care while sporadic cases have been reported and no available vaccine yet.

Previous studies reported that, when facing working stressors from an epidemic, healthcare workers were prone to report adverse psychological outcomes.^{4–6} For instance, a large proportion of healthcare workers suffered depression, anxiety, post-traumatic stress disorder (PTSD) when combating severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS).^{4–6} These adverse psychological outcomes such as burnout not only existed during and shortly after the epidemic, but also persisted in the long term.⁵ Timely interventions (e.g., Internet cognitive behaviour therapy^{7–9}) to protect healthcare workers from psychological side effect of fighting the COVID-19 pandemic urgently need to be developed.

A high proportion of the healthcare workers have reported psychological problems during the COVID-19 epidemic.^{10–21} For example, A study involving 1563 health professionals in 34 hospitals found that 50.7% of the participants declared depressive symptoms, 44.7% anxiety, and 36.1% sleep disturbances from January 29 to 3 February 2020.²¹ Healthcare workers on the frontline had higher psychological morbidity^{13,18,21} while in another study, non-frontline healthcare workers reported the worse outcomes.¹⁶ A similar negative impact of epidemic on psychological health has also been reported in researches in Singapore, India, and many other countries.^{22–25} However, most of the existing studies in China have focused on the situation in Hubei province, the epicentre of the outbreak, and were conducted during the initial stage of the COVID-19 epidemic.^{10–21} To date, there have been

no national estimates of mental health problems on healthcare workers. It is also unclear whether the mental health status of healthcare workers differs across provinces with diverged disease severity, economy and healthcare resources.

To fill this data gap, we conducted a nationwide, cross-sectional survey to evaluate the mental health status among healthcare workers outside Hubei province. We used this survey data to estimate the pooled and subgroup prevalence of depression, anxiety and PTSD in frontline and non-frontline healthcare workers. Furthermore, we estimated the geographic distribution of the above three mental disorders and their correlations with provincial COVID-19 severity and the provincial economic and healthcare resources.

2 | MATERIALS AND METHODS

2.1 | Study design and participant

We conducted a nationwide, hospital-based, cross-sectional survey to assess the mental health status of healthcare workers during the COVID-19 pandemic in China. This study was designed by researchers from the School of Public Health, Fudan University, and was supported by the Chinese Hospital Association (CHA), which has more than 3000 member hospitals (mainly second-class or above) from all 31 provinces in mainland China. By using the sample frame of the healthcare workers in all the member hospitals under the CHA, we applied a consecutive sampling technique to include all the healthcare workers participating in the survey. The survey received a total of 22,079 respondents from all 31 provinces except Tibet. We did not include participants from Hubei province in this study as a reference, unlike other studies. Of note, according to the China official report,²⁶ since early March, newly confirmed domestic cases on the Chinese mainland were dropped to single digits and an initial victory in a critical battle was achieved outside Hubei province. Moreover, during the study period, there are more than 42,000 health workers in 340 medical aid teams gathered from across the country, including 30 provinces treating patients along with local colleagues in Hubei province.²⁷ All these two could result in a biased estimate of the mental health status of healthcare workers in Hubei and with no comparability with the condition outside. We also excluded participants from community health centres and from provinces with fewer than 50 completed questionnaires. The possible incorrect completion of the questionnaires was checked by the principal investigator, PZ, using the following standards. First, questionnaires completed within 3 min were excluded (estimated average time for completing a questionnaire: 8 to 10 min). Second, questionnaires that reported a starting work age of less than 16 were excluded. Third, questionnaires with age years minus working years less than 16 were excluded. Finally, a total of 19,379 participants from 25 provinces outside Hubei were included in this study.

The Institutional Review Board of Fudan University School of Public Health approved this study and online informed consent was obtained from every participant.

2.2 | Procedure and measures

A self-reported questionnaire packet was distributed to all member hospitals under CHA by email. All the healthcare workers at those hospitals were invited to scan a quick response code to get access and fill in the online questionnaire on the Wenjuanxing platform (www.wjx.cn) from 2 March 2020 to 2 April 2020. All study data were completely anonymized. The raw data were extracted from the platform on 3 April 2020.

