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A longitudinal study on the mental health status of healthcare workers in Hubei and influencing factors

Short title: **symptoms of healthcare workers during COVID-19**

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Abstract

Objectives: The COVID-19 outbreak beginning in late 2019 has resulted in negative emotions among the public. However, there many healthcare workers risked their lives by voluntarily traveling to the worst-hit area, Hubei Province, to support anti-pandemic work. This study explored the mental health changes of those healthcare workers and tried to discover the influencing factors.

Design: The longitudinal online survey was begun on February 8, 2020, using the snowball sampling method, and this first phase ended on February 22, 2020 (T1). The follow-up survey was conducted from February 8 to February 22, 2021 (T2).

Setting: Healthcare workers from outside of the Hubei area who went to the province to provide medical assistance.

Participants: 963 healthcare workers who completed both surveys.

Measures: Self-Rating Scale of Sleep (SRSS), Generalized Anxiety Scale (GAD-7), and 9-item patient health questionnaire (PHQ-9).

Results: There were no significant differences in the SRSS scores or in the GAD-7 scores between T1 and T2 ($t=0.994$, 0.288; $p>0.05$). However, the PHQ-9 score at T2 was significantly higher than the score at T1 ($t=-10.812$, $p<0.001$). Through multiple linear regression analysis, we found that the following traits could predict higher GAD-7 and PHQ-9 scores at T2: male sex, single marital status, nurses with lower professional technical titles, and healthcare workers having a history of psychosis, treating seriously ill patients, having relatively poor self-perceived health, caring for patients who died, having family members who had been infected with COVID-19.

Conclusions: The results indicate that the depression levels of these special healthcare workers increased in the long term, and the initial demographics and experiences related to the pandemic played an important role in predicting their long-term poor mental health. In the future, more appropriate psychological decompression training should be given to these special healthcare workers.

Keywords: Anxiety; COVID-19; Depression; Healthcare workers; Longitudinal change

Strengths and limitations of this study

1.The first investigation on the special group of healthcare workers who went to the worst-hit area to support anti-pandemic work.

2.Though other researches have used the method of longitudinal study to explore the mental health of healthcare workers, our study investigated the relatively longer time period from the first outbreak of COVID-19, which could help to know the long time change of their mental health.

3.Our study kept the same subjects in the two surveys, which could certify the accuracy of the data.

4.Only self-reported scales were used, therefore, the rates of depression and anxiety might be the rates of probably depression and anxiety.

1. Introduction

The COVID-19 outbreak beginning in late 2019 has been spreading for over two years. Reports have suggested that the pandemic has resulted in negative emotions among the public.[1 2] Even before the outbreak, healthcare workers tended to have long working hours, great work stress, and emotional fatigue, putting them at higher risk of mental disorders than others who work in nonhealthcare areas.[3 4] After the sudden outbreak of COVID-19, the shortage of personal protective equipment (PPE) and the need for their professional skills exacerbated the stress healthcare workers were already under. Thus, negative mental health outcomes were anticipated.[5 6] However, there many healthcare workers risked their lives by voluntarily traveling to the worst-hit area, Hubei Province, to support anti-pandemic work. It was reported that there were 25633 voluntary medical workers from outside the Hubei area who offered medical assistance in the province beginning on January 24, 2020.[7]

To date, many studies have reported that the mental health of front-line healthcare workers has been affected by the pandemic,[8 9] with rates of anxiety and depression ranging from 12 to 23% and 15 to 27%, respectively.[10 11] Other studies have investigated Chinese medical staff who had direct contacted with COVID-19 patients and found that they were at high risk of psychopathology and were experiencing high anxiety symptoms.[11 12] However, these studies were all cross-sectional studies conducted during the initial phase of the outbreak. Maunder et al. found that those who provided healthcare for SARS patients continued to experience substantial long-term psychological distress,[13] and Matua et al. also revealed that the impact on mental health brought by the Ebola pandemic can persist for a long time after the acute outbreak.[14] Considering the pervasive and profound impact of large-scale outbreaks on the mental health of front-line healthcare workers,[15] it is vital to conduct longitudinal surveys that could help us to understand the changes in their mental health and the profound impact of the ongoing pandemic.

After reviewing the latest studies investigating the longitudinal change in the mental health of healthcare workers, we found that that most studies focusing on the 1-4 months following the initial outbreak. They found that healthcare workers' self-perceived job performance deteriorated over time, and they presented with common mental disorders.[16-18] Their poor psychological well-being was generally stable over time but sometimes increased.[19 20] To our knowledge, the longest time interval studied was 8 months post-outbreak, where researchers found that during repeated outbreaks in Japan, psychological distress in healthcare workers remained elevated and at the same level as in the first wave of the COVID-19 outbreak.[21]

The COVID-19 pandemic is showing signs of repeated outbreaks worldwide and of gradually becoming an ongoing battle for healthcare workers. It is important to understand the long-term impact on this population, especially for those healthcare workers who voluntarily went to Hubei and were in contact with COVID-19 patients. Therefore, we designed this longitudinal study to identify their mental health changes 1 year after the first outbreak and to explore what factors in the initial phase had an influence on their mental health. These findings, in turn, may help us guide creation of a psychological crisis intervention system to deal with similar situations in the future.

2. Methods

Design

This longitudinal online survey was begun on February 8, 2020, using the snowball sampling

method, and this first phase ended on February 22, 2020 (T1). The follow-up survey was conducted from February 8 to February 22, 2021 (T2, nearly one year after the first outbreak of COVID-19 in China). The snowball sampling method was used to distribute questionnaires online. Because of the convenience of the network and to acquire the latest information of these subjects, we chose the WeChat platform to distribute the first questionnaire to a group of healthcare workers who travelled to Hubei to offer medical aid. We also encouraged those who completed the questionnaires to forward the link to other healthcare workers who did the same. Informed consent was obtained on the first page of our questionnaires; and only when the participant clicked the button to consent could he or she access the survey. If an individual did not agree to participate, the survey would close automatically. To acquire longitudinal data, we put an invitation at the end of the survey to participate in the follow-up survey. Those who agreed to join the follow-up needed to leave their WeChat account information, which was used to deliver the second survey. The research was reviewed and approved by the Institutional Review Board of the medical centre.

Participants

Only healthcare workers from outside of the Hubei area who went to the province to provide medical assistance were selected as our subjects. A total of 1260 participants returned valid questionnaires in the first survey. Among them, only 1098 left their WeChat account information for the next survey. After we delivered the second survey link to WeChat, 963 subjects returned valid questionnaires. The loss rate for the follow-up was 23.6% (297/1260). There were no systematic differences in demographic characteristics among the subjects who dropped out at T2.

Measurements

All the questionnaires used in our research were self-reported. The concrete scales included (1) demographic and experiences related to the pandemic questionnaire, including gender, age, marital status, highest education, professional technical title, occupation (physician or nurse), history of psychosis, self-perceived health conditions (1 means very good physical condition; 2 means good; 3 means average; 4 means poor; 5 means very poor), working years, whether the patients with COVID-19 they treated had died, whether they nursed/treated seriously ill patients with COVID-19, and whether their family members had been infected with COVID-19. This questionnaire was completed only at T1; (2) the Self-Rating Scale of Sleep (SRSS),[22] which is composed of 10 items with scores of 1-5 points per item. The higher the score was, the worse the sleep problem. According to the report, 22.14 ± 5.48 was the Chinese public's average score;[23] (3) the Generalized Anxiety Scale (GAD-7) and the 9-item Patient Health Questionnaire (PHQ-9),[24 25] which were the simplest scales to evaluate levels of anxiety and depression. The GAD-7 consists of 7 items worth 0-3 points each. The cut-off points for mild/moderate/severe anxiety were 5, 10, and 15, respectively. The PHQ-9 is composed of 9 items worth 0-3 points per item. The cut-off points for mild/moderate/moderately severe/severe depression were 5, 10, 15, and 20, respectively.

