



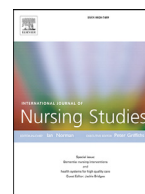
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Prevalence and associated factors of depression and anxiety among nurses during the outbreak of COVID-19 in China: A cross-sectional study

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ABSTRACT

Background: Coronavirus disease 2019 (COVID-19) is a public health emergency of international concern and has caused traumatic experience for nurses worldwide. However, the prevalence of depression and anxiety symptoms in nurses, and how psychosocial factors influence nurses in this public crisis are unknown.

Objectives: To determine the effect of COVID-19 on the mental health of nurses and the prevalence of anxiety and depression symptoms among nurses in China during the outbreak.

Design: A cross-sectional study.

Settings and participants: A total of 3,228 nurses in Sichuan Province and Wuhan City were selected by convenience sampling. All participants were invited to complete the questionnaire through WeChat from January 27 to February 3, 2020.

Methods: A self-reported questionnaire combining depression and anxiety scale was used to collect data anonymously. Binary and multivariate logistic regression was applied to measure the odds of psychosocial factors of anxiety and depression and perceived health, respectively.

Results: The total incidence of depression (34.3%) and anxiety (18.1%) during the COVID-19 outbreak was lower than that during the SARS outbreak; however, the rate of depression in our study (47.1%) was high and similar in a recent study (50.4%) about the health care workers exposed to COVID-19 in China. The results indicated that COVID-19-related stress, relationship quality with family, and demographic characteristics were associated with depression, anxiety, and perceived health status. Furthermore, the prevalence of depression was similar between nurses working in low-risk COVID-19 wards as high as working in high-risk COVID-19 wards (OR, 1.078; 95% CI, 0.784–1.481).

Conclusions: Our study revealed the high prevalence of depression and anxiety among nurses during the outbreak of COVID-19. COVID-19 factors and psychosocial factors were associated with mental health of nurses. The results suggest that hospitals should implement effective mental health promotion programs focused on occupational safety and family support to improve the well-being of nurses.

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What is already known about the topic?

- Coronavirus disease 2019 (COVID-19) is a traumatic experience among nurses in China and imposes a significant economic burden on society. Depression and anxiety are associated with several work-related factors, including high work demands, low job control, effort-reward imbalance, and the high risk of exposure.

What this paper adds

- This study shows that COVID-19-related stress, relationship quality with family, and demographic characteristics are associated with depression and anxiety and perceived health status. Our results indicated that the prevalence of depression was similar between nurses working in low-risk COVID-19 wards as was as high as working in high-risk COVID-19 wards.

1. Introduction

1.1. COVID-19

The Municipal Health Commission of Wuhan, the capital of Hubei Province in China, notified an outbreak of atypical pneumonia caused by a novel coronavirus, designated severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the International Committee on Taxonomy of Viruses ([Coronaviridae Study Group of the International Committee on Taxonomy of Viruses 2020](#)). This entity was named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO) on February 11, 2020, and the type of pneumonia was designated novel coronavirus pneumonia. COVID-19 spread to 215 countries or territories, and caused 8.8 million confirmed cases of pneumonia as of July 26, 2020 ([WHO, 2020](#)). SARS-CoV-2 is the third most pathogenic human coronavirus that has emerged in the last two decades ([Perlman, 2020](#)), after severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) ([de Wit et al., 2016](#); [Cui et al., 2019](#)). Since December 2019, when COVID-19 emerged in Wuhan and rapidly spread throughout China, the government has suspended all public transportation services in Wuhan on January 23, 2020, to prevent viral spread. Many details of the emergence of SARS-CoV-2 such as its origin and transmission dynamics remain unknown ([Munster et al., 2020](#); [Q. Li et al., 2020](#)). As of February 14, 1716 confirmed cases of infection of medical staff were reported, with six deaths ([Epidemiology Working Group for NCIP Epidemic Response, Chinese Center for Disease Control and Prevention 2020](#)). COVID-19 has caused depression, anxiety, and fear across China during the outbreak of this public crisis.

