


ORIGINAL ARTICLE

Anxiety and its association with perceived stress and insomnia among nurses fighting against COVID-19 in Wuhan: A cross-sectional survey

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Funding information

This research did not accept any support

Abstract

Aims and Objectives: To investigate the present status of anxiety among nurses fighting the spread of COVID-19 and its association with perceived stress and insomnia.

Background: With the outbreak of COVID-19, nurses have been caring for infected patients for a considerable length of time in Wuhan, China. Previous COVID-19 studies generally focused on patients' medical treatment, but few considered healthcare workers' psychological needs while working with a pandemic involving an unfamiliar infectious disease. Numerous nurses have experienced mental health problems, such as anxiety.

Design: The STROBE guidelines for a cross-sectional questionnaire were implemented.

Methods: An online survey of 643 frontline nurses working with COVID-19-infected patients was conducted from 3–10 March 2020. Sociodemographic data were collected, and the Generalized Anxiety Disorder Scale, the Chinese Perceived Stress Scale and the Athens Insomnia Scale were administered.

Results: One-third (33.4%) of participants reported anxiety, which was associated with perceived stress and insomnia among Chinese frontline nurses in Wuhan during the COVID-19 pandemic. Significant associations were found between anxiety, perceived stress, insomnia, working four-night shifts per week, experience working during more than two epidemics and fear of COVID-19.

Conclusions: This study found that a substantial proportion of frontline nurses caring for COVID-19-infected patients experienced anxiety. We recommend that nurse managers focus on working conditions and cultivate safe and satisfactory work environments. Meanwhile, frontline nurses should foster awareness of mental health and rely on online resources for psychological training to alleviate anxiety.

Relevance to clinical practice: The findings of this study could facilitate better understanding of anxiety among frontline nurses; more importantly, healthcare authorities and nursing managers need to pay more attention to ensuring intervention training to reduce anxiety for frontline nurses worldwide.

KEYWORDS

anxiety, COVID-19, cross-sectional survey, insomnia, pandemic

1 | INTRODUCTION

Since the first case was confirmed in December 2019, over 70,000 cases of the coronavirus disease 2019 (COVID-19) have been reported in mainland China (The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team, 2020). The spread of COVID-19 rapidly increased in December 2019, and the disease has now become a public health emergency of international concern. As many as 50,000 individuals were infected and more than 2000 died in Wuhan (Chen et al., 2020). With the rapidly increasing number of people infected, the medical and nursing resources in Wuhan are facing major challenges. A cross-sectional survey conducted by researchers at King Saud and Jazan universities in Saudi Arabia revealed that healthcare workers felt more anxious than usual when they faced the infectious disease-MERS epidemic (Alsubaie et al., 2019). COVID-19 is also an infectious disease. In this study, we investigated the anxiety levels of healthcare workers dealing with COVID-19.

The World Health Organization (WHO) reported that there were more than 1,000,000 people infected with COVID-19 and 50,000 deaths worldwide as of 4 April 2020 (World Health Organization, 2020). The WHO has assessed the world at a high risk of COVID-19. COVID-19 is a pandemic, which exerts great pressure on clinical nurses worldwide. This study explored the prevalence of anxiety and related factors among Chinese nurses fighting to contain the spread of COVID-19 in Wuhan, China. These findings have the potential to serve as a reference for the mental health assessment of frontline nurses worldwide.

2 | BACKGROUND

Anxiety is typically related to feelings of unease and apprehension, among others. It is both a psychological and physiological state characterised by cognitive, emotional and behavioural factors (National Institute Of Mental Health, 2020). Anxiety is a sense of fear accompanied by various unpleasant physical feelings (Denat et al., 2016). As the healthcare staff that have the most frequent contact with patients, nurses experience very heavy workloads. In China, nurses have particularly high workloads because of the large patient population and the shortage of healthcare workers' resources. Li et al. (2016) found that 32.8% of nurses had anxiety symptoms and that stressful event experiences increased their anxiety. Accordingly, the current status of anxiety among clinical nurses is worth examining.

Empirical studies have shown that nurses in mainland China experienced higher levels of anxiety when they undertake work that they were unable to finish. Gao et al. (2012) investigated anxiety and related factors among 1807 registered nurses and found that 43.4% nurses exhibited anxiety. A study in Hong Kong reported that 37.3%

What does this paper contribute to the wider global clinical community?

- This study explores anxiety, perceived stress and insomnia among frontline nurses fighting against COVID-19 in Wuhan, China.
- Perceived stress and insomnia can affect nurses' anxiety levels. The frequency of night shifts, previous experience working during an epidemic and the degree of COVID-19 fear all deserve attention in efforts to improve nurses' mental health.
- Nurse managers can use these measurements to assess nurses' anxiety status and offer a scientifically based solutions to relieve it.

of nurses exhibited anxiety, which correlated with individual and work factors. Individual factors included marital status and household income, while work factors included clinical specialty and years employed (Cheung et al., 2016). Karanikola et al. (2016) conducted a cross-sectional survey of Greek oncology nurses, of whom 11.1% exhibited symptoms of clinical anxiety, and 6.9% exhibited very severe symptoms of tension. This may be associated with the nurses' frequent exposure to death.

