



ORIGINAL ARTICLE

# Predictive factors of anxiety and depression among nurses fighting coronavirus disease 2019 in China

Yongli Pang,<sup>1</sup>  Hengying Fang,<sup>1</sup> Lili Li,<sup>2</sup> Minhua Chen,<sup>3</sup> Yuanli Chen<sup>2</sup> and Miaoxia Chen<sup>1</sup>

<sup>1</sup>Department of Nursing, <sup>2</sup>Department of Infectious Diseases, and <sup>3</sup>Department of Psychology, The Third Affiliated Hospital of Sun Yat-sen University, Guangzhou, China

**ABSTRACT:** Anxiety and depression are common mental illnesses among nurses fighting coronavirus disease 2019 (COVID-19). However, the precise factors that affect anxiety and depression in this population require further evaluation. This study aimed to explore factors associated with anxiety and depression among nurses fighting COVID-19 in China. We used convenience sampling to recruit 282 nurses fighting COVID-19 in three hospitals. Participants were questioned about demographic characteristics, daily working time, daily sleep duration, sleep quality, anxiety, depression, resilience, and coping styles. Linear regression analysis indicated that resilience ( $\beta = -0.217$ ,  $P < 0.001$ ), positive coping style ( $\beta = -0.281$ ,  $P < 0.001$ ), negative coping style ( $\beta = 0.395$ ,  $P < 0.001$ ), and sleep quality ( $\beta = 0.153$ ,  $P = 0.010$ ) were predictive factors for anxiety, and the model explained 44.20% ( $P < 0.001$ ) of variability. Resilience ( $\beta = -0.239$ ,  $P < 0.001$ ), positive coping style ( $\beta = -0.222$ ,  $P < 0.001$ ), negative coping style ( $\beta = 0.152$ ,  $P < 0.001$ ), and sleep quality ( $\beta = 0.104$ ,  $P = 0.003$ ) were identified as explanatory factors for depression, and the model explained 34.50% ( $P < 0.001$ ) of variability. The present study suggested that resilience, coping styles, and sleep quality could account for an individual's levels of anxiety and depression.

**KEY WORDS:** anxiety, coping styles, coronavirus disease 2019, depression, nurses, resilience, sleep.

**Correspondence:** Miaoxia Chen, Department of Nursing, The Third Affiliated Hospital of SunYat-sen University, 600 Tianhe Road, Guangzhou 510630, China. Email: 1109986151@qq.com

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Yongli Pang, MM, RN, Nurse.

Hengying Fang, MD, RN, Deputy of Nursing Department director.

Lili Li, RN, Head Nurse.

Minhua Chen, RN, Head Nurse.

Yuanli Chen, RN, Head Nurse.

Miaoxia Chen, MM, RN, Head of the Nursing Department.

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## INTRODUCTION

At the end of 2019, a form of pneumonia caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) spread sharply throughout China and a growing number of countries around the world (Rodríguez-Morales *et al.* 2020; Zhu *et al.* 2020). COVID-19 causes a series of respiratory illness symptoms and is characterized primarily by fever, cough, and respiratory distress syndrome (Xiao *et al.* 2020). As of 4 July 2020, a total of 10 922 324 cases of COVID-19 have been confirmed and 523 011 deaths have occurred globally. COVID-19 is highly infectious from person to person and is thought to spread primarily via respiratory droplets, resembling the spread of influenza. Healthcare workers must undergo training on how

to protect themselves before handling highly infectious patients, but personal protective equipment (PPE) cannot be guaranteed to be absolutely safe (Ji *et al.* 2017). It was reported that a total of 1716 medical workers across 422 medical institutions in China were infected with COVID-19 (Epidemiology Working Group for NCIP Emergency Response 2020). Anxiety and depression are common mental illnesses in healthcare workers during outbreaks of infectious diseases such as Ebola haemorrhagic fever and severe acute respiratory syndrome (SARS) (Chen *et al.* 2005; Li *et al.* 2015). Furthermore, a systematic review including 33 062 participants found that the prevalences of anxiety and depression in healthcare workers during the COVID-19 pandemic were 23.2% and 22.8%, respectively. (Pappa *et al.* 2020). High rates of anxiety and depression for such healthcare workers might increase the risk of accidents, as well as reduce work efficiency and quality of life (QoL) (Lehmann *et al.* 2016; McAlonan *et al.* 2007). However, current literature focusing on the prevalence of anxiety and depression among medical staff during the COVID-19 pandemic is limited, and the precise factors that might affect the mental health status of this population require further evaluation (Huang & Zhao 2020; Que *et al.* 2020). Therefore, it is necessary to explore the factors associated with anxiety and depression among nurses on the front lines of COVID-19.

