


ORIGINAL ARTICLE

Factors associated with insomnia among Chinese front-line nurses fighting against COVID-19 in Wuhan: A cross-sectional survey

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Abstract

Aim: To investigate the prevalence of insomnia among front-line nurses fighting against COVID-19 in Wuhan, China, and analyse its influencing factors.

Background: Insomnia is an important factor that can affect the health and work quality of nurses. However, there is a lack of big-sample studies exploring factors that affect the insomnia of nurses fighting against COVID-19.

Method: This cross-sectional study using the Ascension Insomnia Scale, Fatigue Scale-14 and Perceived Stress Scale took place in March 2020. Participants were 1,794 front-line nurses from four tertiary-level general hospitals.

Results: The prevalence of insomnia among participants was 52.8%. Insomnia was predicted by gender, working experience, chronic diseases, midday nap duration, direct participation in the rescue of patients with COVID-19, frequency of night shifts, professional psychological assistance during the pandemic, negative experiences (such as family, friends or colleagues being seriously ill or dying due to COVID-19), the degree of fear of COVID-19, fatigue and perceived stress.

Conclusion: The level of insomnia among participants was higher than the normal level. Interventions based on influencing factors should be implemented to ensure nurses' sleep quality.

Implications for Nursing Management: An in-depth understanding of the influencing factors of insomnia among front-line nurses can help nurse managers develop solutions to improve front-line nurses' sleep quality, which will enhance the physical and mental conditions of nurses and promote the quality of care.

KEYWORDS

China, COVID-19, front-line nurses, influencing factors, insomnia

1 | BACKGROUND

Insomnia refers to the difficulty in falling asleep at night (more than 30 min), the difficulty in maintaining the sleep state after falling asleep or waking up early in the morning without the ability to return to sleep. Most studies have found that the measurement of physiological activity in insomnia patients will increase, including the measurement of metabolism, hormone, heart and high-frequency electroencephalogram (EEG) (Bonnet & Arand, 2006, 2010; Nofzinger et al., 2004). Previous studies have found that insomnia can induce not only physiological diseases such as hypertension, diabetes and cardiovascular disease, but also cause of psychological diseases such as anxiety, depression, two-way emotional disorder and suicide tendency (Khan & Aouad, 2017; Pigeon, Bishop, & Krueger, 2017). When insomnia occurs, the social function during the daytime is often affected, with symptoms including fatigue, sleepiness, inattention, performance impairment, reduced work efficiency and poor quality of life (Espie, Kyle, Hames, Cyhlarova, & Benzeval, 2012; Sateia, 2014). Thus, insomnia seriously damages personal physical and mental health and social functions. According to Ozminowski, Wang, and Walsh (2007), in the United States young adults with insomnia have an average of \$1,253 higher direct and indirect costs than adults without insomnia. Among older adults, the direct costs of insomniacs have increased by approximately \$1,143 than those without insomnia. Therefore, insomnia also brings a heavy burden to the economy and medical system.

According to a survey by LeBlanc et al. (2009), one third of adults in Western countries had difficulty falling asleep or maintaining sleep at least once a week. From 2000 to 2010, the diagnostic rate of insomnia in Norway increased from 11.9% to 15.5% (Pallesen, Sivertsen, Nordhus, & Bjorvatn, 2014). In 2012, 2,861 and 1,095 participants were recruited from the United States and the United Kingdom for a study to investigate sleep quality (Ellis, Perlis, Neale, Espie, & Bastien, 2012). The results showed that the prevalence of acute insomnia in the United States and the United Kingdom was 9.5% and 7.9%, respectively. In addition, the incidence of acute insomnia in the United Kingdom was 31.2%–36.6% every year.