Statistical analysis

Descriptive statistics were computed for all variables. The mean scores were then used for comparison among groups using paired T test statistics. The chi-square test was used to detect the differences in levels of anxiety and depression at different time points. Because the total GAD-7 and PHQ-9 scores were both close to a normal distribution, we used multiple linear regression with the stepwise method to screen the influencing factors for anxiety and depression. A P value of < 0.05 was considered statistically significant. All statistical analyses were carried out using the Statistical Package for Social Science (version 11.0, IBM Corp).

Patient and Public Involvement

No patient involved.

3. Results

The demographic data

There were 963 subjects who completed both surveys, among whom 521 were male and 442 were female. The age range was 23-40 years old for an average age of 30.33 ± 4.48. Regarding marital status, 488 were married, and 475 were unmarried. The working years of all subjects ranged from 2 to 20 years, with an average of 8.63 ± 4.44 years. Eighty-one subjects reported a history of psychosis, including 69 with anxiety disorder and 12 with depression (all psychosis should be diagnosed by psychiatrists). Other demographic details and experiences related to the pandemic are shown in Table 1.

Table 1. The distribution of demographic characteristic and pandemic experiences (n=963).

Variables and assignment	Means / N (%)
Gender	
Man (1)	521 (54.1)
Woman (2)	442 (45.9)
Ages (years)	30.33 ±4.48
Marriage	
Unmarried (1)	475 (49.3)
Married (2)	488 (50.7)
Widowed (3)	0
Highest Education	
Secondary (1)	70 (7.3)
Junior (2)	351 (36.4)
Undergraduate (3)	484 (50.3)
Graduate (4)	58 (6.0)
Professional technical title	
Novice (1)	518 (53.8)
Middle (2)	361 (37.5)
Senior (3)	84 (8.7)
Physician or not	
No (2)	702 (72.9)
Yes (1)	261 (27.1)
History of psychosis	
Yes (1)	81 (8.4)
No (2)	882 (91.6)
Self-perceived health conditions	
Very good (1)	224 (23.3)
Good (2)	598 (62.1)

Average (3)	141 (14.6)
Poor (4)	0
Very poor (5)	0
Working years (years)	8.63 ±4.44
Whether the patients they treated had died	
Yes (1)	306 (31.8)
No (2)	657 (68.2)
Whether nursed/treated seriously ill patients with COVID-19	
Yes (1)	908 (94.3)
No (2)	55 (5.7)
Whether their family members had been infected with COVID-19	
Yes (1)	31(3.2)
No (2)	932 (96.8)

The SRSS, GAD-7, and PHQ-9 scores at different time points

Overall, the mean SRSS score of all the subjects was significantly higher than the national norm of SRSS (22.14 ± 5.48) in both T1 and T2 (t=14.656, 14.064; p<0.001), indicating that the subjects' sleep quality was poor. The mean GAD-7 and PHQ-9 scores at T1 and T2 both indicated moderate anxiety and moderate depression among all the subjects.

When looking into the longitudinal change of these three scales, there were no significant differences in the SRSS scores and in the GAD-7 scores between T1 and T2 (t=0.994, 0.288; p>0.05), which means the sleep quality and the anxiety level of the subjects did not show significant change. However, the PHQ-9 score at T2 was significantly higher than the score at T1 (t=-10.812, p<0.001), which demonstrates that the depressive symptoms of the subjects had further deteriorated. The detailed data of the three scales are listed in Table 2.

Table 2. The disparity between the two time-points on the mean scores of SRSS, GAD-7, and PHQ-9 (n = 963).

	T1 (Mean± SD)	T2 (Mean± SD)	t	*P*
SRSS	25.20 ± 6.48	24.91 ± 6.12	0.994	0.320
GAD-7	13.04 ± 3.87	13.03 ± 3.80	0.288	0.774
PHQ-9	14.70 ± 4.70	14.96 ± 4.62	-10.812	<0.001

The rates of different degrees of anxiety and depression at different time points

We used the chi-square test to determine the differences in the rates of different degrees of anxiety and depression over time and found that there were no significant differences in the rates of mild, moderate, and severe anxiety at the two time points (χ^2 = 1.399; 1.528; 0.083, df = 1, p >0.05). The rates of mild depression showed a significant decrease from T1 to T2 (χ^2 = 6.687, df = 1, p=0.012), and no significant change was found in the rates of other levels of depression (χ^2 = 0.052;

3.823; 0.019, df = 1, p >0.05). The detailed comparison results and the distribution of severity of anxiety and depression are listed in Table 3 and Figure 1.

Table 3. The rates of different degrees of anxiety and depression symptoms among different time points (n = 963).

	T1 % (n)	T2 % (n)	χ^2	*P*
GAD-7				
No anxiety	0	0	-	-
Mild anxiety	21.7 (209)	19.5 (188)	1.399	0.260
Moderate anxiety	43.8 (422)	46.6 (449)	1.528	0.234
Severe anxiety	34.5 (332)	33.9 (326)	0.083	0.810
PHQ-9				
No depression	0	0	-	-
Mild depression	12.5 (120)	8.8 (85)	6.687	0.012
Moderate depression	50.1 (482)	49.5 (477)	0.052	0.855
Moderately severe depression	24.8 (239)	28.9 (277)	3.823	0.057
Severe depression	12.7 (122)	12.9 (124)	0.019	0.946

Multiple linear regression analysis of long-term influencing factors of the GAD-7 and PHQ-9 total scores

To build the prediction model, we included all the demographic variables and experiences related to the pandemic as independent variables. The assignments of all variables are shown in Table 1. Because sleep quality is usually associated with anxiety and depression, we also considered the SRSS score at T1 as one of the independent variables.

Through multiple linear regression, we found that the following factors could predict higher GAD-7 and PHQ-9 scores at T2: male sex, unmarried marital status, and the job title of nurse or a lower professional technical title, and those healthcare workers having a history of psychosis, having nursed / treated patients seriously ill with COVID-19, having relatively poor self-perceived health conditions, having the patients they treated die, and having family members infected with COVID-19. Subjects with fewer working years showed higher GAD-7 scores, and younger respondents showed higher PHQ-9 scores. The F values (11, 951) in the regression equation were 120.160 and 271.902 (P < 0.001) for GAD-7 and PHQ-9, respectively. The adjusted R squared values were 0.577 and 0.756, which means that the screened influencing factors can effectively explain 57.7% and 75.6% of the variance in the two models. The results of the influencing factors of the GAD-7 and the PHQ-9 scores are listed in Table 4 and Table 5.

Table 4. The multiple linear regression analysis of influencing factors of GAD-7.