Stress refers to non-specific systemic responses of the body when stimulated by various internal and external environmental factors, which can be caused by different physiological and psychological factors (Selye, 1976). Nurses are recognised as one of the professional groups that experiences the highest levels of stress (Lee & Kim, 2020). Coping improperly with stress can affect the mental health of nurses, reduce their nursing quality and lead to job burnout. Salilih and Abajobir (2014) studied 343 nurses, of whom 37.8% reported experiencing stress associated with their work shifts, illnesses and other factors. Nursing requires intensive concentration and independent thinking to make health-related decisions for patients. Anxiety can interfere with the ability of nurses to make appropriate decisions (Polat et al., 2019) and can thus result in mistakes and a reduction of nursing quality.

Long-term night shift work and overwhelming work stress are main factors that cause sleep disturbances among nurses. This is also a predominant manifestation of anxiety. According to Kunzweiler et al. (2016), coping with sleep disorders and stress requires comprehensive interventions, such as the creation of a healthy work environment.

COVID-19 is highly contagious. There is no known treatment for the infection except for meticulous supportive care (Wang et al., 2020). Both the unknown source of infection and transmission

speed have led to a large number of infections and a shortage of personal protective equipment (PPE). In this century, there have been two previous major coronavirus epidemics, namely SARS and MERS; in both, nurses played the most important role. Threatened by viral infections and limited PPE, nurses experienced enormous pressure when treating patients infected with COVID-19 (Smith et al., 2020). A previous study has discussed the association between anxiety and stress among nurses in difficult working environments (Ghawadra et al., 2019). Under such urgent circumstances, nurses are vulnerable to anxiety and stress. Since the outbreak of COVID-19, nurses have spent a considerable amount of time taking care of infected patients. Anxiety is considered as a factor related to stress and sleep disturbance in this study. Thus, this study investigated the prevalence of anxiety and its associations with stress and insomnia among nurses treating patients with COVID-19 in Wuhan.

3 | METHODS

3.1 | Study design

A cross-sectional online survey was used to collect data from nurses in a designated hospital. The structure of the manuscript is consistent with the STROBE reporting requirements (see Appendix S1).

3.2 | Setting

The questionnaires were created using Questionnaire Star software and distributed through the social media platform WeChat, one of the fastest-growing mobile apps in China (Montag et al., 2018). We contacted the nursing department at the hospital to clarify the purpose, significance and content of the survey (i.e. assessing frontline nurses' anxiety level) to obtain their informed consent and cooperation assurance. The research team set up a questionnaire survey group that was responsible for the distribution and collection of questionnaires from the clinical ward. First, we entered the WeChat group by scanning a QR code; nurses usually use WeChat groups to communicate or publish work-related information in mainland China. Second, we disseminated the questionnaire link in WeChat groups and sent messages inviting group members to complete questionnaires. Participants could submit their answers only if all the questions were answered, and each WeChat ID could only complete the questionnaire once. This survey was distributed between 3–10 March 2020.

3.3 | Study population and sample

Participants were recruited from one general teaching hospital, which specialised in nursing work pertaining to COVID-19 in Wuhan. The inclusion criteria were having a nurse qualification certificate and participating in clinical nursing work with COVID-19-infected patients since 1 January 2020. The exclusion criteria were international nurses,

trainee nurses from other hospitals and nurses who were continuously off duty since 1 January 2020, throughout the investigation period (i.e. on leave for various reasons). The sample size was estimated based on the formula $N = \frac{(Z_{\frac{\alpha}{2}})^2 p(1-p)}{d^2}$, where N = initial estimated sample size, Z = confidence level (α), p = prevalence, and d = marginal error. The anxiety of frontline nurses was estimated from a previous study, reported as 44.6% by Lai et al. (2020). With a 95% confidence level, a margin of error of .05 and an assumed 20% invalid completion rate, it was estimated that at least 456 questionnaires should be distributed.

3.4 | Instruments

3.4.1 | Sociodemographic questionnaire

The sociodemographic variables assessed included gender, age, years employed as a nurse, marital status, professional title, educational degree, average daily nap time, daily sleep time, exercise time and daily working hours.

3.4.2 | Questionnaire regarding the COVID-19 environment

The questions related to the pandemic environment in the preceding month included the total number of times the respondent was involved in saving a patient's life, direct patient care involvement, the average number of night shifts worked, whether they received occupational protection training, professional psychological assistance, had an occupational-related exposure, had been infected, had prior epidemic nursing experience, had experienced a negative event and a self-assessment of the extent of their fear of COVID-19.