1.2. Psychological factors

There are an estimated 322 million people with depressive symptoms and 264 million with anxiety worldwide ([WHO, 2017](#)). Moreover, nurses experienced higher rates of depression compared to the general population, especially in the face of health emergencies ([Dyrbye et al., 2014](#)). During the SARS outbreak, 57% of nurses working in Hong Kong developed symptomatic depression ([Tam et al., 2004](#)), 29–35% had high levels of distress in Canada ([Mauder, 2004](#)), and 68% had high levels of stress in Taiwan ([Tzeng, 2003](#)). SARS-CoV infections among medical staff represented more than 22% of all infection cases in Hong Kong, leading to negative emotions such as depression and anxiety ([WHO, 2004](#)). Specific stressors associated with emotional distress include the lack of effective treatment ([Lau and Chan, 2005](#)), high work demands ([Rau et al., 2010](#)), low job control ([Dragano et al., 2008](#)), effort-reward imbalance ([Pikhart et al., 2004](#)), work-family conflict

([Chandola et al., 2004](#)), and the life-threatening nature of the disease, especially direct exposure to SARS patients ([Su et al., 2007](#)). Severe psychological problems may compromise physical, mental, and social health, increasing suicide risk ([Kapur et al., 2016](#)).

1.3. Social factors

SARS, MERS, and COVID-19 have caused fear and anxiety worldwide ([Mauder et al., 2004](#); [Wu et al., 2009](#); [Al Knawy et al., 2019](#); [Lai et al., 2020](#)). Understanding the impact of COVID-19 infection control on personal and family health helps plan emergency responses to future infectious disease outbreaks. First, nursing workload and long working hours are significant predictors of mental health ([Helen et al., 2019](#)). Nurses who are assigned unfamiliar tasks appear to suffer a higher risk of anxiety than other nurses doing familiar work ([Mauder et al., 2004](#)). A study reported that health care workers at high risk of contracting SARS were more likely to have a higher prevalence of depression and anxiety, and develop post-traumatic stress during the SARS epidemic ([McAlonan et al., 2007](#)). In addition, the relationship quality with family is important since it can improve psychological distress. Some studies reported that work-family satisfaction was negatively correlated with psychological distress ([Ford et al., 2007](#); [Barnett et al., 2019](#); [Oshio et al., 2017](#)). Social support is known to reduce depression and anxiety, and family support is associated with lower anxiety levels among nurses ([Chen et al., 2006](#)). Although the transmission of SARS-CoV-2 in the early phase of the outbreak remains largely unknown, there is evidence that the risk of SARS-CoV infection and the level of emotional exhaustion is higher among nurses ([Brooks et al., 2018](#)). Therefore, work stress, family dissatisfaction, and infectious disease exposure are more strongly related to psychological distress. Managing psychological distress can improve the physical, mental, and social health of nurses.

1.4. Aims of the study

The objective of this study is to assess the prevalence rates of depression and anxiety in nurses during the first COVID-19 epidemic through a questionnaire survey. The factors associated with the mental health of nurses were determined to provide the basis for establishing psychological intervention programs for these professionals. In this study, we hypothesize that COVID-19-related stress, relationship quality with family, and perceived health status are associated with the risk of depression and anxiety.

2. Methods

2.1. Study design and participants

A total of 5300 nurses in Sichuan Province and Wuhan City were selected in this cross-sectional study by convenience sampling. All participants were invited to complete the questionnaires from January 27, 2020, to February 3, 2020. We invited 35 volunteers (29 coordinators of regional hospital network established by West China Hospital, and 6 members of the Nursing Academy Specialty Committee) from 35 hospitals to investigate their hospital nurses. A professional questionnaire survey platform called "Wenjuan Xing" was used to investigate psychological health of participants through 46 WeChat groups (number of participants range from 83 to 395). We defined pneumology, infection, fever clinics, isolation wards, or ICUs as high-risk Covid-19 wards, and general outpatient or emergency wards as middle-risk Covid-19 wards, defined other wards as low-risk Covid-19 wards. In this study, a self-made questionnaire combining the Self-rating Depression Scale (SDS) and Self-rating Anxiety Scale (SAS) was used to

Table 1
Main questions in the questionnaire.