Our primary outcomes of interest were the prevalence of depression, anxiety and PTSD. Depression was measured by the Patient Health Questionnaire (PHQ-9), which includes nine items with a score ranging from 0 to 27 to assess the frequency of depressive symptoms in the past 2 weeks.²⁸ Anxiety was measured by the Generalized Anxiety Disorder Scale (GAD-7), using seven items with a score range 0–21 to assess the frequency of

anxiety symptoms in the past 2 weeks.²⁹ The PTSD Checklist for DSM-5 (PCL-5), a 20-item questionnaire (score range 0–80), was adopted to identify probable patients with PTSD.³⁰ Among all three measurements, higher scores indicated greater distress. Validated cut-offs of 10, 10 and 33 were used to identify patients with depression (≥ 10), anxiety (≥ 10) and PTSD (≥ 31), which have been widely used in many studies to assess depressive, anxiety and PTSD symptoms in adolescents in China.^{31–33}

A set of sociodemographic variables were chosen for subgroup analysis based on our review of the previous literatures and expert consultations. Demographic data included age, gender (male/female), marital status (married, divorced, never married), child status (having dependent child[ren] or not), educational level (high school and below, some college, undergraduate, graduate), technical title (senior, intermediate, junior, none), working years (continuous), department (i.e., intensive care, respiratory medicine, thoracic surgery, medical imaging department, fever clinic) and occupation (physician, nurse and others). Work positions were defined as frontline if the responders worked on the frontline of COVID-19 screening, diagnosis, reporting, and treatment or non-frontline if not. Information about geographic region was derived from the respondents' current workplace. Statistics regarding the disease severity, economy and medical resources in each province were derived from national official website and report.³⁴

2.3 | Statistical analysis

All the analyses were stratified into frontline and non-frontline healthcare workers. First, we described participants' characteristics and their statistics were reported as numbers (*n*) with percentages (%). Second, we calculated the crude and age-standardized prevalence of three mental disorders: depression, anxiety and PTSD. The age and gender distribution of our sample and national HCWs were compared and listed in Figure S1. To adjust for difference in age composition between our sample and national HCWs, the prevalence was adjusted by direct standardization according to Chinese HCWs Population (2019).³⁴ Third, we calculated the age-standardized prevalence of three mental disorders in the predefined subgroups (gender, marital status, child status, education level and occupation). Last, we compared the age-standardized prevalence of three mental disorders in different provinces. All the prevalence values are presented as percentage and 95% confidence interval (95%CI). We compared directly standardized rates with a log rate ratio statistic.³⁵

In sensitivity analyses, we calculated the crude and age-standardized prevalence of depression, anxiety and PTSD using a subset sample with participants from Ningxia, Beijing, Hunan and Shaanxi excluded, considering inadequate sample size of the groups (the number of participants came from Beijing, Hunan and Shaanxi province was less than 50, respectively) or a large proportion of the whole sample (the sample came from Ningxia province accounted for more than 10%).

We used Excel 2018 software for data management. *p* values are two-sided, and a *p* value of less than 0.05 was deemed significant. Analyses were performed with SAS (version 9.4, SAS Institute, Cary, NC, USA) and R (version 3.6.3). We did not impute missing data. We followed the STROBE cross-sectional statement for cross-sectional studies checklist throughout this study.³⁶

3 | RESULTS

In total, 19,379 healthcare workers were included. 15,509 (80.0%) participants were women and 8884 (45.8%) participants were between 25 and 34 years old. Most of the participants were married (*n* = 14,647, 75.6%) and had at least one dependent child (*n* = 12,260, 63.3%). In the sample, 4492 (23.2%) participants were physicians and 8863 (45.7%) were nurses. Most of the participants worked in the tertiary care setting (*n* = 12,719, 65.6%) and 7089 (36.6%) participants were frontline healthcare workers. Compared with non-frontline workers, frontline

workers were older, had a higher proportion of men, and were more experienced with a higher educational level, technical title and longer working years (Table 1).

The age-standardized prevalence of depression, anxiety and PTSD was 15.5% (95% CI: 14.9–16.1%), 12.7% (95% CI: 12.1–13.3%) and 5.2% (95% CI: 4.8–5.6%), respectively. Frontline workers had higher prevalence of depression, anxiety and PTSD than non-frontline workers (depression: 18.2% vs. 13.9%; anxiety: 14.7% vs. 11.6%; PTSD: 6.1% vs. 4.6%, all with p values < 0.001).