Variable	Regression coefficients	Standard error of regression coefficient	Standardized regression coefficient	*t*	*P*	*95% CI*
Constant	26.394	1.432		18.432	< 0.001	(23.584, 29.204)
Gender	-3.402	0.195	-0.446	-17.406	< 0.001	(-3.786, -3.019)
History of psychosis	-3.340	0.359	-0.244	-9.308	< 0.001	(-4.044, -2.636)
Whether nursed/treated seriously ill patients with COVID-19	-6.174	0.392	-0.377	-15.732	< 0.001	(-6.945, -5.404)
Self-perceived health conditions	2.234	0.158	0.359	14.169	< 0.001	(1.925, 2.544)
Whether the patients they treated had died	-2.195	0.240	-0.269	-9.142	< 0.001	(-2.666, -1.724)
Whether their family members had been infected with COVID-19	-2.700	0.537	-0.125	-5.030	< 0.001	(-3.753, -1.646)
Marriage	-0.732	0.222	-0.096	-3.292	0.001	(-1.168, -0.296)
Physician or not	1.731	0.301	0.202	5.748	< 0.001	(1.140, 2.322)
Professional technical title	-1.551	0.253	-0.265	-6.126	< 0.001	(-2.047, -1.054)
Working years	-0.091	0.029	-0.106	-3.165	0.002	(-0.147, -0.035)

$F(11, 951) = 120.160$ ($P < 0.001$), $R = 0.763$, $R^2 = 0.577$

Table 5. The multiple linear regression analysis of influencing factors of PHQ-9.

Variable	Regression coefficients	Standard error of regression coefficient	Standardized regression coefficient	*t*	*P*	*95% CI*
Constant	37.648	1.618		23.267	< 0.001	(34.472, 40.823)
Gender	-1.482	0.196	-0.160	-7.559	< 0.001	(-1.866, -1.097)
History of psychosis	-10.461	0.332	-0.629	-31.543	< 0.001	(-11.112, -9.811)
Whether nursed/treated seriously ill patients with COVID-19	-5.280	0.350	-0.266	-15.069	< 0.001	(-5.967, -4.592)

Self-perceived health conditions	1.930	0.150	0.255	12.879	< 0.001	(1.636, 2.224)
Whether the patients they treated had died	-2.232	0.220	-0.225	-10.164	< 0.001	(-2.662, -1.801)
Whether their family members had been infected with COVID-19	-4.217	0.510	-0.161	-8.272	< 0.001	(-5.218, -3.217)
Marriage	-1.480	0.216	-0.160	-6.858	< 0.001	(-1.903, -1.056)
Physician or not	1.283	0.278	0.124	4.619	< 0.001	(0.738, 1.829)
Professional technical title	-2.221	0.292	-0.313	-7.608	< 0.001	(-2.794, -1.648)
Age	-0.350	0.043	-0.340	-8.129	< 0.001	(-0.434, -0.265)

F (11, 951) = 271.902 (P < 0.001), R = 0.871, R^2 = 0.756

4. Discussion

Through this longitudinal survey, we discovered that one year after the first outbreak of the pandemic, the sleep quality and anxiety levels remained stable among 963 healthcare workers who voluntarily went to Hubei to provide medical support compared with their condition in the first month during their assistance, while their levels of depression showed an obvious increase. The initial demographics and experiences related to the pandemic played an important role in predicting the long-term poor mental health of these healthcare workers.

We found that during our first wave of survey, the sleep quality of our subjects was significantly worse than that of the general public, which showed a result similar to that of Liang et al., who demonstrated that frontline healthcare workers were at a higher risk of insomnia compared to the general population during the pandemic.[26] The reason for their poor sleep quality might be work overload, high work-related demands, and complex COVID-facing environments in the new workplace, which they had to adapt to at the cost of more emotional stress.[27 28] These issues could be the cause of the high mean scores of GAD-7 and PHQ-9 at T1, both of which were measured at the level of moderate. To our surprise, all respondents reported some anxiety and/or depressive symptoms, which indicated that the mental health of these healthcare workers was relatively poor. Many studies have revealed that the prevalence of anxiety and depressive symptoms in medical staff working in the areas most affected by the COVID-19 pandemic was high, [12 26 29 30] and the prevalence of anxiety ranged from 23-34%, and the prevalence of depression ranged from 15-27% according to various meta-analysis.[31-33] The reason for the obviously different prevalence of anxiety and depression in our results might be due to the different tools used and the different stages in which the surveys were conducted.[34] Moreover, the subjects in our study all came from other provinces, and many of them may not have had previous experience with a serious pandemic. Thus, they may have needed to execute strict closed-loop management during their stint in Hubei, creating acute stress.

In the second wave of our survey a year after the initial survey was administered, we found that sleep quality and anxiety levels did not show significant changes among the respondents. This finding

demonstrated that these subjects still had poor mental health statuses even though they had returned to their original workplaces and that the pandemic's impact could persist for a long time. López et al. found that from the first measurement to the four-month follow-up in their study, more healthcare workers presented anxiety and depression during the pandemic.[16] One study discovered that poor psychiatric status and sleep quality were still common one month after healthcare workers arrived in Hubei during the COVID-19 outbreak[17] and that those who were deployed to high-risk areas reported a high level of stress three months later.[35] Because there was no literature investigating the long-term impact of COVID-19 on healthcare workers, we could only refer to the experiences of past pandemics when setting up our research. We know that the symptoms of anxiety and depression were still common among healthcare workers within one to three years after the SARS outbreak.[36 37] We could see the profound and persistent impact brought about by that pandemic. However, there are differences between COVID-19 and SARS. COVID-19 has been ongoing for nearly two years, and some small-scale outbreaks have occurred repeatedly, which might keep healthcare workers in a constant state of alert or preparing for outbreaks, guarding against unexpected contacts, and facing the risk of infection or transmission to their family members which could be torturous and exhausting.[38 39] Therefore, the mental health of our subjects remained poor one year later, and the depression score even deteriorated at T2. More subjects reported moderately severe depression at T2, which indicates that the degree of depression worsened over time. One probable reason might be the delayed reaction caused by serious disaster-related events.[40 41] Another reason might be the recession of anxiety, overloaded emotional pressure may cause healthcare workers exhausted, with the time passing, they didn't have enough energy to worry, and they gradually turned into more severe depression.[42]

We found that the long-term influencing factors for anxiety and depressive symptoms were similar. Healthcare workers with a history of psychosis were more prone to show anxiety and depressive symptoms, similar to the findings of other studies.[13 16 17] These results also indicated that experiences related to the pandemic, including having nursed/treated seriously ill patients with COVID-19, having the patients they treated die, and having family members infected with COVID-19, may predict the prevalence of anxiety and depression. Other reports revealed that poorer mental health was associated with managing COVID-19 patients and family exposure to COVID-19.[19 43] We also discovered that those who thought of themselves as having relatively poor health may experience more anxiety and depression, which was similar to the findings of Manara et al.[44] Another factor screened was the sex/gender, and we found that male healthcare workers tended to feel more negative emotions, which was contrary to previous studies.[45 46] The reason may be that the age of male aid workers is generally older, and their physical strength and energy recovery level would therefore not be as fast as that of young women. Thus, they are more prone to fatigue. In addition, women are considered to be more willing to express their feelings through language at any time.[47] As a result, they will store fewer negative emotions. Men will find it more difficult to release negative emotions caused by stress. We also found that unmarried ones, nurses,those with lower professional technical titles were prone to present greater anxiety and depression, which was in contrast to Cai et al.'s report.[48] We all know that communication with family and companions are important social support sources,[49] but unmarried individuals do not have the support of spouses. Due to the large number of infected patients in Hubei Province, more nurses were required to care for them and to conduct clinical treatment activities, such as blood sampling, infusions and medication distribution. The great workload undoubtedly added more pressure on nurses than physicians, and the nurses were relatively young with lower professional technical titles and less experience, making them vulnerable

to distress.[43] Finally, we found that those with fewer working years were more likely to become anxious, and younger individuals were more likely to become depressed, which was similar to previous findings.[13 43 45]

Conclusions

The COVID-19 outbreak beginning in late 2019 has been spreading for almost 2 years. After the sudden outbreak of COVID-19, the shortage of personal protective equipment placed additional stress on professional healthcare workers. However, there has been little information on the change in mental health of healthcare workers who went to Hubei to offer assistance. This is the first study investigating the longitudinal mental health of front-line healthcare workers who went to Hubei to assist other health professionals during the initial COVID-19 outbreak and 1 year later. We found that sleep quality and anxiety levels remained stable among them, while depression levels showed obvious increases. The initial demographics and experiences related to the pandemic played an important role in predicting the long-term mental health of these special healthcare workers.