3.4.3 | Generalised anxiety disorder

Anxiety was evaluated with the Generalized Anxiety Disorder (GAD-7) scale developed by Spitzer et al. (2006). This scale comprises seven items, each of which describes the typical symptoms of generalised anxiety disorder. Each item is rated according to its occurrence and duration over the past two weeks using a 4-point Likert scale, with options of 0 (*none*), 1 (*lasts several days*), 2 (*lasts more than a week*) and 3 (*lasts almost every day*). The score for GAD-7 ranges from 0–21; more than 5 points represent the presence of anxiety. A normal anxiety score ranges from 0–4, mild anxiety ranges from 5–9, moderate anxiety ranges from 10–14 and severe anxiety ranges from 15–21 (Spitzer et al., 2006). In this study, Cronbach's alpha was .95.

3.4.4 | Perceived stress

Perceived stress was assessed using the Chinese Perceived Stress Scale (CPSS) developed by Cohen et al. (1983), as revised by

Ting-zhong and Han-teng (2003). It comprises 14 items that reflect the tension and sense of being unable to control stress; participants were asked to answer based on their own feelings using a 5-point Likert scale (0 = *never* to 4 = *very often*). The total score ranges from 0–56. Scores above 25 points are considered positive evidence of stress (Ting-zhong & Han-teng, 2003). The higher the score, the greater the stress level. In 2003, the scale was translated into Chinese (Ting-zhong & Han-teng, 2003) and validated for the Chinese population. Cronbach's alpha was .71 in the prior study and .82 in the current study.

3.4.5 | Insomnia

The Athens Insomnia Scale (AIS) was used to assess nurses' sleep quality. It has been previously used among nurses in China (Shen et al., 2016). AIS was used to evaluate the sleep quality of participants in the month preceding the study. The scale comprises eight self-report items, such as the time to fall asleep, the number of hours remaining awake at night, waking up earlier than expected, total sleep time, sleep quality, daytime mood, daytime physical function and daytime drowsiness. The score of each item ranges from 0–3, and the total score ranges from 0–24. The higher the score, the poorer the sleep quality. Scoring more than 4 points is seen as positive evidence of insomnia (Soldatos et al., 2000). In this study, the Cronbach's alpha value was .90.

3.5 | Ethical considerations

This study was approved by the Ethics Committee of the Union Hospital affiliated to Tongji Medical College, Huazhong University of Science and Technology (Approval number 2020-0189). The contents and procedures were first explained to participants in a WeChat group. They were assured that participating in this study was voluntary and anonymous. As it was administered online, only those who chose 'agree to participate in the investigation' could complete the survey. All data and information were held in a secure location and were used only for this study. If desired, participants were offered mental health support after completing the survey.

3.6 | Data analyses

Analyses were performed using SPSS v26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics consisted of frequencies and percentages, and means \pm standard deviations for normally distributed quantitative data or medians (Q1, Q3) for non-normally distributed data. Chi-square tests were conducted to evaluate differences in the variables with respect to anxiety. Significant ($p < .05$) sociodemographic and anxiety-related variables were selected as covariates in subsequent analyses. Odds ratios (OR) with 95% confidence

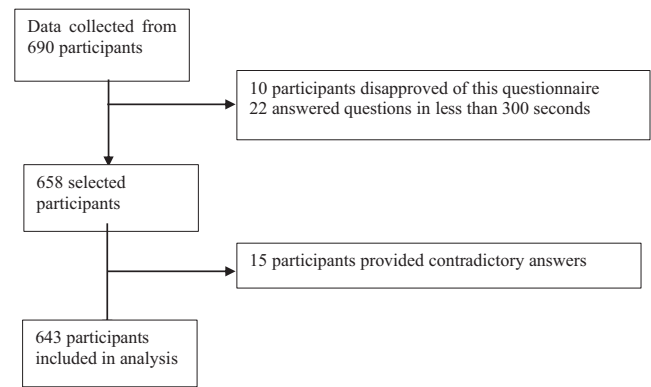


FIGURE 1 Flow chart of participants' inclusion

intervals (CI) of risk factors were calculated using binary logistic regression models to analyse the effects of sociodemographic variables, perceived stress and insomnia on anxiety of participants. Spearman's correlation coefficient was used to analyse the relationships between anxiety, perceived stress and insomnia. All results with $p < .05$ were considered statistically significant.

4 | RESULTS

The questionnaire survey group checked each returned questionnaire and excluded any with invalid responses. Additional exclusion criteria were illogical answers ($n = 15$), such as contradictory and inconsistent contents; questionnaires answered in under 300 s ($n = 22$); simple repetitions/the same answers; and stated disagreement with the questionnaire ($n = 10$). These exclusions minimised the bias that may occur in self-report data. In this study, we recruited via 28 WeChat groups; each group included 20–30 nurses. There were 690 participants in total, and 643 questionnaires were included in the analysis. The details of the exclusions are shown in Figure 1. We considered that when we sent the online survey link via WeChat groups, every member was invited to complete the questionnaires; that is, 690 questionnaires were effectively distributed, with a response rate of 93.2%.