Questions	Options
COVID-19-related stress	
1. Did you feel the fear of SARS-CoV-2 infection?	Not at all, a little, very much
2. Did you concern for unknown origin of SARS-CoV-2?	Not at all, a little, very much
3. Did you worry about lack of effective treatment of COVID-19?	Not at all, a little, very much
4. Did you worry about poor social support during the COVID-19 pandemic?	Not at all, a little, very much
5. Did you worry about poor patient compliance during the COVID-19 pandemic?	Not at all, a little, very much
6. Were you overworked for taking care of patients during the COVID-19 pandemic?	Not at all, a little, very much
Relationship quality with family	
1. How would you rate your couple relationship quality during the COVID-19 pandemic?	Bad, ordinary, good
2. How would you rate your parent-child relationship quality during the COVID-19 pandemic?	Bad, ordinary, good
3. How would you rate your relationship quality with other family members during the COVID-19 pandemic?	Bad, ordinary, good
Perceived health	
1. How would you rate your personal or family health during the COVID-19 pandemic?	Poor, good, excellent

conduct an anonymous survey with the permission of the research ethics committees of the participating hospitals. Participants were informed about the aims of the study and importance of enrollment. A total of 3228 nurses answered the questionnaire, corresponding to a response rate of 60.91%.

2.2. Questionnaire

2.2.1. Demographic characteristics

Demographic data, including gender, age, education level, hospital department, job position, type of hospital, city of residence, and exposure level, were collected. High exposure level are defined as nurses who care for, close contact, or live with Covid-19 patients; elevated exposure level are defined as one Covid-19 patient or more are found in nurses' department, public transportation, or community; normal exposure level are defined as no Covid-19 patient is found in nurses' department, public transportation, or community.

2.2.2. Stressors

We have developed a self-reported questionnaire (Table 1) base on psychosocial factors during the SARS and Covid-19 epidemic (Nickell et al., 2004; Reznik et al., 2020). The questionnaire contained ten main items: unknown origin of COVID-19, fear of infection, lack of effective treatment, poor patient compliance, nursing workload, poor social support, parent-child relationship quality, couple relationship quality, relationship quality with other family members, and perceived health status.

2.2.3. Self-rating depression scale

The 20-item SDS was used to evaluate depressive symptoms (Zung, 1965). The SDS evaluates affective, psychological, and somatic symptoms associated with depression in adults and served as a reliable and valid tool to assess depressive symptoms in the Chinese population (Gong et al., 2014). Responses were scored from 1 (never or rarely) to 4 (usually or always). 10 items on positive symptoms and 10 items on negative symptoms. The total score ranged from 25 to 100 and was obtained by multiplying the total original score by 1.25, with higher scores indicating more severe depression. Depression was classified as mild (50–59 points), moderate (60–69 points), and severe (>70 points). In this study, Cronbach's α coefficient for this scale was 0.892.

2.2.4. Self-rating anxiety scale

The 20-item SAS (Zung, 1971) was utilized to evaluate anxiety symptoms. The SAS is widely used and has good accuracy to evaluate psychometric properties in the Chinese population (Tao and Gao, 1994). Responses were scored from 1 (never or rarely) to 4 (usually or always), and the total score ranged from 25 to 100. The total score was determined as the original score multiplied by 1.25.

Anxiety was classified as none (25–49 points), mild (50–59 points), moderate (60–69 points), and severe (70–100 points). The Cronbach's α coefficient of this scale was 0.865.