Because of the particularity of their occupation, nurses have a great responsibility, a heavy workload, huge pressure and the need to work in shifts, so they are more likely to suffer from insomnia (Huang, Wu, Ho, & Wang, 2018). The incidence of insomnia among nurses in a certain region of Poland was 47.8% (Zdanowicz, Turowski, Celej-Szuster, Lorencowicz, & Przychodzka, 2020). In four tertiary hospitals in Shanghai, China, 51.0%–72.1% of nurses in various departments had different degrees of insomnia. The average incidence of insomnia among nurses is 57.4% in four hospitals (Yang, Li, & Lu, 2011). COVID-19 exploded in December 2019 and has become a public health emergency of international concern. When it began, numerous medical staff went to Wuhan to provide medical assistance, and nurses have become the major driving force. Because COVID-19 is easily transmitted from person to person, a large number of confirmed and suspected cases have emerged in a short time at home and abroad (Li et al., 2020; World Health Organization,

2020). In the early stage of the outbreak, medical materials and human resources were in short supply, and front-line nurses were under heavy workload, experienced difficulty at work and were at risk of being infected. It has been reported that the front-line clinical nurses fighting against COVID-19 had poor sleep quality, and the incidence of insomnia was as high, at 64.15% (Wu, Song, & Chen, 2020). If nurses suffer from insomnia for an extended period, their physical and mental health would be threatened, and the risk of adverse event due to fatigue would increase, which could cause irreparable losses (Lockley et al., 2007). At the same time, previous studies have shown that insomnia would increase the turnover intention of nurses (Søbstad, Pallesen, Bjorvatn, Costa, & Hystad, 2020). Therefore, it is extremely important to reduce the incidence of insomnia among nurses during the pandemic to promote personal development, relieve physical and mental disorders, ensure the quality of nursing and stabilize the nursing team.

Recently, nurses' insomnia has been increasingly studied, but the sample size of existing studies is small and the representativeness is limited. For example, Zdanowicz et al. (2020) selected 200 nurses from two hospitals to investigate the current situation of insomnia in Polish nurses, and Wu et al. (2020) selected 106 nurses to investigate the sleep quality and its influencing factors of front-line nurses fighting against COVID-19. In addition, most of the existing studies only report the current status, and a comprehensive analysis of the influencing factors of insomnia in nurses is still rare, which makes it difficult to make targeted interventions. However, researches on the influencing factors of insomnia in any group show that older adults, women (especially women before and after menopause), and those with a history of insomnia, a family history of insomnia, the tendency to be awakened easily, psychological diseases (such as depression, anxiety, post-traumatic stress disorder), chronic diseases (lung diseases, hypertension, diabetes and so on), nervous system diseases (such as Parkinson's), drugs, other sleep disorders (such as apnoea syndrome) and central nervous system stimulants have an increased risk of insomnia (Drake, Cheng, Almeida, & Roth, 2017; Drake, Pillai, & Roth, 2014; Jansen et al., 2019; Stein et al., 2018). In addition, there is a correlation between insomnia and higher levels of job stress, effort-reward imbalance, high demand, heavy workload and low social support (Yang et al., 2018). Hence, insomnia is affected by various factors, but the factors that affect insomnia of front-line nurses fighting against COVID-19 are currently unclear.

The aim of this study was to investigate the prevalence of insomnia among Chinese front-line nurses fighting against COVID-19 in Wuhan and to analyse its influencing factors.

2 | METHODS

2.1 | Study design and participants

The design of the study was cross-sectional and descriptive. It was conducted in four public tertiary hospitals from 3–10 March 2020 in Wuhan, China. The convenience sampling method was

used to obtain samples. The sample size should be 5–10 times the number of scale entries (DeVellis, 1991). Furthermore, considering a sample dispersion rate of 20%, it was expected that at least 432 participants would be required. The inclusion criteria were as follows: (a) participant had a nurse's qualification certificate; (b) participant was based in Wuhan or came to Wuhan to provide medical assistance; and (c) participant volunteered to take part in this study. The exclusion criteria were as follows: (a) internships in hospitals and (b) nurses who did not work continuously from 1 January 2020 to the beginning of this study due to maternity or sick leave.

After accounting for inclusion and exclusion criteria, a total of 1,886 online questionnaires were distributed, including 1,794 valid questionnaires. The effective response rate was 95.12%. The effective respondents of the four hospitals participating in the study were 631, 491, 427 and 245, and the effective response rates were 95.75%, 95.16%, 94.89% and 93.87%, respectively.

2.2 | Instruments

2.2.1 | Demographic information

The demographic information consisted of gender, age, working experience, professional title, highest educational level, the presence or absence of chronic diseases, midday nap duration and frequency of exercise.

2.2.2 | Working status

The working status aspects consisted of the frequency of night shifts, whether the participant directly participated in the rescue of patients with COVID-19, whether the participant received the relevant professional occupational protection training, whether the participant received professional psychological assistance, whether occupational exposure had occurred, whether the participant had experienced negative events (such as family, friends or colleagues being seriously ill or dying due to COVID-19) and the degree of fear of COVID-19.