The factors associated with anxiety and depression are numerous. A systematic review concluded that individual, demographic, environmental, and work-related factors are major predictors of depression and anxiety symptoms (Brooks *et al.* 2018). The occurrence of anxiety and depression can be attributed to deficiencies in resiliency, coping strategies, and sleep.

Resilience is considered a major influence on anxiety and depression. Many studies have focused on the role of resiliency in predicting anxiety and depression in cancer patients. Studies have indicated that higher levels of resilience are associated with lower levels of depressive symptomatology and better QoL among women diagnosed with breast cancer (Fradelos *et al.* 2017; Ristevska-Dimitrovska *et al.* 2015). Resilience has received considerable attention in medical rescue workers (Ogińska-Bulik & Zadworna-Cieślak 2018). However, little is known about its role in predicting anxiety and depression in this population.

Several studies have shown that mental illnesses are affected by coping strategies. Passive coping strategies were associated with poor mental health (Schreuder *et al.* 2012). Conversely, another study indicated that a

positive coping style was associated with less anxiety and depression (Tsaras *et al.* 2018). However, the strategies used by front-line COVID-19 nurses to cope with mental illnesses are not currently known.

Poor duration and quality of sleep are considered to be two factors that negatively affect psychological outcomes. It is recommended to sleep >7 hours/night for the best health outcomes; <6 hours of quality sleep per night is considered sleep deprivation (Yin *et al.* 2017). Many people with depression report sleep disturbances, and individuals who experience anxiety and depression also report a lack of sleep (Lopresti *et al.* 2013). Poorer sleep quality has been linked to a higher level of depressive symptoms (Matsumoto *et al.* 2016). However, few studies have explored the relationships between sleep, anxiety, and depression in front-line nurses treating COVID-19 patients. Detecting the factors associated with anxiety and depression in these nurses will contribute to a better understanding of the mechanisms underlying their mental health. Therefore, the purpose of this study was to investigate the prevalence of and factors associated with anxiety and depression among nurses on the front lines of the COVID-19 pandemic.

## METHODS

### Design

A cross-sectional study design was used to investigate the prevalence of and factors associated with anxiety and depression in front-line nurses fighting COVID-19 in China.

### Sample

Participants in this study were recruited from three hospitals that received patients with COVID-19 in both Guangdong and Hubei Provinces. Inclusion criteria included working on the front lines against COVID-19 for at least 1 week, and agreement to participate. Participants were excluded if they had been isolated due to suspected or diagnosed COVID-19.

### Procedures

We used a convenience sampling method to collect data during the period from 10–20 March 2020. Sociodemographic characteristics (age, gender, marital status, participation in Ebola and SARS rescue, daily working time, daily sleep duration, and sleep quality)

were assessed via a questionnaire that we created. Anxiety, depression, resilience, and coping styles were assessed using, respectively, the Generalized Anxiety Disorder 7-item scale (GAD-7); Patient Health Questionnaire (PHQ-9); Connor–Davidson Resilience Scale (CD-RISC), Chinese version; and Simplified Coping Style Questionnaire (SCSQ). All four of these questionnaires, as well as the informed consent and the sociodemographic questionnaire, were online. We sent the participants a hyperlink to the online questionnaires via WeChat or email, which they then completed. Participants were given detailed instructions in email or WeChat, which they were required to read and confirm having read before they could access and complete the questionnaires. They were required to submit their answers within 1 week. We distributed a total of 314 questionnaires, of which 289 were returned (response rate: 92.04%). Due to incomplete information, we excluded seven participants, leaving 282 valid responses (effective response rate, 97.58%).