4.1 | Sociodemographic characteristics

Sociodemographic characteristics are shown in Table 1. We analysed the data from 643 respondents, of whom 629 (97.8%) were female and 14 (2.2%) were male, with an average age of 31.8 ± 7.8 years (ranging from 20–56 years), and a median of 8 years working as a nurse. As shown in Table 1, 215 (33.4%) participants reported feeling anxious in the last month prior to the online survey date. Our study confirmed that the percentage of nurses experiencing anxiety was within the range of 30%–40%, which is consistent with the findings reported by Cheung et al. (2016). It should be noted that the average daily working hours were significantly associated with anxiety ($p = .004$) (Table 1).

4.2 | Prevalence and COVID-19-related characteristics associated with anxiety

A questionnaire designed by the authors for this study was used to investigate the working environment amid COVID-19 prevention and control. Details of these characteristics are shown in Table 2. Seven COVID-19-related characteristics were associated with anxiety: direct involvement in patient care, the average

number of night shifts, occupational exposure to the virus, infection, prior epidemic nursing experience, experience of negative events and degree of fear of COVID-19. These characteristics were entered into a logistic regression model. The frequency of each item in the GAD-7 showed that the incidence of mild anxiety symptoms ranged from 22%–38%. The percentage of participants exhibiting severe anxiety was 1.2%–2.4%. The details are shown in Table 3.

TABLE 1 Sociodemographic characteristics of participants

Variables		All (n = 643) No. (%)	Not anxious (n = 428) n (row%)	Anxious (n = 215) n (row%)	χ^2	p-value
Age	≤25	139 (21.6%)	97 (69.8%)	42 (30.2%)	6.305	0.098
	26–35	355 (55.2%)	244 (68.7%)	111 (31.3%)		
	36–45	84 (13.1%)	47 (56.0%)	37 (44.0%)		
	>45	65 (10.1%)	40 (61.5%)	25 (38.5%)		
Sex	Male	14(2.2%)	12 (85.7%)	2 (14.3%)	0.549	0.596
	Female	629(97.8%)	416 (66.1%)	213 (33.9%)		
Working years	≤5	244 (37.9%)	176 (72.1%)	68 (27.9%)	8.508	0.075
	6–10	186 (28.9%)	119 (64.0%)	67 (36.0%)		
	11–15	90 (14.0%)	62 (68.9%)	28 (31.1%)		
	16–20	29 (4.6%)	17 (58.6%)	12 (41.4%)		
	≥21	94 (14.6%)	54 (57.4%)	40 (42.6%)		
Marital status	Married	385 (59.9%)	245 (63.6%)	140 (36.4%)	3.693	0.055
	Unmarried and others	258 (40.1%)	183 (70.9%)	75 (29.1%)		
Professional title	Nurse	166 (25.8%)	118 (71.1%)	48 (28.9%)	4.345	0.227
	Secondary nurse	293 (45.6%)	198 (67.6%)	95 (32.4%)		
	Chief nurse	169 (26.3%)	103 (60.9%)	66 (39.1%)		
	Deputy chief nurse and above	15 (2.3%)	9 (60.0%)	6 (40.0%)		
Educational level	Junior college and below	109 (17.0%)	69 (63.3%)	40 (36.7%)	0.793	0.673
	Undergraduate course	518 (80.5%)	349 (67.3%)	169 (32.7%)		
	Master's degree and above	16 (2.5%)	10 (62.5%)	6 (37.5%)		
Average daily nap time (min)	Never	115 (17.9%)	66 (57.4%)	49 (42.6%)	7.819	0.050
	<30	217 (33.7%)	146 (67.3%)	71 (32.7%)		
	30–60	275 (42.8%)	187 (68.0%)	88 (32.0%)		
	>60	36 (5.6%)	29 (80.6%)	7 (19.4%)		
Average daily sleep time (h)	≤5	22 (3.4%)	12 (54.5%)	10 (45.5%)	5.757	0.056
	6–8	598(93.0%)	396 (66.2%)	202 (33.8%)		
	9–10	23 (3.6%)	20 (87.0%)	3 (13.0%)		
Average exercise time (times per week)	0	356 (55.4%)	234 (65.7%)	122 (34.3%)	4.173	0.243
	≤1	204 (31.7%)	140 (68.6%)	64 (31.4%)		
	2–3	58 (9.0%)	34 (58.6%)	24 (41.4%)		
	≥4	25 (3.9%)	20 (80.0%)	5 (20.0%)		
Average daily working hours	4–6	237 (36.9%)	169 (71.3%)	68 (28.7%)	13.353	0.004
	7–8	324 (50.4%)	217 (67.0%)	107 (33.0%)		
	9–10	62 (9.6%)	29 (46.8%)	33 (53.2%)		
	≥10	20 (3.1%)	13 (65.0%)	7 (35.0%)		

χ^2 = chi-square test; p-value = level of statistical significance; Significant ($p < 0.05$).