For each subgroup, the age-standardized prevalence of depression, anxiety and PTSD remained higher in frontline workers than in non-frontline workers except in participants with a high education level. Furthermore, the prevalence of the three mental disorders was separately compared; frontline healthcare workers reported higher prevalence of depression among those who having at least one dependent child and were nurses, while only nurses reported higher prevalence of depression in the non-frontline group (Figure 1). Similarities in subgroups with higher prevalence were found for anxiety and PTSD (Figure S2 and S3 in the Supplement). However, compared to the male counterparts, frontline female workers reported relatively a higher prevalence of anxiety but lower prevalence of depression and PTSD, while non-frontline female workers reported relatively higher prevalence of depression and anxiety but lower prevalence of PTSD (Figure 1, Figure S2 and S3 in the Supplement). Moreover, compared with participants with a high education level, those with the undergraduate level reported lower prevalence of PTSD in frontline workers (Figure S3 in the Supplement).

Large variations in age-standardized prevalence of depression were observed across provinces, ranging from 8.6% in Fujian to 20.9% in Gansu (Interquartile Range: 12.4–17.7%). Heterogeneity in geographic distribution was also seen for the prevalence of anxiety, from 6.9% in Guizhou to 22.3% in Guangxi (IQR: 9.9–15.1%), and on PTSD, from 2.2% in Xinjiang to 9.9% in Gansu (IQR: 3.3–6.3%). If we use the terms high and low to refer to the five highest and five lowest prevalence estimates of the three mental disorders, Ningxia and Gansu had consistently high prevalence of three disorders, and Hainan and Qinghai were high on two of three (Hainan: high in prevalence of anxiety and PTSD, Qinghai: high in prevalence of depression and PTSD). Zhejiang, Fujian and Guizhou had consistently low prevalence, and Jiangsu and Jiangxi were low on two of three (Jiangsu: low in prevalence of depression and anxiety, Qinghai: low in prevalence of depression and PTSD). Frontline and non-frontline groups had similar ranks in the provinces in terms of the prevalence of the three mental disorders.

When the provinces were categorized into East, Middle and West regions,³⁷ we found that frontline healthcare workers reported the highest age-standardized prevalence of depression (19.7%, 95% CI: 17.9–21.5%) and PTSD (7.3%, 5.8–8.8%) in the West, and the highest anxiety (15.3%, 13.5–17.2%) in Middle, while the lowest of depression (16.1%, 14.3–17.9%), anxiety (14.1%, 12.3–15.9%) and PTSD (4.9%, 3.7–6.1%) were consistently found in the East China. Among non-frontline workers, the prevalence of depression, anxiety and PTSD was consistently highest in the West, followed by the Middle and the lowest in the East. Figure 2 presents the age-standardized prevalence of depression across provinces (ranked by prevalence from low to high) together with their corresponding confirmed COVID-19 cases, indicating no clear relationship between prevalence of depression and the corresponding disease severity in the province. Similar results were found in on anxiety and PTSD (Figure S4 and S5 in the Supplement). The age-standardized prevalence of depression, anxiety and PTSD, however, were correlated to the provincial per capita gross domestic product and number of healthcare workers per 1000 population, with lower prevalence in provinces with better economy and more healthcare resources (Figure 3, Figure S6 and S7 in the Supplement). Particularly, we also found the correlation of the age-standardized prevalence of mental disorders and provincial economy and healthcare resources existed in East and West China, but not in Middle China (Figure 3, Figure S6 and S7 in the Supplement).

Sensitivity analyses, with participant from Ningxia, Beijing, Hunan and Shaanxi excluded, showed a relatively lower age-standardized prevalence of depression (14.4%, 13.7%–15.0%), anxiety (11.9%, 11.2%–12.6%) and PTSD (4.7%, 4.3%–5.1%). Frontline workers still reported higher prevalence of depression, anxiety and PTSD than non-frontline workers (depression: 16.8% vs. 13.1%; anxiety: 13.8% vs. 10.9%; PTSD: 5.4% vs. 4.4%, all with p value < 0.001).