## Materials

### *Measurement of anxiety*

We chose GAD-7 to screen for generalized anxiety and to assess symptom severity. This scale contains seven items graded on a Likert scale, from 0 (not at all) to 3 (nearly every day), with total score range of 0–21. The sensitivity and specificity of the GAD-7 are both >90% (He *et al.* 2010). Participants who scored  $\geq 10$  on the GAD-7 were likely suffering from severe anxiety symptoms (Quon *et al.* 2015).

### *Measurement of depression*

We adopted the PHQ-9 to measure depression (Kroenke *et al.* 2001). This scale assesses depressive symptoms over the past 2 weeks. Each of its nine items is scored from 0 (not at all) to 3 (nearly every day). Total score range is 0–27; the higher the score, the more severe the symptoms of depression. A score of  $\geq 10$  among the general population indicates moderate or severe depressive symptoms. The PHQ-9, with both sensitivity and specificity of >90%, has been widely applied to detect depression in Chinese populations (Wang *et al.* 2014).

### *Measurement of resilience*

We used the Chinese version of the 25-item CD-RISC to assess resilience. The original CD-RISC was developed by Connor and Davidson (2003). Items are scored from 0 to 4, with a total score range of 0–100; higher scores reflect higher resilience. The range of

Cronbach's alpha coefficients for the Chinese version of the CD-RISC is 0.76–0.91 (Yu & Zhang 2007).

### *Measurement of coping styles*

We measured coping styles via the SCSQ (Xie 1998), which was developed in China based on coping theory. Its items are divided into two categories: negative coping styles (8 items) and positive coping styles (12 items). The Cronbach's alpha coefficients of the SCSQ for negative and positive coping styles were 0.80 and 0.73, respectively.

## Demographic characteristics

This study covered seven demographic characteristics. For age, there were four options: '20–29', '30–39', '40–49', or '50–59' years. For gender, participants could select 'female' or 'male'. Marital status was either 'single' or 'married'. For the question of whether the participant had previously performed front-line nursing care of Ebola or SARS patients, the answer was either 'yes' or 'no'. 'Daily working time (hours)' was measured by average working time over the past 1 week; options were '4–6', '6.1–8', '8.1–10', or '>10' hours. 'Daily sleep time (hours)' was measured by average sleep duration over the past week; the four options were ' $\leq 4$ ', '4.1–6', '6.1–8', or '>8' hours. 'Sleep quality' also had four options: 'good', 'general', 'bad', or 'very bad'.

## Ethical considerations

Ethical approval was obtained from the Ethics Committee of The Third Affiliated Hospital of Sun Yat-sen University.

## Statistical data analyses

We analysed data using SPSS software version 23.0 (IBM Corp., Armonk, NY, USA). Categorical variables were reported as proportions and quartile. We used the Kolmogorov–Smirnov test and normality plots to assess normal distribution of data.

Non-normally distributed data were reported as the median of the interquartile range (IQR). The Mann–Whitney *U*-test was used to compare scores of anxiety and depression according to demographic variables such as gender, marital status, and participation in Ebola and SARS rescue. The Kruskal–Wallis test was used to compare scores of anxiety and depression according to age, daily working time, daily sleep duration, and sleep quality. We used bivariate correlation to

analyse the correlations between anxiety, depression, resilience, and coping styles. Linear regression was applied to explore the correlates of anxiety and depression. A two-sided  $P < 0.05$  was considered to indicate statistical significance.

## FINDINGS

### Demographic characteristics

The demographic characteristics of the 282 nurses are described in Table 1.

Mean age was  $31.61 \pm 7.60$  (range, 20–55) years; 250 (88.65%) of participants were female. Also, 22.70% of the participants had participated in Ebola or SARS rescue. Approximately one quarter (25.53%) of participants worked >8 hours/day. Roughly one in five respondents slept <6 hours/day, and 17.38% of participants identified their sleep quality as bad/very bad.

### Levels of anxiety, depression, resilience, and coping style

The participants' levels of anxiety, depression, and resilience, as well as coping styles, are shown in Table 2.