TABLE 2 Prevalence and COVID-19-related statistics associated with anxiety

Variables		All (n = 643) n (%)	Not anxious (n = 428) n (row%)	Anxious (n = 215) n (row%)	F	p-value
The total number of days of nursing work (per week)	≤1	85 (13.2%)	57 (67.0%)	28 (33.0%)	5.154	0.272
	1-2	155 (24.1%)	110 (71.0%)	45 (29.0%)		
	3-4	151 (23.5%)	106 (70.2%)	45 (29.8%)		
	5-6	216 (33.6%)	133 (61.6%)	83 (38.4%)		
	=7	36 (5.6%)	22 (61.1%)	14 (38.9%)		
Directly involved in patients care	Yes	59 (9.2%)	32 (54.2%)	27 (45.8%)	4.434	0.035
	No	584 (90.8%)	396 (67.8%)	188 (32.2%)		
Average number of night shifts (times per week)	0	108 (16.8%)	81 (75.0%)	27 (25.0%)	10.720	0.030
	1	210 (32.7%)	147 (70.0%)	63 (30.0%)		
	2	57 (8.9%)	33 (57.9%)	24 (42.1%)		
	3	19 (2.9%)	9 (47.4%)	10 (52.6%)		
	4	249 (38.7%)	158 (63.5%)	91 (36.5%)		
Received occupational protection training	Yes	615 (95.6%)	413 (67.2%)	202 (32.8%)	2.220	0.136
	No	28 (4.4%)	15 (53.6%)	13 (46.4%)		
Received professional psychological assistance	Yes	83 (12.9%)	58 (69.9%)	25 (30.1%)	0.471	0.493
	No	560 (87.1%)	370 (66.1%)	190 (33.9%)		
Had occupational-related exposure	Yes	59 (9.2%)	27 (45.8%)	32 (54.2%)	12.628	<0.001
	No	584 (90.8%)	401 (68.7%)	183 (31.3%)		
Had been infected	Yes	25 (3.9%)	11 (44.0%)	14 (56.0%)	5.950	0.015
	No	618 (96.1%)	417 (67.5%)	201 (32.5%)		
Had epidemic nursing experience before (SARS, MERS, H7N9, etc.)	Yes	27 (4.2%)	12 (44.4%)	15 (55.6%)	6.297	0.012
	No	616 (95.8%)	417 (67.7%)	199 (32.3%)		
Had a negative experience	Yes	137 (21.3%)	70 (51.1%)	67 (48.9%)	18.715	<0.001
	No	506 (78.7%)	358 (70.8%)	148 (29.2%)		
Degree of COVID-19 fear	None	52 (8.1%)	47 (90.4%)	5 (9.6%)	83.289	<0.001
	Mild	224 (34.8%)	183 (81.7%)	41 (18.3%)		
	Moderate	239 (37.2%)	148 (61.9%)	91 (38.1%)		
	Severe	116 (18.0%)	47 (40.5%)	69 (59.5%)		
	Excessive severe	12 (1.9%)	3 (25.0%)	9 (75.0%)		

F = One-way ANOVA; p-value = level of statistical significance; Significant ($p < 0.05$).

4.3 | Correlations between GAD-7, CPSS and AIS

GAD-7 scores ranged from 0–21, with a median of 4; 33.4% ($n = 215$) participants reported anxiety. CPSS scores ranged from 11–30, with a median of 21; 41.4% ($n = 266$) participants reported stress. AIS scores ranged from 0–18, with a median of 8; 41.5% ($n = 267$) participants reported insomnia. Spearman's correlations indicated that CPSS and AIS were positively correlated with GAD-7 ($p < .05$). The details are shown in Table 4.

4.4 | Binary logistic regression analysis of factors associated with anxiety

Binary logistic regression analysis was performed using the variables statistically significant in univariate analyses as independent

variables and participants' experience of anxiety as the dependent variable. Table 5 shows that anxiety was significantly associated with an average of four-night shifts per week (Odds ratio, OR = 2.44, 95% CI = 1.24–4.75); having previously worked during more than two epidemics (13.76, 1.06–178.05); and moderate, severe or excessively severe fear of COVID-19 (4.80, 1.50–15.34; 9.50, 2.81–32.04; 13.58, 1.74–105.83, respectively); CPSS (4.15, 2.65–6.50); and AIS (8.51, 5.38–13.47).