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Contributors: ND was in charge of this study, supervising the process and of providing expert opinion. PZ and ND organized the study design and analyzed the data. Collaborators YX and YGL ensured that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved. All other authors participated in conducting the survey. PZ wrote the first draft of the manuscript, and ND critically revised it. All authors approved the final version of the manuscript.

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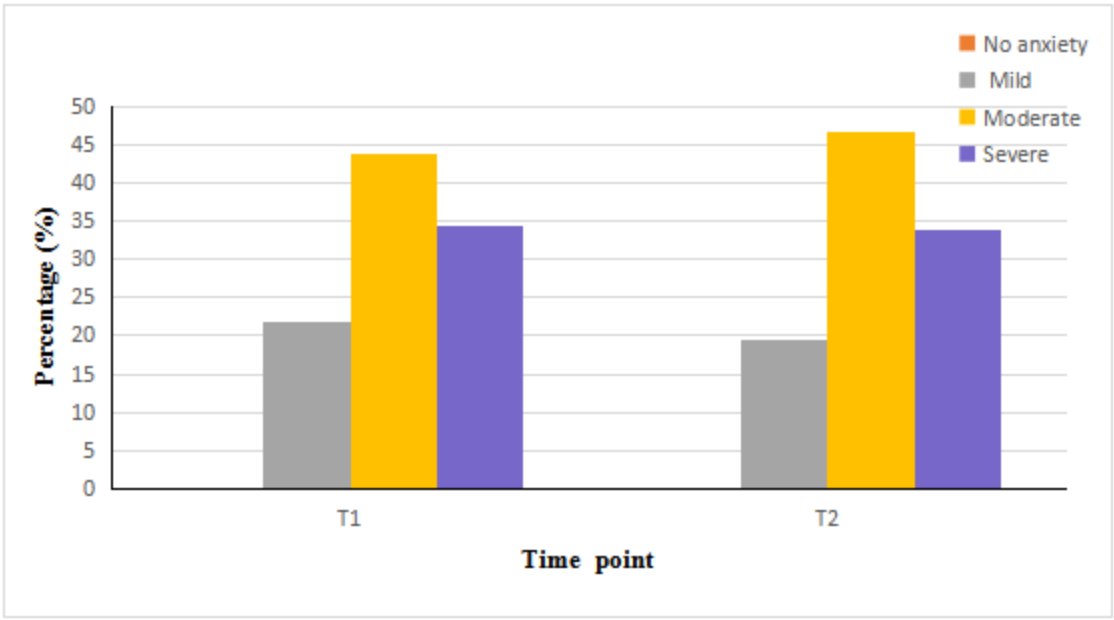
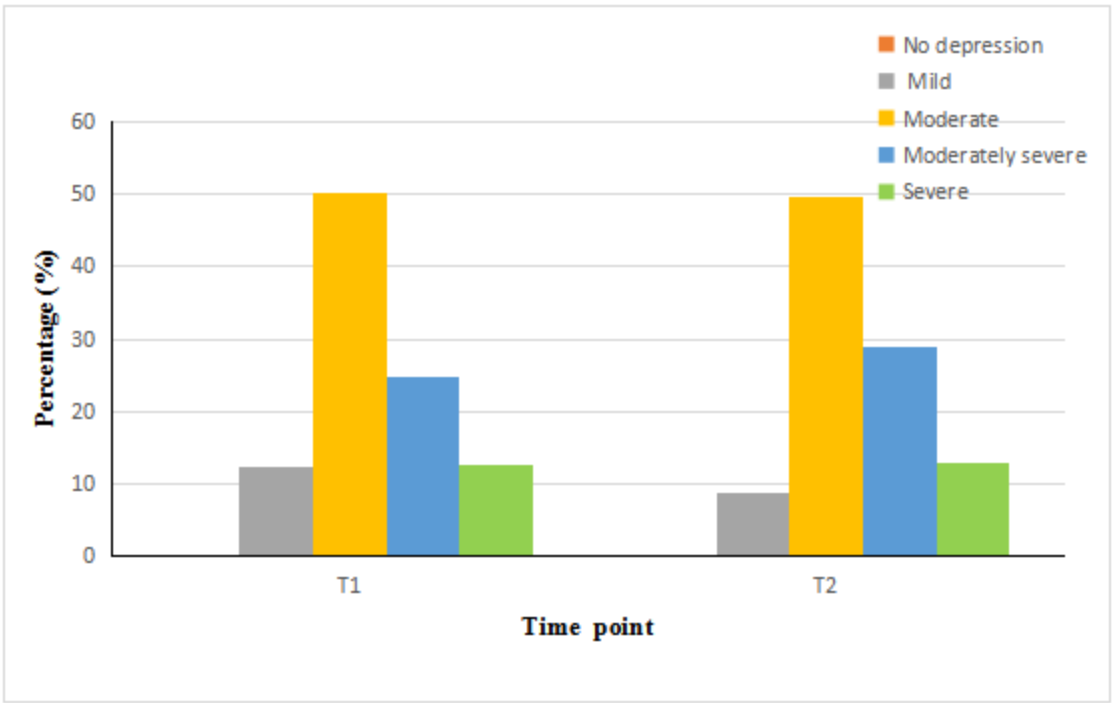
Figure legend:

Figure 1. The distribution of severity of anxiety and depression over time. The first figure stands for the anxiety level, and the second one stands for the depression level.


No anxiety
Mild
Moderate
Severe
Percentage (%)
50
45
40
35
30
25
20
15
10
5
0
T1
T2
Time point


No depression
Mild
Moderate
Moderately severe
Severe
Percentage (%)
60
50
40
30
20
10
0
T1
T2
Time point

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3-4
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*4*
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	4
		(*e*) Describe any sensitivity analyses	N/A

Continued on next page

Results			
Participants	13 *	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	4
		(c) Consider use of a flow diagram	N/A
Descriptive data	14 *	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	4
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	4
Outcome data	15 *	*Cohort study*—Report numbers of outcome events or summary measures over time	*4*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5
		(*b*) Report category boundaries when continuous variables were categorized	6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	2
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The mental health status of healthcare workers assisted in Hubei during the initial outbreak of COVID-19 and their influencing factors: A Prospective cohort study

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The mental health status of healthcare workers assisted in Hubei during the initial outbreak of COVID-19 and their influencing factors: A Prospective cohort study

Short title: **symptoms of healthcare workers during COVID-19**

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Abstract

Objectives: The COVID-19 outbreak beginning in late 2019 has resulted in negative emotions among the public. However, there many healthcare workers risked their lives by voluntarily traveling to the worst-hit area, Hubei Province, to support anti-pandemic work. This study explored the mental health changes of those healthcare workers and tried to discover the influencing factors.