According to the cut-off values used by Quon *et al.* (2015), participants who scored  $\geq 10$  had significant

clinical depression or anxiety; in the general population, a score of  $\geq 10$  indicates moderate to severe symptoms of depression. The prevalences of anxiety and depression in front-line COVID-19 nurses were 47.52% and 56.74%, respectively ( $N = 282$ ).

### Compare depression and anxiety scores based on demographic variables

Table 3 presents anxiety and depression scores by demographic variable.

Past participation in Ebola and SARS rescue, daily working time, and sleep quality were significantly associated with anxiety; past participation in Ebola and SARS rescue, daily working time, daily sleep duration, and sleep quality were significantly linked to depression ( $P < 0.05$ ). Front-line COVID-19 nurses who had participated in Ebola or SARS rescue had lower levels of anxiety and depression. Moreover, participants whose daily working time was ' $\leq 4$  hours' or '4.1–6 hours' had lower levels of anxiety and depression than those whose daily working time was '6.1–8 hours' or '>8 hours'. Participants who worked >8 hours/day had higher levels of anxiety and depression than others. Furthermore, those who identified their sleep quality as bad/very bad reported higher levels of anxiety and depression.

### Bivariate correlations among anxiety, depression, resilience, and coping styles

As Table 4 shows, anxiety was negatively correlated with the two positive psychological variables (CD-RISC

**TABLE 1** Demographic characteristics of the participants ( $n = 282$ )

Demographic items	Categories	Frequency	Percentage
Ages (years)	20–29	126	44.681
	30–39	112	39.716
	40–49	39	13.830
	50–59	5	1.773
Gender	Female	250	88.652
	Male	32	11.348
Marital status	Singer	113	40.071
	Married	169	59.929
Participation in Ebola or SARS rescue	Yes	64	22.695
	No	218	77.305
Daily working time (hours)	4–6	17	6.028
	6.1–8	193	68.440
	8.1–10	49	17.376
	>10	23	8.156
Daily sleep time (hours)	$\leq 4$	2	0.709
	4.1–6	58	20.567
	6.1–8	196	69.504
	>8	26	9.220
Sleep quality	Good	80	28.369
	General	153	54.255
	Bad	39	13.830
	Very bad	10	3.546

**TABLE 2** Descriptive statistics for anxiety, depression, resilience, and coping styles ( $N = 282$ )

Variables	Mdn	IQR	Range	N (%)
GAD-7	9	(7, 14)	0–21	
<10				64 (52.482)
$\geq 10$				134 (47.518)
PHQ-9	10	(6, 14)	0–27	
<10				122 (43.262)
$\geq 10$				160 (56.738)
CD-RISC	81	(72, 88)	0–100	
SCSQ				
Positive coping style	24	(21, 27)	0–36	
Negative coping style	10	(8, 12)	0–24	

CD-RISC, Connor–Davidson Resilience Scale Chinese version; GAD-7, The Generalized Anxiety Disorder scale-7; IQR, interquartile range; Mdn, median; PHQ-9, The Patient Health Questionnaire; SCSQ, The Simplified Coping Style Questionnaire.