TABLE 1 Characteristics of the participants

Characteristic	No. (%)		
	Total	Frontline	Non-frontline
Overall	19,379 (100)	7089 (36.6)	12,290 (63.4)
Gender			
Men	3870 (20.0)	1758 (24.8)	2112 (17.2)
Women	15,509 (80.0)	5331 (75.2)	10,178 (82.8)
Age, year			
<25	1166 (6.0)	373 (5.3)	793 (6.5)
25–34	8884 (45.8)	2973 (41.9)	5911 (48.1)
35–44	5222 (27.0)	2061 (29.1)	3161 (25.7)
45–54	3347 (17.3)	1359 (19.2)	1988 (16.2)
55–59	694 (3.6)	299 (4.2)	395 (3.2)
≥60	66 (0.3)	24 (0.3)	42 (0.3)
Marital status			
Unmarried ^a	4732 (24.4)	1562 (22.0)	3170 (25.8)
Married	14,647 (75.6)	5527 (78.0)	9120 (74.2)
Child status			
≥1 dependent child	12,260 (63.3)	4672 (65.9)	7588 (61.7)
None or independent	7119 (36.7)	2417 (34.1)	4702 (38.3)
Working years, year			
<5	4054 (20.9)	1283 (18.1)	2771 (22.6)
5–9	4465 (23.0)	1509 (21.3)	2956 (24.1)
10–19	5650 (29.2)	2172 (30.6)	3478 (28.3)
20–29	3299 (17.0)	1352 (19.1)	1947 (15.8)
≥30	1911 (9.9)	773 (10.9)	1138 (9.3)
Education level			
Graduate	2039 (10.5)	639 (9.0)	1400 (11.4)
Undergraduate	12,164 (62.8)	4581 (64.3)	7603 (61.9)
<Undergraduate	5176 (26.7)	1889 (26.7)	3287 (26.8)
Technical title			
Senior	3349 (17.3)	1438 (20.3)	1911 (15.6)
Intermediate	5783 (29.8)	2237 (31.6)	3546 (28.9)
Junior	8268 (42.7)	2833 (40.0)	5435 (44.2)
None	1979 (10.2)	581 (8.2)	1398 (11.4)
Department			
High-risk ^b	6872 (35.5)	3956 (55.8)	2916 (23.7)
Ordinary	12,507 (64.5)	3133 (44.2)	9374 (76.3)

TABLE 1 (Continued)

Characteristic	No. (%)		
	Total	Frontline	Non-frontline
Occupation			
Physicians	4492 (23.2)	1598 (22.5)	2894 (23.6)
Nurses	8863 (45.7)	2878 (40.6)	5985 (48.7)
Others	6024 (31.1)	2613 (36.9)	3411 (27.8)
Hospital classification			
Tertiary	12,719 (64.3)	4215 (58.1)	8504 (67.9)
Secondary	6660 (33.7)	2874 (39.6)	3786 (30.2)
Whether the hospital is designated for COVID-19 patient treatment?			
Designated for COVID-19	7799 (40.2)	3424 (48.3)	4375 (35.6)
Non-designated but with fever clinics	10,551 (54.5)	3460 (48.8)	7091 (57.7)
Neither	1029 (5.3)	205 (2.9)	824 (6.7)
Working location			
East	6837 (35.3)	2335 (32.9)	4502 (36.6)
Middle	3862 (19.9)	1421 (20.1)	2441 (19.9)
West	8680 (44.8)	3333 (47.0)	5347 (43.5)

^aUnmarried subgroup includes those never married, divorced, separated, widowed, or living as if married.

^bHigh-risk departments include intensive care, respiratory medicine, thoracic surgery, fever clinics, infection, laboratory and imaging, and isolation wards.

4 | DISCUSSION

In this nationwide study, we found that the pooled age-standardized estimate of depression was the most prevalent (18.2%, 95% CI: 17.2%–19.2%), followed by anxiety (14.7%, 13.7%–15.6%) and PTSD (6.1%, 5.4%–6.8%) in frontline workers, and their prevalence was higher than that of non-frontline counterparts (depression: 18.2% vs. 13.9%; anxiety: 14.7% vs. 11.6%; PTSD: 6.1% vs. 4.6%). Consistently, we found the prevalence of mental disorders was higher in frontline workers than in non-frontline workers in most subgroups. Compare to the counterpart, higher prevalence was reported by healthcare workers who were married and having dependent child. The prevalence of mental disorders was the highest in West China, followed by Middle China, and the lowest in East China. Large variations were found across provinces in the prevalence of mental disorders both in frontline and non-frontline groups.

Previous studies reported inconsistent estimates of the prevalence of mental disorders in healthcare workers during the COVID-19 pandemic in China.^{10–21} For example, a recent study of 2285 medical professionals in February 2020 in China showed that prevalence of symptoms of anxiety, depression, insomnia and the overall psychological problems was 46.04%, 44.37%, 28.75% and 56.59%, respectively.¹⁴ In an additional study, about 24.2% of 4618 health professionals in China experienced high levels of anxiety or/and depressive symptoms since the COVID-19 outbreak.¹⁵ Most of these studies used a convenient sampling design with a possibly unrepresentative population, which might explain the large variations of the prevalence estimates across these studies.³⁸ Using two-stage cluster sampling, a cross-sectional survey of 1257 healthcare workers in 34 hospitals showed that the