Design: The longitudinal online survey was begun on February 8, 2020, using the snowball sampling method, and this first phase ended on February 22, 2020 (T1). The follow-up survey was conducted from February 8 to February 22, 2021 (T2).

Setting: Healthcare workers from outside of the Hubei area who went to the province to provide medical assistance.

Participants: 963 healthcare workers who completed both surveys.

Measures: Self-Rating Scale of Sleep (SRSS), Generalized Anxiety Scale (GAD-7), and 9-item patient health questionnaire (PHQ-9).

Results: There were no significant differences in the SRSS scores or in the GAD-7 scores between T1 and T2 ($t=0.994, 0.288$; $p>0.05$). However, the PHQ-9 score at T2 was significantly higher than the score at T1 ($t=-10.812$, $p<0.001$). Through multiple linear regression analysis, we found that the following traits could predict higher GAD-7 and PHQ-9 scores at T2: male sex, single marital status, nurses with lower professional technical titles, and healthcare workers having a history of psychosis, treating seriously ill patients, having relatively poor self-perceived health, caring for patients who died, having family members who had been infected with COVID-19.

Conclusions: The results indicate that the depression levels of these special healthcare workers increased in the long term, and the initial demographics and experiences related to the pandemic played an important role in predicting their long-term poor mental health. In the future, more appropriate psychological decompression training should be provided for these special healthcare workers.

Keywords: Anxiety; COVID-19; Depression; Healthcare workers; Longitudinal change

Strengths and limitations of this study

- The participants included in this study sample had some homogeneity in their roles in the assistance work, which could guarantee that the conclusion can be extended to this special group.
- The prospective study design (1year of follow-up for the same sample) could help us to understand the participants' long-term mental health changes compared with their initial data, which could also indicate the defeating work during the COVID-19 pandemic.
- The study used the snowball sampling method and followed the voluntary principle to recruit subjects, which did not include the data of those who were not willing to expose their mental status considering the social influence.
- The data were self-reported, and therefore, the participants' mental health could only represent the probability of anxiety and depression, and could not represent the diagnosis.

1. Introduction

The COVID-19 outbreak beginning in late 2019 has been spreading for over two years. Reports have suggested that the pandemic has resulted in negative emotions among the public.[1 2] Even before the outbreak, healthcare workers tended to have long working hours, substantial work stress, and emotional fatigue, putting them at higher risk of mental disorders than others who work in non-healthcare areas.[3 4] After the sudden outbreak of COVID-19, the shortage of personal protective equipment (PPE) and the need for professional skills exacerbated the stress that healthcare workers were already experiencing. Thus, negative mental health outcomes were anticipated.[5 6] However, many healthcare workers risked their lives by voluntarily travelling to the worst-hit area, Hubei Province, to support anti-pandemic work. It was reported that there were 25633 voluntary medical workers from outside the Hubei area who offered medical assistance in the province beginning on January 24, 2020.[7]

To date, many studies have reported that the mental health of front-line healthcare workers has been affected by the pandemic,[8 9] with rates of anxiety and depression ranging from 12 to 23% and 15 to 27%, respectively.[10 11] Other studies have investigated Chinese medical staff who had direct contact with COVID-19 patients and found that they were at high risk of psychopathology and were experiencing high rates of anxiety symptoms.[11 12] However, these studies were all cross-sectional studies that were conducted during the initial phase of the outbreak. Maunder et al. found that those who provided healthcare for SARS patients continued to experience substantial long-term psychological distress ,[13] and Matua et al. also revealed that the impact on mental health caused by the Ebola pandemic persisted for a long time after the acute outbreak.[14] Considering the pervasive and profound impact of large-scale outbreaks on the mental health of front-line healthcare workers,[15] it is vital to conduct longitudinal surveys that could help us to understand the changes in their mental health and the profound impact of the ongoing pandemic.

After reviewing the latest studies investigating the longitudinal changes in the mental health of healthcare workers, we found that most studies focused on the 1-4 months following the initial outbreak. They found that healthcare workers' self-perceived job performance deteriorated over time, and they presented with common mental disorders.[16-18] Their poor psychological well-being was generally stable over time but sometimes increased.[19 20] To our knowledge, the longest time interval studied was 8 months post-outbreak, where researchers found that during repeated outbreaks in Japan, the psychological distress in healthcare workers remained elevated and at the same level as that in the first wave of the COVID-19 outbreak.[21]

The COVID-19 pandemic is showing signs of repeated outbreaks worldwide and of gradually becoming an ongoing battle for healthcare workers. It is important to understand the long-term impact on this population, especially for healthcare workers who voluntarily went to Hubei and were in contact with COVID-19 patients. Because the condition of the initial outbreak of COVID-19 was unknown, it might have become an obvious source of stress for these healthcare workers, and it was reported that a similar major disaster's impact on mental health might last for a long period of time. [22] Therefore, we designed this longitudinal study to identify the mental health changes in healthcare workers 1 year after the first outbreak and to explore what factors in the initial phase influenced their mental health. These findings, in turn, may help guide the creation of a psychological crisis intervention system to deal with similar situations in the future.

2. Methods

Design

This longitudinal online survey began on February 8, 2020, using the snowball sampling method, and the first phase ended on February 22, 2020 (T1). The follow-up survey was conducted from February 8 to February 22, 2021 (T2, nearly one year after the first outbreak of COVID-19 in China). The snowball sampling method was used to distribute the questionnaires online. Because of the convenience of the network and to acquire the latest information of these subjects, we chose the WeChat platform to distribute the first questionnaire to a group of healthcare workers who travelled to Hubei to offer medical aid. We also encouraged those who completed the questionnaires to forward the link to other healthcare workers who would do the same. Informed consent was obtained on the first page of our questionnaires, and only when the participant clicked the button to consent could he or she access the survey. If an individual did not agree to participate, the survey would close automatically. To acquire longitudinal data, we included an invitation at the end of the survey to participate in the follow-up survey. Those who agreed to participate in the follow-up survey needed to leave their WeChat account information, which was used to deliver the second survey. The research was reviewed and approved by the Institutional Review Board of the medical centre.

Participants

Only healthcare workers from outside of the Hubei area who went to the province to provide medical assistance were selected as our subjects. A total of 1260 participants returned valid questionnaires in the first survey. Among them, only 1098 provided their WeChat account information for the next survey. After we delivered the second survey link through WeChat, 963 subjects returned valid questionnaires. The rate of loss to follow-up was 23.6% (297/1260). There were no systematic differences in demographic characteristics among the subjects who dropped out at T2.

Measurements

All the questionnaires used in our research were self-reported. The specific scales included (1) demographics and experiences related to the pandemic questionnaire, including gender/sex, age, marital status, highest education level, professional technical title, occupation (physician or nurse), history of psychosis, self-perceived health conditions (1 indicated a very good physical condition; 2 indicated good; 3 indicated average; 4 indicated poor; 5 indicated very poor), number of working years, whether the COVID-19 patients they had treated died, whether they nursed/treated seriously ill COVID-19 patients, and whether their family members had been infected with COVID-19. This questionnaire was completed only at T1; (2) the Self-Rating Scale of Sleep (SRSS),[23] which is composed of 10 items with scores of 1-5 points per item. The higher the score was, the worse the participant's sleep problems. According to the report, the Chinese public's average score was 22.14 ± 5.48;[24] (3) the Generalized Anxiety Scale (GAD-7) and the 9-item Patient Health Questionnaire (PHQ-9),[25 26] which are the simplest scales used to evaluate levels of anxiety and depression. The GAD-7 consists of 7 items that receive 0-3 points each. The cut-off points for mild/moderate/severe anxiety were 5, 10, and 15, respectively. The PHQ-9 is composed of 9 items that receive 0-3 points each. The cut-off points for mild/moderate/moderately severe/severe depression were 5, 10, 15, and 20, respectively.