2.3. Data analysis

Data were analyzed using SPSS software version 25.0. Descriptive statistics were used to determine the distribution of demographic characteristics, including gender, age, education level, hospital department, exposure level, and so on. Continuous variables were reported as means and standard deviations. Categorical variables were expressed as absolute values and percentages. Bivariate and multivariate logistic regression was used to measure the risk factors of anxiety, depression and perceived health, respectively. The bivariate logistic regression analyses were used to estimate the odds ratio for each independent variable, to assess which of the factors associated with depression and anxiety. Multivariate logistic regression analysis was used with potential associated characteristics (demographic characteristics, COVID-19-related stress, and relationship quality with family) as independent variables and perceived health status as dependent variable. A two-sided p-value of less than 0.05 was considered statistically significant.

2.4. Ethical approval

The participating hospitals' research ethics committees approved this study. The first section of the questionnaire mainly included informed consent, participants will read the informed consent at first, if they agree to participate in the study they will click "I agree" to complete the following survey. The questionnaire survey was anonymous, and personal information was not disclosed, except for demographic data.

3. Results

3.1. Demographic characteristics

A total of 3228 nurses were enrolled, and their demographic characteristics are summarized in Table 2. Most of the study population were women, accounting for 96.7% of the total, and 89.5% of them were aged ≤ 39 years old. In addition, 13.6% of the participants worked in high-risk COVID-19 wards, 18.0% exposed to high level of COVID-19, and 1.1% worked in Wuhan.

3.2. Prevalence of depression and anxiety symptoms

The rate of depression and anxiety in the study sample is shown in Table 3. The total prevalence of depression and anxiety

Table 2
Demographic characteristics of the study subjects (n = 3228).

Characteristic	n	%
Gender		
Male	107	3.3%
Female	3121	96.7%
Age, yr		
<29	1522	47.1%
30–39	1368	42.4%
40–49	247	7.7%
>50	91	2.8%
Education level		
College degree or lower	1076	33.3%
Undergraduate degree	2137	66.2%
Master or higher	15	0.5%
Professional titles		
Primary title	2344	72.6%
Intermediate title	742	23.0%
Senior title	142	4.4%
Hospital department		
Low-risk Covid-19 wards	2417	74.9%
Middle-risk Covid-19 wards	373	11.5%
High-risk Covid-19 wards	438	13.6%
Hospital		
Tertiary general hospital	3148	97.5%
Tertiary specialist hospital	44	1.4%
Other	36	1.1%
City		
Wuhan	35	1.1%
Chengdu	1191	36.9%
Other cities in Sichuan Province	2002	62.0%
Exposure level		
high	582	18.0%
elevated	231	7.2%
normal	2415	74.8%

Table 3
Prevalence of depression and anxiety among nurses during the early phase of the COVID-19 pandemic.

	No. (%) Total (n = 3228)	No. (%) Care for COVID-19 patients (n = 285)
Depression	1107(34.3)	134(47.1)
Mild	728(22.6)	60(21.1)
Moderate	317(9.8)	57(20.0)
Severe	62(1.9)	17(6.0)
Anxiety	585(18.1)	81(28.4)
Mild	463(14.3)	42(14.7)
Moderate	94(2.9)	30(10.5)
Severe	28(0.9)	9(3.2)

among nurses were 34.3% and 18.1%, respectively. The rates of depression and anxiety in nurses who cared for the COVID-19 patients was 47.1% and 28.4%, respectively.

3.3. Risk factors associated with depressive symptoms

The results from the binary logistic regression analysis are presented in Table 4. The factors COVID-19-related stress and poor relationship quality with family increased the risk of depression. Nursing workload (OR, 1.319; 95% CI, 1.167–1.492), unknown origin (OR, 1.190; 95% CI, 1.045–1.355), the fear of infection (OR, 1.146; 95% CI, 1.103–1.191), bad couple relationship (OR, 1.358; 95% CI, 1.213–1.520), and poor family members relationship (OR, 1.455; 95% CI, 1.294–1.635) were associated with a higher risk of depressive symptoms. Nurses working in high-risk and low-risk Covid-19 wards were at a higher level of depression than those working in middle-risk Covid-19 wards. The city of residence and type of hospital also influenced the risk of depression, and this risk was higher among those working in Wuhan and general tertiary hospitals.