FIGURE 1 Crude and age-standardized prevalence of depression among groups and subgroups. In this figure, the group variable was frontline or non-frontline. The subgroup variables included gender, marital status, education level, and occupation. In frontline group, individuals having at least one dependent child ($p = 0.05$) and being nurses ($p = 0.04$) reported higher prevalence of depression, while in non-frontline group, only being nurses ($p = 0.01$) reported higher prevalence of depression

FIGURE 2 Age-standardized prevalence of depression in frontline and non-frontline healthcare workers across provinces. In (A), each province has two columns: the column with the dark colour represents outcomes in frontline groups while the column with a light colour represents outcomes in non-frontline groups. Age-standardized prevalence of depression in Beijing, Hunan and Shaanxi were not shown because their 95% CIs were wide due to the small sample size. In (B), summarized number of confirmed cases at each province until 31 Mar 2020 were reported

overall prevalence of depression and anxiety outside Hubei province were 11.3% and 9.8%, respectively,²¹ much lower than in the previous studies. However, most participants (81.2%) in this study were from Hubei province, limiting its generalizability to the whole country. Furthermore, most of the published studies were conducted during the outbreak peak period (before Mid-March) when the number of confirmed and suspected cases was increasing rapidly both in and outside Hubei province.²⁶ Therefore, frontline healthcare workers under such an overwhelming workload might be unwilling or unable to participate in those surveys, resulting in an over-represented sample of non-frontline samples.

Our study, supported by CHA, was able to conduct a nationwide survey of over 3000 hospitals in China. The similar distribution of age and gender in our study to the standard Chinese healthcare worker population indicated the good representativeness of the sample (Figure S1 in the Supplement). Since there are no available national surveys on healthcare workers in China, we compared our results to the estimated prevalence of depression and anxiety in the general population in China with the same measurements.³⁹ Compared to the general public,

FIGURE 3 Correlation of age-standardized prevalence of depression and GDP per capita as well as the number of healthcare workers per 1000 population in the provinces. In each figure, dots in blue show the provinces in the East region; dots in yellow show the provinces in the Middle region; dots in grey show the provinces in the West region. The blue line is the univariate regression line using the age-standardized prevalence of depression and the GDP per capita in 2018 (A) or the number of healthcare workers per 1000 population in 2018 (B) from the provinces in the East China. Accordingly, Pearson's correlation coefficients are -0.7 and -0.2 . The yellow line is the univariate regression line using the age-standardized prevalence of depression and the GDP per capita in 2018 (A) or the number of healthcare workers per 1000 population in 2018 (B) from the provinces in the Middle China. Accordingly, Pearson's correlation coefficients are 0.2 and 0.6 . The grey line is the univariate regression line using the age-standardized prevalence of depression and GDP per capita in 2018 (A) or the number of healthcare workers per 1000 population in 2018 (B) from the provinces in the West region. Accordingly, Pearson's correlation coefficients are -0.3 and 0.0

frontline healthcare workers reported both higher prevalence of depression (18.2% vs. 17.3%) and anxiety (14.7% vs. 10.4%), while non-frontline healthcare workers were higher for anxiety (11.6% vs. 10.4%) but lower for depression (13.9% vs. 17.3%).³⁹

We found that frontline workers reported higher overall prevalence of depression, anxiety and PTSD than non-frontline workers. This is consistent with previous studies about the psychological effect of emerging virus outbreaks, showing that increased contact with affected patients was associated with a higher risk of adverse psychological outcome.^{13,18,21} In subgroup analyses, we also found that healthcare workers who were married, were nurses, and had dependent children reported higher prevalence of depression, anxiety and PTSD in both frontline and non-frontline groups. In previous studies during the SARS outbreak, nurses and staff who caring for others were also more vulnerable to psychological distress.^{3,5,40} Linked to this were the high risk of infection that nurses might experience during their close and frequent contact with patients as well as longer working hours than usual³⁸ and the fear of infecting their family or having an infected family member.²⁰ Particular attention is required regarding the mental health status of nurses and those caring for others. Conflicting results have been reported regarding the association of gender as well as with the prevalence of depression, anxiety and PTSD among frontline and non-frontline workers. Male participants from one previous study during the viral outbreak also reported higher risk of adverse psychological outcomes⁶ while in some other studies, female participants were the more vulnerable group.⁴¹ More research is needed to address the gendered nature of the pandemic as well as pre-existing health inequities.