Statistical analysis

Descriptive statistics were computed for all variables. The mean scores were then used for

comparison among groups using paired T test statistics. The chi-square test was used to detect the differences in levels of anxiety and depression at different time points. Because the total GAD-7 and PHQ-9 scores were both close to a normal distribution, we used multiple linear regression with the stepwise method to screen the influencing factors for anxiety and depression. A P value of < 0.05 was considered statistically significant. All statistical analyses were carried out using the Statistical Package for Social Science (version 11.0, IBM Corp).

Patient and Public Involvement

No patient involved.

3. Results

Demographic data

There were 963 subjects who completed both surveys, among whom 521 were male and 442 were female. The age range was 23-40 years old, with an average age of 30.33 ± 4.48 years. Regarding marital status, 488 subjects were married, and 475 were unmarried. Among them, there were 702 nurses and 261 physicians (all of them were clinical physicians). The number of working years of all subjects ranged from 2 to 20 years, with an average of 8.63 ± 4.44 years. Eighty-one subjects reported a history of psychosis, including 69 with anxiety disorder and 12 with depression (all psychosis should be diagnosed by psychiatrists). Other demographic details and experiences related to the pandemic are shown in Table 1.

Table 1. The distribution of demographic characteristic and pandemic experiences (n=963).

Variables and assignment	Means / N (%)
Gender	
Man (1)	521 (54.1)
Woman (2)	442 (45.9)
Ages (years)	30.33 ±4.48
Marriage	
Unmarried (1)	475 (49.3)
Married (2)	488 (50.7)
Widowed (3)	0
Highest Education	
Secondary (1)	70 (7.3)
Junior (2)	351 (36.4)
Undergraduate (3)	484 (50.3)
Graduate (4)	58 (6.0)
Professional technical title	
Novice (1)	518 (53.8)
Middle (2)	361 (37.5)
Senior (3)	84 (8.7)
Occupation	
Nurse (2)	702 (72.9)
Physician (1)	261 (27.1)

History of psychosis	
Yes (1)	81 (8.4)
No (2)	882 (91.6)
Self-perceived health conditions	
Very good (1)	224 (23.3)
Good (2)	598 (62.1)
Average (3)	141 (14.6)
Poor (4)	0
Very poor (5)	0
Working years (years)	8.63 ±4.44
Whether the patients they treated had died	
Yes (1)	306 (31.8)
No (2)	657 (68.2)
Whether nursed/treated seriously ill patients with COVID-19	
Yes (1)	908 (94.3)
No (2)	55 (5.7)
Whether their family members had been infected with COVID-19	
Yes (1)	31(3.2)
No (2)	932 (96.8)

The SRSS, GAD-7, and PHQ-9 scores at different time points

Overall, the mean SRSS score of all the subjects was significantly higher than the national norm of the SRSS (22.14 ± 5.48) at both T1 and T2 (t=14.656, 14.064; p<0.001), indicating that the subjects' sleep quality was poor. The mean GAD-7 and PHQ-9 scores at T1 and T2 both indicated moderate anxiety and moderate depression among all the subjects.

When looking into the longitudinal changes in the scores of these three scales, there were no significant differences in the SRSS scores or in the GAD-7 scores between T1 and T2 (t=0.994, 0.288; p>0.05), which means the sleep quality and the anxiety levels of the subjects did not show significant changes. However, the PHQ-9 score at T2 was significantly higher than the score at T1 (t=-10.812, p<0.001), which demonstrates that the depressive symptoms of the subjects had further deteriorated. The detailed data of the three scales are listed in Table 2.

Table 2. The disparity between the two time-points on the mean scores of SRSS, GAD-7, and PHQ-9 (n = 963).

	T1 (Mean± SD)	T2 (Mean± SD)	t	*P*
SRSS	25.20 ± 6.48	24.91 ± 6.12	0.994	0.320
GAD-7	13.04 ± 3.87	13.03 ± 3.80	0.288	0.774
PHQ-9	14.70 ± 4.70	14.96 ± 4.62	-10.812	<0.001

The rates of different degrees of anxiety and depression at different time points

We used the chi-square test to determine the differences in the rates of different degrees of anxiety and depression over time and found that there were no significant differences in the rates of mild, moderate, and severe anxiety at the two time points (χ^2 = 1.399; 1.528; 0.083, df = 1, p >0.05). The rates of mild depression showed a significant decrease from T1 to T2 (χ^2 = 6.687, df = 1, p=0.012), and no significant change was found in the rates of other levels of depression (χ^2 = 0.052; 3.823; 0.019, df = 1, p >0.05). The detailed comparison results and the distribution of severity of anxiety and depression are listed in Table 3 and Figure 1.

Table 3. The rates of different degrees of anxiety and depression symptoms among different time points (n = 963).

	T1 % (n)	T2 % (n)	χ^2	*P*
GAD-7				
No anxiety	0	0	-	-
Mild anxiety	21.7 (209)	19.5 (188)	1.399	0.260
Moderate anxiety	43.8 (422)	46.6 (449)	1.528	0.234
Severe anxiety	34.5 (332)	33.9 (326)	0.083	0.810
PHQ-9				
No depression	0	0	-	-
Mild depression	12.5 (120)	8.8 (85)	6.687	0.012
Moderate depression	50.1 (482)	49.5 (477)	0.052	0.855
Moderately severe depression	24.8 (239)	28.9 (277)	3.823	0.057
Severe depression	12.7 (122)	12.9 (124)	0.019	0.946

Multiple linear regression analysis of long-term influencing factors of the GAD-7 and PHQ-9 total scores

To build the prediction model, we included all the demographic variables and experiences related to the pandemic as independent variables. The assignments of all variables are shown in Table 1. Because sleep quality is usually associated with anxiety and depression, we also considered the SRSS score at T1 as one of the independent variables.

Through multiple linear regression, we found that the following factors could predict higher GAD-7 and PHQ-9 scores at T2: male sex, unmarried marital status, having a job title of nurse or a lower professional technical title, having a history of psychosis, having nursed/treated seriously ill COVID-19 patients, having relatively poor self-perceived health conditions, having the patients they treated die, and having family members infected with COVID-19. Subjects with fewer working years showed higher GAD-7 scores, and younger respondents showed higher PHQ-9 scores. The F values (11, 951) in the regression equation were 120.160 and 271.902 (P < 0.001) for the GAD-7 and PHQ-9 scores, respectively. The adjusted R squared values were 0.577 and 0.756, which means that the screened influencing factors could effectively explain 57.7% and 75.6% of the variance in the two models. The results of the influencing factors of the GAD-7 and PHQ-9 scores are listed in Table 4 and Table 5.

Table 4. The multiple linear regression analysis of influencing factors of GAD-7.