3.4. Risk factors associated with anxiety symptoms

The results from the binary logistic regression analysis of the factors associated with anxiety are shown in Table 5. Nursing workload (OR, 1.432; 95% CI, 1.218–1.683), unknown origin (OR, 1.260; 95% CI, 1.063–1.495), and the fear of infection (OR, 1.132;

Table 4
Binary logistic regression analysis of the factors associated with depression.

Variable	B	OR	95% CI
COVID-19-related stress			
Nursing workload	0.277	1.319***	(1.167, 1.492)
Unknown origin	0.174	1.190**	(1.045, 1.355)
Fear of infection	0.136	1.146***	(1.103, 1.191)
Relationship quality with family			
Couple relationship	0.306	1.358***	(1.213, 1.520)
Family members relationship	0.375	1.455***	(1.294, 1.635)
Demographic characteristics			
Department			
Low-risk Covid-19 wards		1	reference
Middle-risk Covid-19 wards	−0.284	0.753*	(0.595, 0.952)
High-risk Covid-19 wards	0.075	1.078	(0.784, 1.481)
Hospital			
General tertiary		1	reference
Specialized tertiary	−1.078	0.340**	(0.159, 0.728)
Others	−1.235	0.291*	(0.102, 0.828)
City of residence			
Wuhan		1	reference
Chengdu	0.086	1.090	(0.530, 2.242)
Other cities in Sichuan Province	−0.326	0.722***	(0.604, 0.862)

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$; OR, odds ratio; 95% CI, 95% confidence interval; COVID-19, coronavirus disease.

Table 5
Binary logistic regression analysis of the factors associated with anxiety.

Variable	B	OR	95% CI
COVID-19-related stress			
Nursing workload	0.359	1.432***	(1.218, 1.683)
Unknown origin	0.231	1.260**	(1.063, 1.495)
Fear of infection	0.124	1.132***	(1.080, 1.879)
Relationship quality with family			
Parent-child relationship	0.136	1.146**	(1.034, 1.270)
Family members Relationship	0.381	1.464***	(1.290, 1.660)
Perceived health status			
Demographic characteristics			
City of residence			
Wuhan		1	reference
Chengdu	−0.674	0.510	(0.201, 1.292)
Other cities in Sichuan Province	−0.521	0.594***	(0.470, 0.750)
Exposure level			
High	0.446	1.562***	(1.222, 1.997)
Elevated		1	reference
Normal	0.266	1.305	(0.906, 1.879)

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$; OR, odds ratio; 95% CI, 95% confidence interval; COVID-19, coronavirus disease.

95% CI, 1.080–1.879) were associated with anxiety symptoms. Staff with a high exposure level were more likely to experience anxiety symptoms.

3.5. Risk factors associated with perceived health status

Multivariate logistic regression analysis revealed that the factors significantly associated with perceived health status were unknown origin (OR, 1.52; 95% CI, 1.204–1.940), fear of infection (OR, 1.100; 95% CI, 1.042–1.162), lack of effective treatment (OR, 1.605; 95% CI, 1.261–2.043), poor patient compliance (OR, 1.235; 95% CI, 1.039–1.469), poor social support (OR, 1.28; 95% CI, 1.083–1.512), parent-child relationship (OR, 1.422; 95% CI, 1.248–1.619), family members relationship (OR, 4.985; 95% CI, 4.098–6.064), age (OR, 0.676; 95% CI, 0.545–0.840), and female gender (OR, 0.432; 95% CI, 0.217–0.861) (Table 6).

4. Discussion

It is widely recognized that psychological and social factors are linked to work-related stress (Laferton et al., 2019), and these factors strongly affect nurses' health (Gigli et al., 2020) and clin-

Table 6
Multivariate logistic regression analysis of the factors associated with perceived health status.