Our findings suggest that adverse psychological outcomes among healthcare workers during the COVID-19 pandemic are a widespread problem in China, with inescapably regional variations at the same time. Specifically, the prevalence of depression, anxiety and PTSD was relatively low in East China, and substantially higher in the middle and west, which was not related to the number of COVID-19 confirmed cases but was instead correlated with provincial per capita gross domestic product and the number of healthcare workers per 1000 population. Prosperous regions with enough medical resources, such as Zhejiang and Jiangsu, had the lowest prevalence of mental disorders among provinces that had more than 500 confirmed cases. Less developed regions with limited medical resources, such as Hainan, had the highest prevalence in East region, and Gansu and Ningxia had the highest prevalence across all regions. Anhui and Henan, the two provinces geographically linked to Hubei province, had the highest prevalence of depression, anxiety and PTSD in the middle region.

In most provinces, frontline healthcare workers consistently reported worse psychological outcomes than their non-frontline counterparts. Surprisingly, in Sichuan province, non-frontline healthcare workers reported higher prevalence of depression, anxiety and PTSD. Given the great imbalance in the distribution of limited healthcare resources in Sichuan,⁴² the pre-existing mental health status of most healthcare workers in Sichuan could already be serious. Even in internal regions with the concentration of healthcare resources, such as Chengdu city in Sichuan, healthcare workers could sustain enormous stressors to restore medical services to what they were a year ago amid regular epidemic control efforts, as the possible large number of patients with a high proportion from allopatry may impose great pressure on coronavirus prevention and control.⁴³ The latter condition was similar for provinces such as Shanghai and Zhejiang where prevalence of PTSD also worse in non-frontline healthcare workers, despite their economic prosperity and relatively rich medical resources.

A potential limitation of this study was the use of self-reported measurements to assess mental health outcomes and did not make clinical diagnosis. The gold standard for establishing psychiatric diagnosis involved structured clinical interview and functional neuroimaging.^{44,45} However, access to participants and training interviewers were both impossible given the stringent social distancing measures and mobility restrictions. Moreover, nonresponse bias might be diminished as we had a representative sample and conducted the survey when the COVID-19 cases had levelled off. We, however, have little information about non-responders to clarify this notion. Lastly, this is a cross-sectional study and lack of psychiatric assessments before the COVID-19 outbreak to provide accurate estimates of the COVID-19 influence on mental health. However, on the basis

of a longitudinal study on the general population, it appears that the psychological impact of COVID-19 on mental health will last for a long time.⁴⁶

The COVID-19 pandemic is likely to have pervasive and diverse effects on the mental health of healthcare workers. No surprisingly, the direct contact with COVID-19 patient led to an increasing risk of adverse psychological outcomes. Considering the reversal and readily transmissibility of pandemic, those non-frontline workers also had risks with a certain degree of infection during their normal work. Even remote working is likely to have its own challenges. Of note, prevalence of adverse psychological outcomes during the COVID-19 also has a significant association with geographically distribution of medical resources and regional economic level. Plenty of international evidence shows that mental ill health and poverty interact in a vicious cycle in low-income and middle-income countries.⁴⁷ Moreover, a pandemic will increase the need for intensive care resources. During a public health emergency, healthcare systems in regions with low level of medical resources will be more likely to have inadequate medical resources to respond to the crisis.⁴⁸ To mitigate such effects, planning for the potential public health crisis must occur. Sufficient medical resources may be a protective factor to mental health condition of healthcare personnel when such a public health emergency happened. Future policy making should be targeted to speed up the expansion and balanced distribution of high-quality medical resources.

5 | CONCLUSIONS

Healthcare workers faced enormous stress not only from the direct risk presented by the COVID-19 outbreak, but also from the profound changes in their professional practice. Prevalence of adverse psychological outcomes has a significant association with geographically distribution of health resources and regional economic level. Sufficient health resource may be a protective factor to mental health condition of healthcare personnel when such a public health emergency happened. It is critical to conduct longitudinal research to trace the adverse psychological impacts on healthcare workers in the post COVID-19 world and to introduce effective and efficient interventions for specific individuals and geographic locations with high risks of worse outcomes.

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CONFLICTS OF INTEREST

Danni Chen reports personal fees from dMed Biopharmaceutical Co., Ltd, outside the submitted work. The authors declare no conflict of interest.

ETHICS STATEMENT

The study was approved by the Institutional Review Board of the School of Public Health, Fudan University (IRB# IRB00002408 & FWA00002399).

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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