5 | DISCUSSION

This study investigated the prevalence of anxiety, the factors associated with anxiety, and the association between perceived stress and insomnia among Chinese frontline nurses fighting COVID-19 in

TABLE 3 Response frequency for each item in the Generalized Anxiety Disorder Scale

GAD-7 item	n (%)			
	Normal	Mild	Moderate	Severe [#]
1. Feel nervous, anxiety, or eagerness	335 (52.1)	246 (38.3)	47 (7.3)	15 (2.3)
2. Unable to stop or control worry	396 (61.5)	198 (30.8)	39 (6.1)	10 (1.6)
3. Worry too much about all kinds of things	375 (58.3)	216 (33.6)	42 (6.5)	10 (1.6)
4. It is hard to relax	405 (63.0)	195 (30.3)	30 (4.7)	13 (2.0)
5. Unable to sit still because of uneasiness in the heart	463 (72.0)	147 (22.9)	25 (3.9)	8 (1.2)
6. Become prone to annoyance or impatience	362 (56.2)	221 (34.4)	48 (7.5)	12 (1.9)
7. Feel frightened by the feeling that something terrible is going to happen	411 (63.9)	193 (30.0)	30 (4.7)	9 (1.4)

#Normal: GAD-7 score 0–4; mild, 5–9; moderate, 10–14; severe, 15–21 (Spitzer et al., 2006).

TABLE 4 Spearman correlations among GAD-7, CPSS, AIS[#]

Variable	GAD-7	CPSS	AIS
GAD-7	–	0.509 [*]	0.660 [*]
CPSS	0.509	–	0.498 [*]

#GAD-7, CPSS and AIS denote the 7-item Generalized of Anxiety Disorder Scale, Perceived Stress Scale and Athens Insomnia Scale, respectively.

* $p < 0.001$.

Wuhan. The response rate was higher than that in previous studies (Lai et al., 2020; Mo et al., 2020), possibly because qualified professionals in the field of mental health offered interventions after the online survey by phone or online, which elicited participants' interest and encouraged them to respond truthfully.

5.1 | Status of anxiety

Recently, the mental health of nurses has received increasing research attention. This is especially true during major disasters. As shown in Table 1, most participants were female, aged 26–35 years, married, and with less than 5 years of occupational experience. Of the participants, 33.4% ($n = 215$) felt anxious, as reflected in their GAD-7 scores; this proportion was slightly lower than that of a previous study, in which 44.6% reported anxiety (Lai et al., 2020). The nurses' anxiety level was no higher than that of other healthcare workers reported in previous Chinese studies, perhaps due to the following reasons. First, the data were collected in March, more than 30 days after the outbreak began; thus, protective supplies were adequate at that time, potentially reducing anxiety. Second, more designated hospitals were gradually set up, which ensured the treatment of critically ill patients.

When compared with other surveys that analysed anxiety by GAD-7 in the context of outbreaks of infectious disease (Jeong et al., 2016), the prevalence of frontline nurses' anxiety was higher in the current study (7.9% vs. 33.4%, respectively). The reasons for this may be an unusually high nursing workload when treating patients with infectious diseases, increasing infection rates among the

population and the high degree of virulence of COVID-19. In addition, only 9.6% of participants said they were not afraid of COVID-19 (Table 2). These may be factors contributing to the higher rate of anxiety.

5.2 | Predictors of anxiety

Patients with infectious diseases increase the pressure on nurses and potentially promote negative psychological symptoms in nurses (Lee & Kang, 2020), such as anxiety and depression. The COVID-19 outbreak was unexpected, and the severity of the pandemic and the virus transmission are greater than in other worldwide epidemics, including MERS and SARS. Referring to Table 2, it is important to note that nurses' anxiety was promoted by COVID-19-related factors, including nurses' direct involvement in patient care, the average number of night shifts per week, job-related exposure, becoming infected, previous epidemic nursing experiences and degree of fear of COVID-19. Studies have revealed that night shift work can increase depression and anxiety symptoms (Kalmbach et al., 2015) and that rotating shifts can have adverse effects on the psychological health of nurses. Huang et al. (2013) conducted a prospective randomised control study, which showed that exposure to bright light during the first half of the night shift, while avoiding sun exposure during daylight hours after work decreased nurses' anxiety-related symptoms. The quarantine ward generally operates with a 4-h shift for nurses in Wuhan, due to limited tolerance for wearing protective suits. While reducing working hours, the frequency of night shifts increased. As can be seen in Table 1, frontline nurses had a maximum of four-night shifts per week. Therefore, we suggest implementing an intervention that includes short bright light exposure before night shifts, to reduce anxiety symptoms.

The COVID-19 pandemic was not the first infectious disease outbreak; SARS, MERS and others occurred previously. In the present study, 4.2% of participants indicated that they had previously worked during SARS, MERS, Asian Lineage Avian Influenza (H7N9) and others. A literature review concluded that high percentages of healthcare professionals, especially nurses, experienced negative psychological effects after disaster rescue tasks (Mao et al., 2018).