**TABLE 3** Compare depression and anxiety scores based on demographic variables (N = 282)

Demographic items	GAD-7			PHQ-9		
	Mdn (IQR)	Z/Chi-square	P value	Mdn (IQR)	Z/Chi-square	P value
Age (years)		2.998	0.392		2.456	0.483
20–29	9 (7, 14)			10 (6, 15)		
20–39	9 (7, 14)			10 (6, 14)		
40–49	13 (8, 14)			10 (9, 14.5)		
50–59	8 (8, 9)			10 (9, 10)		
Gender		–0.281	0.779		–0.413	0.679
Female	9 (7, 14)			9.5 (6, 16)		
Male	9 (7, 14)			10 (6, 14)		
Marital status		–1.371	0.170		–0.398	0.697
Single	9 (7, 14)			10 (6, 15)		
Married	12 (7, 14)			10 (7, 14)		
Participation in Ebola and SARS rescue		–3.423	0.02		–3.085	0.01
Yes	8 (6.5, 13)			8.5 (5, 10.5)		
No	13 (8, 14)			10 (7, 15)		
Daily working time (hours) (hours)		19.868	<0.001		21.443	<0.001
4–6	9 (7, 13)			8 (5, 11)		
6.1–8	9 (7, 14)			10 (6, 14)		
8.1–10	14 (9, 15)			12 (9, 15)		
>10	14 (8, 14)			14 (10, 16)		
Daily sleep duration (hours)		7.004	0.072		7.822	0.050
≤4	12 (7, 17)			14 (8, 20)		
4.1–6	13 (8, 15)			12 (8, 15)		
6.1–8	9 (7, 14)			10 (6, 14)		
>8	8 (5, 14)			10 (5, 12)		
Sleep quality		30.337	<0.001		26.172	<0.001
Good	8.5 (6, 13.5)			8.5 (5, 12)		
General	9 (7, 14)			10 (7, 14)		
Bad	14 (8, 14)			14 (10, 16.5)		
Very bad	16 (14, 17)			13 (9, 21)		

GAD-7, The Generalized Anxiety Disorder scale-7; IQR, interquartile range; Mdn, median; PHQ-9, The Patient Health Questionnaire.

score:  $r = -0.379$ ,  $P < 0.01$ ; positive coping style:  $r = -0.413$ ,  $P < 0.01$ ). A similar pattern was discovered between these two variables and depression (CD-RISC score:  $r = -0.375$ ,  $P < 0.01$ ; positive coping style:  $r = -0.340$ ,  $P < 0.01$ ). Negative coping style was significantly linked to anxiety ( $r = 0.507$ ,  $P < 0.01$ ) and depression ( $r = 0.432$ ,  $P < 0.01$ ).

### Linear regression analysis assessing associations of anxiety and depression

Linear regression analysis indicated that CD-RISC score ( $\beta = -0.217$ ,  $P < 0.001$ ), positive coping style ( $\beta = -0.281$ ,  $P < 0.001$ ), negative coping style ( $\beta = 0.395$ ,  $P < 0.001$ ), and sleep quality ( $\beta = 0.153$ ,  $P = 0.010$ ) were explanatory factors for anxiety and that the model explained 44.20% ( $P < 0.001$ ) of variability (Table 5). CD-RISC score ( $\beta = -0.239$ ,  $P < 0.001$ ), positive coping style ( $\beta = -0.222$ ,  $P < 0.001$ ), negative coping style ( $\beta = 0.152$ ,  $P < 0.001$ ), and sleep quality

**TABLE 4** Bivariate correlation among anxiety, depression, resilience, and coping styles

Variables	CD-RISC	SCSQ (Positive coping style)	SCSQ (Negative coping style)
GAD-7	–0.379**	–0.413**	0.507**
PHQ-9	–0.375**	–0.341**	0.432**

CD-RISC, Connor–Davidson Resilience Scale Chinese version; GAD-7, The Generalized Anxiety Disorder scale-7; PHQ-9, The Patient Health Questionnaire; SCSQ, The Simplified Coping Style Questionnaire.

\*\* $P < 0.01$ .

( $\beta = 0.104$ ,  $P = 0.003$ ) were identified as explanatory factors for depression, and the model explained 34.50% ( $P < 0.001$ ) of variability (Table 6). However, participation in Ebola and SARS rescue, daily working time, and daily sleep duration showed no significant relationships with resilience, anxiety, or depression.

**TABLE 5** Linear regression for exploring the correlates of anxiety

Variables	B	SE B	$\beta$	t value	P value
Constant	14.840	1.785		8.313	<0.001
CD-RISC	-0.078	0.017	-0.217	-4.669	<0.001
SCSQ (Positive coping style)	-0.188	0.031	-0.281	-6.037	<0.001
SCSQ (Negative coping style)	0.459	0.054	0.395	8.547	<0.001
Sleep quality	0.872	0.267	0.153	3.261	0.010

$\Delta R^2 = 0.450$ , Adjusted  $R^2 = 0.442$ ,  $F = 56.606$ ,  $P < 0.001$ .