Variable	Regression coefficients	Standard error of regression coefficient	Standardized regression coefficient	*t*	*P*	*95% CI*
Constant	26.394	1.432		18.432	< 0.001	(23.584, 29.204)
Gender	-3.402	0.195	-0.446	-17.406	< 0.001	(-3.786, -3.019)
History of psychosis	-3.340	0.359	-0.244	-9.308	< 0.001	(-4.044, -2.636)
Whether nursed/treated seriously ill patients with COVID-19	-6.174	0.392	-0.377	-15.732	< 0.001	(-6.945, -5.404)
Self-perceived health conditions	2.234	0.158	0.359	14.169	< 0.001	(1.925, 2.544)
Whether the patients they treated had died	-2.195	0.240	-0.269	-9.142	< 0.001	(-2.666, -1.724)
Whether their family members had been infected with COVID-19	-2.700	0.537	-0.125	-5.030	< 0.001	(-3.753, -1.646)
Marriage	-0.732	0.222	-0.096	-3.292	0.001	(-1.168, -0.296)
Occupation	1.731	0.301	0.202	5.748	< 0.001	(1.140, 2.322)
Professional technical title	-1.551	0.253	-0.265	-6.126	< 0.001	(-2.047, -1.054)
Working years	-0.091	0.029	-0.106	-3.165	0.002	(-0.147, -0.035)

F (11, 951) = 120.160 (P < 0.001), R = 0.763, R^2 = 0.577

Table 5. The multiple linear regression analysis of influencing factors of PHQ-9.

Variable	Regression coefficients	Standard error of regression coefficient	Standardized regression coefficient	*t*	*P*	*95% CI*
Constant	37.648	1.618		23.267	< 0.001	(34.472, 40.823)
Gender	-1.482	0.196	-0.160	-7.559	< 0.001	(-1.866, -1.097)
History of psychosis	-10.461	0.332	-0.629	-31.543	< 0.001	(-11.112, -9.811)
Whether nursed/treated seriously ill patients with	-5.280	0.350	-0.266	-15.069	< 0.001	(-5.967, -4.592)

COVID-19						
Self-perceived health conditions	1.930	0.150	0.255	12.879	< 0.001	(1.636, 2.224)
Whether the patients they treated had died	-2.232	0.220	-0.225	-10.164	< 0.001	(-2.662, -1.801)
Whether their family members had been infected with COVID-19	-4.217	0.510	-0.161	-8.272	< 0.001	(-5.218, -3.217)
Marriage	-1.480	0.216	-0.160	-6.858	< 0.001	(-1.903, -1.056)
Occupation	1.283	0.278	0.124	4.619	< 0.001	(0.738, 1.829)
Professional technical title	-2.221	0.292	-0.313	-7.608	< 0.001	(-2.794, -1.648)
Age	-0.350	0.043	-0.340	-8.129	< 0.001	(-0.434, -0.265)

F (11, 951) = 271.902 ($P < 0.001$), R = 0.871, $R^2 = 0.756$

4. Discussion

Through this longitudinal survey, we discovered that one year after the first outbreak of the pandemic, sleep quality and anxiety levels remained stable among the 963 health care workers who voluntarily went to Hubei to provide medical support, while their levels of depression showed an obvious increase compared with their condition in their first month of assistance. Initial demographics including gender/sex, marital status, occupation, professional technical titles, psychosis history and their experiences with pandemic-defeating work might predict the degree of anxiety and depression in the long term.

Notably, compared with the score at T1, the mean SRSS score showed no significant change one year after our subjects' assistance missions during the outbreak of COVID-19, both of which were significantly worse than that of the national norm, which demonstrates that the sleep quality of our subjects remains poor although they have been back to their own workplace for a long time. One study investigating the impact of assistance work on healthcare workers discovered that poor sleep quality was still common one month after they arrived in Hubei during the COVID-19 outbreak,[17] which was similar to our finding. However, no literature continues to study how their sleep quality changes one year later, and our results could make up the margin. The reason why their sleep quality was still poor over a long period of time might depend on the nature of their job, such as over-loaded work,[27] and the night-shift rules,[28] which can make their sleep poor, while the subsequent repeated outbreaks of COVID-19 in different scales in China keep them at high alert, which might also be related to their poor sleep quality.[28]

With regard to the mean scores on the GAD-7 and PHQ-9, we found that the respondents' anxiety scores did not show significant changes from T2 to T1, while their depression scores increased significantly, and all of them had a moderate level of depression, which indicated that the mental health of these healthcare workers was still poor one year later, and that the pandemic's impact on this special group might persist for a long time. To our surprise, no respondents reported

themselves as having no anxiety and/or depressive symptoms in either survey. Many studies have revealed that the prevalence of anxiety and depressive symptoms in medical staff working in the areas most affected by the COVID-19 pandemic was high; [12 29-31] the prevalence of anxiety ranged from 23-34%, and the prevalence of depression ranged from 15-27% according to various meta-analyses.[32-34] The reason for the obviously different prevalence of anxiety and depression symptoms in our results might be due to the different tools used and the different stages in which the surveys were conducted.[35] The subjects in our study belong to the special group who had to face the unknown new virus, and many of them may not have had previous experience with a serious pandemic; the complex COVID-19 facing environments in the new workplace and the strict closed-loop management during their time in Hubei might have caused them more emotional stress.[36] Hence, it is not surprising that all of the healthcare workers showed some extent of anxiety and depression symptoms in the initial phase.

However, after their return, we uniquely found that they continued to have high levels of anxiety and depression. López et al. found that from the first measurement to the four-month follow-up in their study, more healthcare workers presented anxiety and depression during the pandemic.[16] Because there was no literature investigating the long-term impact of COVID-19 on healthcare workers, we could only refer to the experiences of past pandemics when setting up our research. We know that the symptoms of anxiety and depression were still common among healthcare workers within one to three years after the SARS outbreak.[37 38] We could see the profound and persistent impact caused by that pandemic. However, there are differences between COVID-19 and SARS. COVID-19 has been repeatedly ongoing, which might keep healthcare workers in a constant state of being alert or preparing for outbreaks, guarding against unexpected contacts, and facing the risk of infection or transmission to their family members,[39 40] which could be torturous and exhausting. Therefore, the mental health of our subjects remained poor one year later. When looking at the depression score, it deteriorated further at T2, and more subjects reported moderately severe depression at T2, which indicates that the degree of depression worsened over time. One probable reason might be the delayed reaction caused by serious disaster-related events.[41 42] Another reason might be the recession of anxiety. Healthcare workers with an overload of emotional pressure may become exhausted; as time passes, they do not have enough energy to worry, and they gradually develop more severe depression.[43]

According to our results, the long-term influencing factors for anxiety and depressive symptoms were similar regarding aspects of experiences related to COVID-19, including having nursed/treated seriously ill COVID-19 patients, having the patients they treated die, and having family members infected with COVID-19, which could predict the prevalence of anxiety and depression in our subjects. Other reports also revealed that poorer mental health was associated with managing COVID-19 patients and family exposure to COVID-19.[19 44]

Regarding demographic factors, we found that healthcare workers with a history of psychosis were more prone to show anxiety and depressive symptoms, which was similar to the findings of other studies.[13 16 17] We also discovered that those who thought of themselves as having relatively poor health experienced more anxiety and depression, which was similar to the findings of Manara et al.[45] Another factor screened was gender/sex, and we found that male healthcare workers tended to report more anxiety and depression symptoms, which was contrary to previous studies. [46 47] The reason may be that the age of male aid workers is generally older, and their physical strength and energy recovery level would therefore not be as fast as that of young women. Thus, they are more

prone to fatigue. In addition, women are considered to be more willing to express their feelings through language than men,[48] which might seem to be another kind of emotional release leading to less negative emotions being stored.[49]