TABLE 5 Binary logistic regression analysis of factors associated with anxiety.

Independent variables		OR	95% CI (Confidence interval)	p-value
Average daily working hours	4–6	1	Reference	
	7–8	1.00	0.62–1.62	0.985
	9–10	1.60	0.72–3.53	0.247
	≥10	0.87	0.23–3.29	0.842
Directly involved in patients care	No	1	Reference	
	Yes	0.71	0.35–1.44	0.336
Average number of night shifts (times per week)	0	1	Reference	
	1	1.65	0.84–3.24	0.148
	2	1.40	0.58–3.39	0.458
	3	2.12	0.57–7.93	0.263
	4	2.34	1.19–4.59	0.013
Had occupational exposure	No	1	Reference	
	Yes	0.64	0.30–1.35	0.640
Had been infected	No	1	Reference	
	Yes	0.54	0.18–1.66	0.543
Had epidemic nursing experience before (SARS, MERS, H7N9, etc.)	No	1	Reference	
	Yes	3.97	1.32–11.90	0.014
Had a negative experience	No	1	Reference	
	Yes	1.70	0.99–2.91	0.053
Degree of COVID-19 fear	None	1	Reference	
	Mild	2.89	0.90–9.25	0.074
	Moderate	4.63	1.48–14.43	0.008
	Severe	9.41	2.86–30.99	<0.001
	Excessive severe	13.12	2.86–100.68	0.013
CPSS	No	1	Reference	
	Yes	4.11	2.63–6.44	<0.001
AIS	No	1	Reference	
	Yes	8.45	5.34–13.36	<0.001

Abbreviations: CI, confidence interval; OR, odds ratio.

As shown in Table 2, 15 (55.6%) participants with epidemic occupational experience reported anxiety, indicating that frontline nurses were at a high risk of psychological symptoms if they had previous experience working during epidemics. Thus, it is necessary to provide more effective and individualised psychological counselling for these persons.

A study of the SARS epidemic in Hong Kong suggested that authorities should plan to guarantee the availability of psychological support for frontline health workers (Wong et al., 2005). Zhou (2020) suggested a series of interventions for psychological crisis management. Professional psychological volunteers provided 24-h psychological assistance hotlines and online surveys for different populations, including frontline nurses. This was an effective method for decreasing nurses' anxiety levels.

In situations with unknown aspects, people generally experience fear. As can be seen in Table 2, most participants' degrees of

fear were moderate when facing COVID-19; consistent with this, the scores on the GAD-7 item 'Feel frightened by the feeling that something terrible is going to happen' (Table 3) also showed that most of the frontline nurses feared COVID-19. The reasons for this may be that they were unable to keep apprised of the latest information about the pandemic, the ambiguous nature of the COVID-19 source, being unclear about how long the epidemic would last and feeling as if the pandemic could be endless. This finding was consistent with a previous study of SARS, which found that nurses were frightened of being infected with SARS (Ho et al., 2005).

To avoid the effects of fear-related emotions on normal clinical nursing work, we recommend that frontline nurses receive an appropriate quantity of information at the peak of an epidemic. We encourage nurses to remind each other about and encourage precautionary measures, which can increase self-efficacy (Ho et al., 2005), thereby reducing fear.

5.3 | Correlations between anxiety, perceived stress and insomnia

Stress and insomnia have been significantly associated with anxiety (Tsai et al., 2017). These factors are associated with psychological symptoms. Therefore, perceived stress levels and degree of insomnia were selected in this study as potentially associated with anxiety.

In this study, perceived stress and insomnia showed positive significant associations with anxiety (Table 4). Nearly half of the participants reported being troubled by stress and insomnia. This was similar to results obtained in other regions in China. Cheung et al. (2016) found that symptoms of stress among nurses were almost three times higher than in other Chinese adults and 35% of nurses reported sleep disorders; the proportions were notably high. When compared to normal working situations, nurses may experience severe negative psychological reactions when they are required to cope with epidemics.

According to a Taiwan survey during SARS (Su et al., 2007), the rate of insomnia and anxiety was markedly higher in SARS than in non-SARS wards. Hence, it is imperative to decrease the level of perceived stress and insomnia of frontline nurses who may be reliving their past anxiety in the present.

Emergence of perceived stress was correlated with individual and work-related factors in nurses. However, there are two levels of solutions to stress: macro- and micro-levels (Maunder et al., 2008). Macro-level refers to government and hospital initiatives, whereas micro-level denotes individual and personal measures to alleviate stress. At the macro-level (i.e. official organisational measures), hospitals were the main institutions combating COVID-19. The working environment in terms of hospital safety and satisfaction are important factors that affect perceived stress (Goh et al., 2015). This study showed that a stable and safe working environment is a vital factor in reducing perceived stress.