CD-RISC, Connor–Davidson Resilience Scale Chinese version; GAD-7, The Generalized Anxiety Disorder scale-7; PHQ-9, The Patient Health Questionnaire; SCSQ, The Simplified Coping Style Questionnaire.

**TABLE 6** Linear regression for exploring the correlates of depression

Variables	B	SE B	$\beta$	t value	P value
Constant	15.999	2.245		7.125	<0.001
CD-RISC	-0.101	0.021	-0.239	-4.751	<0.001
SCSQ (Positive coping style)	-0.167	0.038	-0.222	-4.418	<0.001
SCSQ (Negative coping style)	0.446	0.068	0.328	6.555	<0.001
Sleep quality	1.014	0.339	0.152	2.990	0.003

$\Delta R^2 = 0.354$ , Adjusted  $R^2 = 0.345$ ,  $F = 37.934$ ,  $P < 0.001$ .

CD-RISC, Connor–Davidson Resilience Scale Chinese version; GAD-7, The Generalized Anxiety Disorder scale-7; PHQ-9, The Patient Health Questionnaire; SCSQ, The Simplified Coping Style Questionnaire; SD, standard deviation.

## DISCUSSION

This study aimed to identify the risk factors for anxiety and depression among nurses working on the front lines of COVID-19 in China. This study found that a high percentage of such nurses had high levels of anxiety or depression. The prevalences of anxiety (GAD score  $\geq 10$ ) and depression (PHQ-9 score  $\geq 10$ ) in the present study were 47.52% and 56.74%, respectively. This finding was consistent with that of Que *et al.* (2020). When faced with a stressor (the COVID-19 epidemic), various physiological or hormonal responses occur, accompanied by a series of non-specific psychological responses. The corticotropin-releasing factor system (including such organs as the thalamic hypothalamus, amygdala, and neocortex) mediates neuroendocrine responses to psychological stressors and participates in emotional processing, which leads to

depression and anxiety (Faravelli *et al.* 2012). Both the present study and Que's work were carried out in the early stages of the COVID-19 epidemic, when most nurses were facing the most severe epidemic stage, as this was when extreme psychological reactions were most likely to occur. These negative psychological consequences not only affected the attention, understanding, and decision-making ability of medical staff, but might have also reduced their ability to fight against COVID-19 (Kang *et al.* 2020). Furthermore, evidence also indicates that these psychopathological outcomes could have a lasting impact on a nurse's overall health, even 6 months to 3 years after the pandemic outbreak (Liu *et al.* 2012; Maunder *et al.* 2006). In addition, compared with the Chinese public, nurses have a much higher risk of anxiety and depression during the epidemic (Huang & Zhao 2020). This result might be explained by the fact that nurses are facing tremendous pressure from COVID-19, especially those who might be in contact with suspected or confirmed cases. COVID-19 can spread from person to person (Li *et al.* 2020), is associated with high morbidity, and can potentially be fatal (Wang *et al.* 2020), which contributes to greater anxiety and depression in nurses. Furthermore, fear of transmission to their families, concern about the health of loved ones, a lack of contact with their families, and feeling stigmatized may result in severe mental health outcomes (Elbay *et al.* 2020). A possible explanation is that only 22.70% of our participants had experience in infectious disease (e.g. Ebola, SARS) rescue. Their lack of work experience in dealing with an infectious disease outbreak might have put them at high risk of developing anxiety or depression. A recent review provided evidence that lower occupational competence was independently associated with higher levels of anxiety or depression (Elbay *et al.* 2020). Another study emphasized the need for pre-disaster training to enhance nurses' confidence in their ability to cope with pandemic outbreaks (Brooks *et al.* 2017). It has been advised that new psychological services should be developed and used in emerging infectious disease outbreak preparedness training (Zaka *et al.* 2020).