Variable	B	OR	95%CI
COVID-19-related stress			
Unknown origin	0.424	1.52***	(1.204,1.940)
Fear of infection	0.096	1.100**	(1.042,1.162)
Lack of effective treatment	0.473	1.605***	(1.261,2.043)
Poor patient compliance	0.211	1.235*	(1.039,1.469)
Poor social support	0.247	1.28**	(1.083,1.512)
Relationship quality with family			
Parent-child relationship	0.352	1.422***	(1.248,1.619)
Family members relationship	1.606	4.985***	(4.098,6.064)
Demographic characteristics			
Age	-0.391	0.676***	(0.545, 0.840)
Gender			
Male	-0.839	0.432*	(0.217, 0.861)
Female		1	reference

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$; OR, odds ratio; 95% CI, 95% confidence interval; COVID-19, coronavirus disease.

ical care quality (Burton et al., 2020), especially during health crises. This large cross-sectional study compared the psychosocial effects of COVID-19 on distress symptoms and self-perceived health among nurses. To our knowledge, few studies have investigated the relationship between psychosocial factors and distress symptoms and perceived health status among nurses during public health crises. The main findings indicated that nurses experiencing COVID-19-related stress and poor relationship quality with family were more likely to develop depression and anxiety symptoms and have health concerns. Furthermore, more than one-third of the nurses manifested psychiatric symptoms of depression and anxiety based on SDS and SAS scores.

4.1. Psychological stress and associated factors

Our study found that the total prevalence of either depression or anxiety among nurses (1173/3228, 36.3%) was lower than that among nurses caring for SARS patients (69.8–75%) (Chan et al., 2005; Chong et al., 2004), and the health care workers exposed to COVID-19 (Lai et al., 2020). However, the rate of depression among nurses who cared for the COVID-19 patients was almost the same as Lai et al. study (Lai et al., 2020), and higher than that of nurses caring for SARS patients in China (Lung et al., 2009; Su et al., 2007; Chen et al., 2005; Nickell et al., 2004; Lin et al., 2007). This phenomenon may be due to the stage of the pandemic, nurses' expertise, knowledge, and experience with SARS. Most of the previous studies (Chan et al., 2005; Chong et al., 2004; Lung et al., 2009; Su et al., 2007; Chen et al., 2005; Lin et al., 2007) had focused on nurses' mental health at the mid-stage and final-stage of SARS pandemic, comparing with our study at the early stage of COVID-19 pandemic. This led to our result was inconsistent with previous studies. This result may be in part due to the fact that hospitals provided a large amount of high-quality personal protective equipment to nurses in China. The National Health Commission of China also established mental health teams to promote the emotional stability of nurses caring for COVID-19 patients in designated hospitals.

This study found that COVID-19-related stress and relationship quality with family were associated with depression and anxiety scores, which agrees with previous findings (Nickell et al., 2004). Unknown origin of SARS-CoV-2 and fear of infection were associated with higher levels of depression and anxiety in our cohort. Given that nurses were concerned about being infected, as was the case during SARS (Lau and Chan, 2005). Caring for SARS patients without being infected helped them to cope with challenging tasks and reduced the level of distress (Rima et al., 2008).

Tens of thousands of people were infected with SARS-CoV-2 in less than 2 months. Nurses who cared for COVID-19 patients for more than 1 month were quarantined for 2 weeks. This measure affected nurses' relationships with their partner, children, and other family members, and led to feelings of loneliness (Lau and Chan, 2005).

Our results showed that prevalence and scores of depression and anxiety were higher among nurses working in Wuhan and Chengdu than those working in other cities of Sichuan province. Wuhan and Chengdu are the capital of the province of Hubei and Sichuan, in the middle of China, which were facing serious prevention and control of the COVID-19 pandemic situation. COVID-19 occurred in Wuhan, Hubei Province, in December 2019, and became a pandemic, killing thousands of people in China. Lockdown was implemented in Wuhan, with a population of more than 10 million inhabitants, on January 23, 2020. Chengdu is a sprawling metropolis of more than ten million people, prevention and control of the COVID-19 pandemic situation facing very serious. However, about one thousand aid nurses in Chengdu were dispatched to hospitals in Wuhan or other cities of Hubei Province. These interventions increased mental stress among nurses living in Wuhan and Chengdu compared to those living in other cities of Sichuan province.