It was reported in the news during the early stages of the pandemic in Wuhan that some healthcare staff failed to use comprehensive protection in a timely manner due to the predictable shortage of protective materials (Xinhua, 2020). This contributed to increased stress among nurses. Therefore, it is crucial to ensure the adequate and effective use of protective materials to create a favourable working environment. At the same time, conducting adequate professional protection training is also an intervention that is urgently needed. Correspondingly, at the micro-level, awareness of relevant personality characteristics is important. Resilience can help maintain functioning among nursing staff after significant adversity or a disaster (Norris et al., 2008). Guo et al. (2017) conducted a cross-sectional survey in China that indicated nursing managers need to adopt scientific interventions to improve resilience among nurses. For example, interventions might include guaranteeing their leisure time or providing cognitive-behavioural therapy.

The COVID-19 pandemic has continued for an extended period; many people have been infected, which has increased the workload and work intensity for nurses. Appropriate measures should be taken to evaluate the mental health of frontline nurses and protect

them accordingly (Mo et al., 2020); therefore, for nurses working in quarantine wards where offline training is not available, we suggest that nursing managers attach importance to nurses' psychological reactions and take advantage of network platforms to host protective training and psychological relief courses.

The sleep disturbance rate was high among nurses in China. Insomnia has become a universal symptom of sleep disturbance. Dong et al. (2017) showed that 55% of Chinese nurses sampled reported being troubled by sleep problems. In the current study, 41.5% of participants indicated that they experienced insomnia, which suggests that sleep disorders of nurses deserve attention during the COVID-19 pandemic. Li et al. (2019) found that poor sleep quality in Chinese nurses was predicted primarily by exposure to workplace hazards and work demands. Providing a stable environment for frontline nurses could relieve perceived stress and reduce insomnia prevalence.

Furthermore, a meta-analysis revealed that select non-drug interventions positively influence sleep disturbances (Kang et al., 2020). To prevent COVID-19 cross-infection, each frontline nurse lives in a separate room in Wuhan during their quarantine, which is conducive to insomnia treatment for nurses. We also suggest that frontline nurses increase their awareness of sleep health and use non-drug interventions appropriately (e.g. aromatherapy) when they are off duty.

5.4 | Limitations

The research reported herein was subject to limitations. First, its cross-sectional nature constrained the ability to determine causal relationships between the study variables. Second, the use of self-report questionnaires may be influenced by confounding factors such as response bias and incorrect answers. Moreover, most participants were female and healthcare workers other than nurses were not recruited; thus, there are limitations to generalising the findings to other healthcare workers and male nurses. Hence, further studies are recommended to address these limitations and increase the generalisability of the results. It would be of value to replicate these results using larger sample sizes in future studies and to use longitudinal and prospective designs with qualitative aspects to investigate the research theme further and reveal more aspects of this phenomenon.

6 | CONCLUSION

According to the results, 33.4% of frontline nurses reported anxiety and anxiety was associated with perceived stress, insomnia and sociodemographic characteristics (frequency of night shifts per week, degree of COVID-19 fear). To reduce the level of anxiety, macro-level interventions include creating a safe environment and improving nurses' resilience; at the micro-level, one might increase nurses' awareness of mental health and encourage them to take advantage of available online psychological interventions.

7 | RELEVANCE TO CLINICAL PRACTICE

This study indicated that frontline nurses in Wuhan have a moderate level of anxiety, and it is related to stress and insomnia. Alleviating stress and insomnia symptoms will lead to reduced anxiety. Healthcare authorities and nursing managers should take measures to cultivate a suitable environment for reducing nurses' fear of COVID-19 (e.g. reprinting the latest scientific information of COVID-19 disseminated online). Moreover, they need to increase manpower or develop useful workforce strategies to decrease the frequency of night shifts.

ACKNOWLEDGEMENTS

The authors are deeply grateful for the assistance of all nurses, and the nursing administrators from the collaborating hospitals for supporting this investigation.

CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

AUTHOR CONTRIBUTIONS

Yue Shen: data analysis, literature analysis, writing original manuscript preparation. Yuxin Zhan: study design, planning, conduct of study and manuscript editing. Hong Zheng: data collection, literature analysis. Huan Liu: study design, planning. Yonghui Wan: manuscript review, supervision. Wei Zhou: data collection, supervision.

DATA AVAILABILITY STATEMENT

The raw data required to reproduce these findings cannot be shared at this time.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Shen Y, Zhan Y, Zheng H, Liu H, Wan Y, Zhou W. Anxiety and its association with perceived stress and insomnia among nurses fighting against COVID-19 in Wuhan: A cross-sectional survey. *J Clin Nurs*. 2021;30:2654–2664. <https://doi.org/10.1111/jocn.15678>