Individuals with other factors, including being unmarried, being a nurse, and having a lower professional technical title, were prone to present greater anxiety and depression, which was in contrast to Cai et al.'s report.[50] We all know that communication with family and companions are important sources of social support,[51] but unmarried individuals do not have the support of spouses. Due to the large number of infected patients in Hubei Province, more nurses were required to care for them and to conduct clinical treatment activities, such as blood sampling, infusions and medication distribution. The great workload undoubtedly added more pressure for nurses than physicians, and the nurses were relatively young with lower professional technical titles and less experience, making them vulnerable to distress.[44] Finally, we found that healthcare workers with fewer working years were more likely to become anxious, and younger individuals were more likely to become depressed, which was similar to previous findings.[13 44 46]

Conclusions

The COVID-19 outbreak beginning in late 2019 has been spreading for almost 2 years. After the sudden outbreak of COVID-19, the shortage of PPE placed additional stress on professional healthcare workers. However, there has been little information on the changes in the mental health of healthcare workers who went to Hubei to offer assistance. This is the first study investigating the longitudinal mental health of front-line healthcare workers who went to Hubei to assist other health professionals during the initial COVID-19 outbreak and 1 year later. We found that sleep quality and anxiety levels remained stable among the healthcare workers, while their depression levels showed obvious increases. The initial demographics and experiences related to the pandemic played an important role in predicting the long-term mental health of these special healthcare workers.

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Contributors: ND was in charge of this study, supervising the process and of providing expert opinion. PZ and ND organized the study design and analyzed the data. Collaborators YX and YGL ensured that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved. CYL and TG participated in conducting the survey and typing the data. PZ wrote the first draft of the manuscript, and ND critically revised it. PZ, ND, YX, YGL, CYL, and TG approved the final version of the manuscript.

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Patient consent for publication: Not applicable.

Ethics approval: This study involves human participants and was approved by the

the Institutional Review Board of the Fourth People's Hospital of Chengdu. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review: Not commissioned; externally peer reviewed.

Data availability statement: Data are available on reasonable request.

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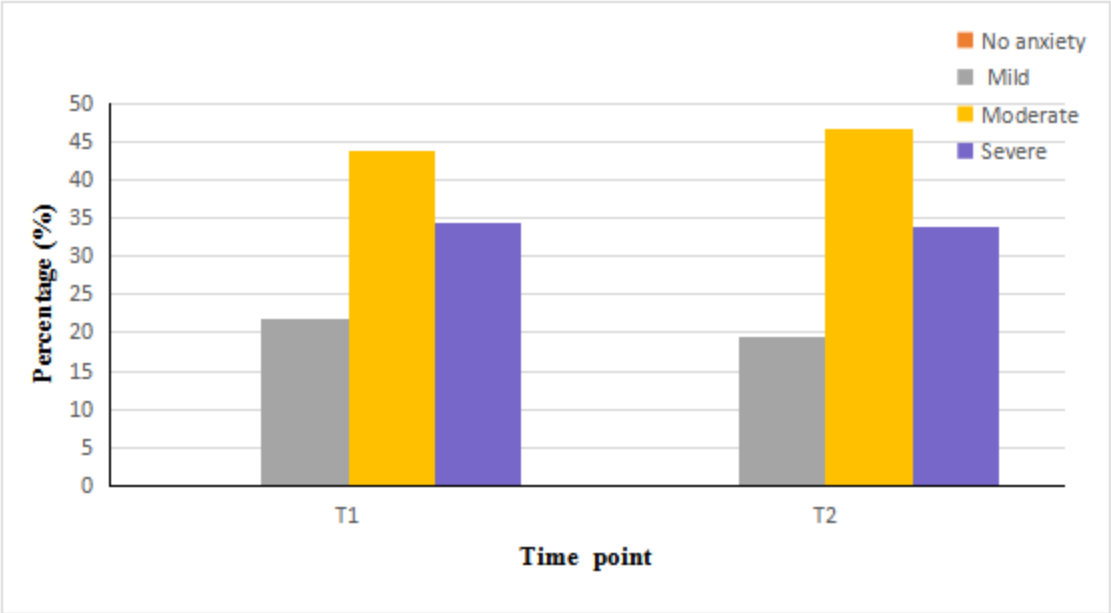
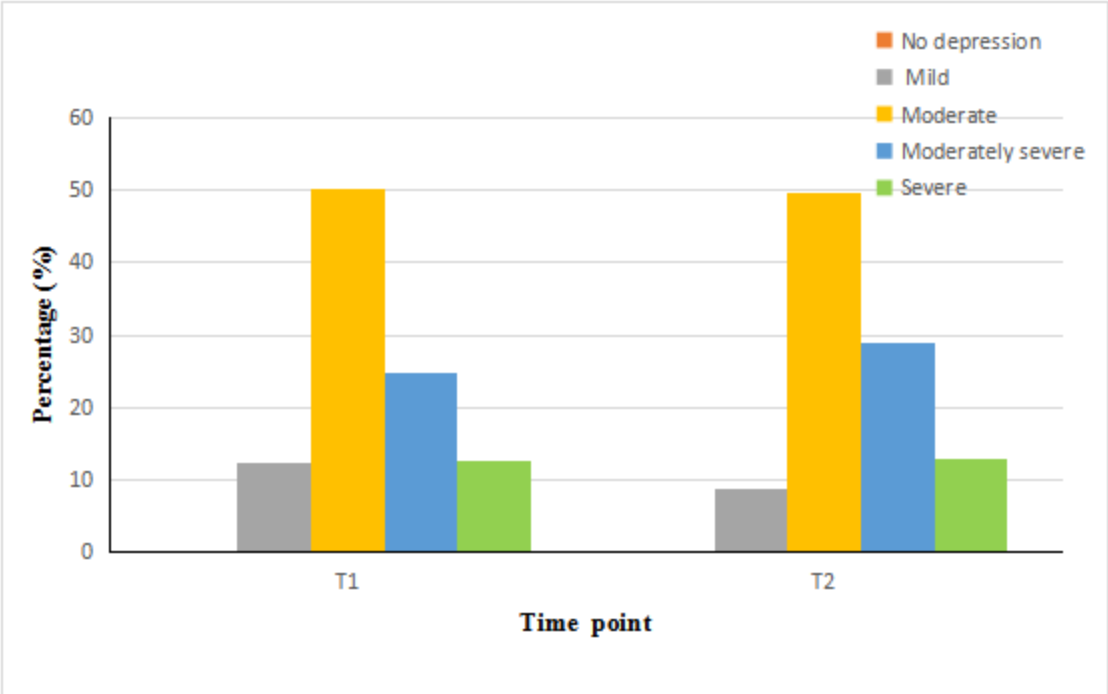
Figure legend:

Figure 1. The distribution of severity of anxiety and depression over time. The first figure stands for the anxiety level, and the second one stands for the depression level.


No anxiety
Mild
Moderate
Severe
Percentage (%)
50
45
40
35
30
25
20
15
10
5
0
T1
T2
Time point


No depression
Mild
Moderate
Moderately severe
Severe
Percentage (%)
60
50
40
30
20
10
0
T1
T2
Time point

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3-4
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*4*
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	4
		(*e*) Describe any sensitivity analyses	N/A

Continued on next page

Results			
Participants	13 *	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	4
		(c) Consider use of a flow diagram	N/A
Descriptive data	14 *	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	4
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	4
Outcome data	15 *	*Cohort study*—Report numbers of outcome events or summary measures over time	*4*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5
		(*b*) Report category boundaries when continuous variables were categorized	6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	2
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.