The concept of resilience among medical workers facing natural disasters has attracted attention (Aiello *et al.* 2011); resilience can help nurses maintain personal health during a pandemic. Our findings indicated that resilience was negatively linked to anxiety and depression among front-line COVID-19 nurses. A recent study of medical workers combating the COVID-19 pandemic also confirmed that greater resilience was associated

with lower rates of anxiety and depression (Lin *et al.* 2020). Resilience has been related to stress-induced activation, such as sympathetic nervous system, which is sufficient to cause an appropriate response to the stressor or threat, yet not so high as to produce anxiety and depression (Averill *et al.* 2018). It is considered a key aspect of positive psychology and thought to aid self-improvement and greatly enhance QoL (Aiena *et al.* 2015). Lower levels of resilience lead to higher levels of emotional stress and to lower QoL related to psychological health (Xu *et al.* 2017). Higher resilience might represent health-protective factors for people dealing with psychological distress (Wu *et al.* 2016). Individuals who are considered resilient can better adjust to traumatic events and overcome the danger of developing anxiety and depression (Dooley, *et al.* 2017). Therefore, we hypothesized that resilience would be positively associated with mental health. Training programmes related to resilience have been shown to benefit healthcare workers (Cleary *et al.* 2018). Resilience training should be a regular part of nurses' training and continuing education programmes and should also be available in online formats (Mauder *et al.* 2010).

According to our results, positive coping strategies were associated with less anxiety and depression. By contrast, passive coping was significantly related to poorer mental health. These findings were in accordance with those of previous studies (Tsaras *et al.* 2018). A negative coping style prevents individuals from directly addressing stressful events (Wong *et al.* 2005). People who employ passive coping strategies often have low self-efficacy when facing mental distress (Al-Sagarat *et al.* 2017). Healthcare workers must deal with their stress in order to guarantee that patients receive the best care. Consequently, it is important for them to cultivate good health and promote their ability to cope effectively in order to reduce their levels of stress. Identifying the factors that influence positive coping strategies among nurses, and training them to use more positive ways of dealing with stress, is of great significance to promoting their mental health and well-being (Tsaras *et al.* 2018).

Our results also showed that good sleep quality is significantly related to less anxiety and depression. Similarly, Mei *et al.* (2020) reported that sleep problems were an important determinant of levels of anxiety and depression among nurses fighting COVID-19. Some possible reasons are as follows. First, medical staff must stay away from family members and live alone, which might increase a nurse's sleep burden. In addition, excessive hours of work and an excessive clinical

workload could also cause sleep disorders. Sleep quality may play a key role in both anxiety and depression. Strong evidence suggests that quality sleep in sufficient quantity can effectively prevent mental illnesses (Lopresti *et al.* 2013), and individuals with sleep problems are at greater risk for anxiety and depression (Prather *et al.* 2013). Attention should be paid to increasing levels of sleep quality among nurses. Further interventions for sleep disorders should be implemented to reduce symptoms of anxiety and depression.

### Limitations of the study

The study has some limitations. First, we used convenience sampling to recruit nurses from only three tertiary hospitals. Second, it was a cross-sectional study, from which we could not draw comparable results across time. Third, we focused only on the symptoms of anxiety and depression; other psychological disorders, such as post-traumatic stress disorder, were not investigated. Despite these limitations, we have produced important evidence about the effects of resilience, coping styles, and sleep quality on anxiety and depression in front-line nurses treating COVID-19 patients. Further longitudinal studies are needed to validate the current findings, but these findings can form an effective basis for future research in this field.

### CONCLUSION

COVID-19 caused significant levels of anxiety and depression among nurses on the front lines of the disease. In the present study, the prevalences of anxiety and depression were 47.52% and 56.74%, respectively. The three most important variables that could account for anxiety and depression levels were resilience, coping styles, and sleep quality. Therefore, in order to be effective, interventions should pay more attention to these three variables in order to reduce levels of anxiety and depression among nurses fighting COVID-19.

### RELEVANCE FOR CLINICAL PRACTICE

The precise factors that affect anxiety and depression among nurses fighting COVID-19 require further evaluation. This study has uncovered important evidence for the effects of resilience, coping styles, and sleep quality on anxiety and depression in this population. Our study shows that higher resilience, positive coping strategies, and good sleep quality were significantly related to less anxiety and depression among nurses

fighting COVID-19. Therefore, improving resilience, coping styles, and sleep quality are promising ways to reduce levels of anxiety and depression among nurses fighting COVID-19.

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