There was no significant difference in the prevalence of depression between nurses in high-risk and low-risk Covid-19 wards; however, the finding disagrees with previous studies on SARS (Chan et al., 2005; Rima et al., 2008; Su et al., 2007; Chen et al., 2005; Chong et al., 2004; Lin et al., 2007). This discrepancy may be due to four reasons. First, the proportion of non-severe COVID-19 patients reported in a previous study was high (926/1099) (Guan et al., 2020). Therefore, we may have neglected the fact that SARS-CoV-2-infected patients were asymptomatic or had mild cases in low-risk Covid-19 wards. Furthermore, the average incubation period of SARS-CoV-2 is 14 days. Consequently, whether patients in low-risk Covid-19 wards were infected with SARS-CoV-2 during the incubation period is unknown. Second, epidemiological evidence indicated that there were thousands of close contacts around us in China (National Health Commission of China, 2020). Therefore, nurses may have a high risk of infection in hospitals or public areas (Wang et al., 2020). Third, SARS-CoV-2 was detected by high-throughput sequencing or real-time reverse-transcriptase polymerase-chain-reaction (RT-PCR), which has a high false-negative rate (Li et al., 2020b). The period from symptom onset to diagnostic confirmation is several days. Therefore, nurses had to be on high alert in light of the risk of infection from asymptomatic patients. Fourth, personal protective equipment (PPE) was in short supply and, therefore, was initially offered to nurses working in high-risk Covid-19 wards, and not nurses working in low-risk Covid-19 wards, which may explain the same high level of depression in the two groups.

4.2. Sociocultural stress and associated factors

Our data highlighted the psychosocial factors were associated with mental health of frontline nurses who had COVID-19-related stress and poor relationship quality with family, including unknown origin, the fear of infection, poor social support, poor quality couple relationship, parent-child relationship conflict, and poor-quality relationship with other family members. These nurses are more likely to have personal and family health concerns. There is no effective treatment or vaccine for COVID-19 to date. Consequently, nurses are concerned about becoming infected through asymptomatic transmission (Chen et al., 2006), lack of effective treatment (Chen et al., 2006), inadequate supply of PPE (Chan et al., 2005; Lau and Chan, 2005), and stigmatization (Chong et al., 2004; Xiang et al., 2020). Our findings agree with previous studies indicating that having work stress and poor relationship quality with family are high-risk factors for psychosocial

distress (Chan et al., 2005; Nickell et al., 2004). A review study showed that perceived stress from the SARS epidemic was also influenced by the timing of the survey (Su et al., 2007). The nurses believed that their work environment was safer after the first peak of the SARS epidemic (Su et al., 2007). Nurses who experienced a high level of stress due to the rapid spread of COVID-19 might not have sufficient time to become better adjusted to caring for affected patients and became more concerned about personal and family health during the outbreak.

Our results revealed that perceived health status was related to age and gender. Younger female frontline nurses tended to become more concerned about personal or family health. Younger age increased the odds of mental health and PTSD during the SARS epidemic (Su et al., 2007; Sim et al., 2004). In addition, female nurses were more likely to suffer from PTSD among trauma-exposed adults (Brewin et al., 2000; Gelder et al., 2000), which may explain why younger female nurses who had more COVID-19-related stress during the COVID-19 outbreak. Therefore, this population should be given more social support to reduce symptom severity.

Frontline nurses need timely mental health care. Our group recommends emergency mental health management, which has been recently used in our hospital (Huang et al., 2020). For this purpose, our hospital established multidisciplinary mental health promotion teams, including psychiatrists, psychiatric nurses, clinical psychologists, and counselors (Xiang et al., 2020). The Department of Psychiatry developed the Huaxi emotional-distress index (HEI) for screening depression and anxiety among medical staff and patients in our hospital (Wang et al., 2017). One or two clinical psychologists and counselors ('sunny angels') from each non-psychiatric ward received systematic psychiatric training. After that, these professionals provided specialized psychiatric treatment for medical staff and patients. These workers continued to serve the medical staff and patients during the COVID-19 pandemic, especially nurses in general inpatient wards.

Second, mental health promotion programs include free-of-charge psychological counseling during health crises through mobile phones and WeChat. This safe communication channel is beneficial to individuals with mild mental problems and those with suicidality or psychological crisis, because of its accessibility and flexibility. Furthermore, medical staff and patients can benefit from psychological counseling during the COVID-19 pandemic.

Third, among the psychological treatment options, our team members usually apply cognitive-behavior therapy (CBT) because evidence has indicated that CBT can address multiple conditions, including anxiety (Asnaani et al., 2020), major depression (Felder et al., 2020), and post-traumatic stress disorder (Shalev et al., 2017). Furthermore, CBT is appropriate for people of all ages (Warwick et al., 2017; McCrae et al., 2020). Our previous study revealed that short-term group CBT could improve negative emotions and sleep, and consequently improve the quality of life of cancer patients (Zheng et al., 2015; Yuan et al., 2016).

Fourth, clear communication with rapid information updates on the COVID-19 outbreak was beneficial for disease control and prevention and for addressing public fear. China has built a daily press release system to ensure efficient and accurate disclosure of COVID-19 epidemic information (Wang et al., 2020). The Chinese government has implemented effective policies to expedite the production of personal protective equipment. In addition, Chinese hospitals accept public donations to reduce shortage of personal protective equipment.

5. Limitations

This study has some limitations. First, the cross-sectional design does not allow establishing a definitive causal link between COVID-

19-related stress, relationship quality with family, and distress symptoms. Therefore, longitudinal studies and prospective controlled studies are necessary to confirm our conclusions. Second, the participants completed the questionnaires using the WeChat application and mobile devices, which might lead to self-selection bias. Third, our self-designed questionnaire was not validated due to time constraints. We should test the reliability and validity of this scale in future research. Fourth, the sample size of Wuhan was small. Therefore, our findings need to be tested in other high risk areas for COVID-19.

Conclusions

Our findings demonstrate that the COVID-19 pandemic had significant psychosocial effects on nurses. COVID-19-related stress, relationship quality with family, and demographic characteristics were associated with depression, anxiety, and perceived health status. In addition, the prevalence of depression was similar between nurses working in low-risk and high-risk COVID-19 wards. Nurses working in a city where the disease is spreading rapidly are more likely to develop distress symptoms than those working in less affected cities. Therefore, hospitals should implement effective mental health promotion programs focused on occupational safety and family support to improve the well-being of nurses.

Conflict of Interest

The authors declare no competing interests.

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Ethical Approval

None declared

CRediT authorship contribution statement

Rujun Zheng: Methodology, Formal analysis, Writing - review & editing. **Yuhong Zhou:** Investigation, Formal analysis, Writing - original draft. **Yan Fu:** Investigation, Visualization, Writing - original draft. **Qiufen Xiang:** Resources, Investigation, Validation. **Fang Cheng:** Resources, Formal analysis. **Huaying Chen:** Resources, Investigation. **Huiqiong Xu:** Resources, Validation. **Lan fu:** Resources, Investigation. **Xiaoling Wu:** Resources, Investigation. **Mei Feng:** Resources, Investigation. **Lei Ye:** Resources, Investigation. **Yongming Tian:** Resources, Investigation. **Rong Deng:** Resources, Investigation. **Shanshan Liu:** Resources, Formal analysis. **Chunhua Yu:** Conceptualization, Validation, Supervision. **Junying Li:** Conceptualization, Methodology, Data curation.

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