2.2.3 | Athens Insomnia Scale (AIS)

The AIS was developed by the Department of Sleep Psychiatry, University of Athens Medical School, Greece, in 2000 (Soldatos, Dikeos, & Paparrigopoulos, 2000). It is a 8-item Likert-type scale, and each item is divided into four grades of 0–3 from none to severe, with a total score ranging from 0 to 32 points. Insomnia occurs when the score is 6 or more. It is easy to use, and it has accurate measurement results. A Greek study (Kousloglou, Mouzas, Bonotis, & Roupa, 2014) showed that the scale's Cronbach's α was 0.91, and the Cronbach's α was 0.895 in our study.

2.2.4 | Fatigue Scale-14 (FS-14)

The FS-14 was developed by the Department of Psychological Medicine of King's College Hospital in the United Kingdom (Taylor-East, Grech, & Gatt, 2013). The scale consists of 14 items, including physical fatigue (items 1 to 8) and mental fatigue (items 9 to 14). The total scores range from 0 to 14 points. Fatigue occurs when the score is 7 or more (Chalder et al., 1993). The Cronbach's α of the two dimensions of the scale is 0.7449 and 0.7953, and the total Cronbach's α is 0.7725 (Morriss, Wearden, & Mullis, 1998). The Cronbach's α was 0.85 in our study.

2.2.5 | Chinese Perceived Stress Scale (CPSS)

The Perceived Stress Scale is a widely recognized and internationally applied scale. This study used the Chinese version, which was revised by Yang and Huang (2003). It consists of 14 items, using a 5-point Likert-type scoring method of 0 to 4. The higher the overall score, the more stress the subject experiences. When the total score is higher than 25, it can be determined that the individual is at a risk of stress state. The Cronbach's α for the CPSS is 0.78, and the Cronbach's α was 0.814 in our study.

2.3 | Data collection

The study was approved by the Medical Ethics Committee of Union Hospital, Tongji Medical College, Huazhong University of Science and Technology (NO. 2020-0189). Before distributing the questionnaire, we contacted one of the directors of the nursing department of each hospital and explained the purpose and procedures of this study in order to obtain their permission. Online questionnaires were distributed to front-line nurses in various departments of the four hospitals via WeChat (It is a cross-platform communication tool, a mobile application used by more than one billion people, which can send links, voices, pictures, videos and text through the mobile phone network.), and respondents filled out the questionnaire and submitted it via their mobile phone or computer. In order to ensure the accuracy of the data, all items were set as required questions to ensure the completeness of the questionnaires, and the questionnaire filling method was set to limit each device to only submit once to avoid participants submitting their answers multiple times. All participants could withdraw from the study at any time without issue. Participants' privacy was strictly protected in this voluntary and confidential investigation.

2.4 | Statistical analysis

Statistical analyses were performed by SPSS 23.0 software. Count data were described by frequency and percentage, and measurement data are described by mean and standard deviation. Mann-Whitney

TABLE 1 Characteristics of front-line nurses (*n* = 1,794)

Characteristics		<i>n</i>	%
Gender	Male	54	3.0
	Female	1,740	97.0
Age groups (years)	≤25	458	25.6
	26–35	914	50.9
	36–45	265	14.8
	46–55	153	8.5
	>56	4	0.2
Working experience (years)	≤5	717	40.0
	6–10	450	25.1
	11–15	277	15.4
	16–20	106	5.9
	≥21	244	13.6
Professional title	Nurse	497	27.7
	Nurse practitioner	811	45.2
	Nurse-in-charge	437	24.4
	Deputy chief nurse and above	49	2.7
Educational level	Technical secondary school	14	0.8
	Junior college	348	19.4
	Undergraduate course	1,404	78.3
	Master's degree and above	28	1.5
Midday nap duration (minutes)	Never	358	19.9
	<30	586	32.7
	30–60	742	41.4
	>60	108	6.0
Frequency of exercise weekly (times)	≤1	1,432	79.8
	2–3	270	15.1
	≥4	92	5.1
Have chronic diseases or not	Yes	157	8.8
	No	1,637	91.2
Frequency of night shifts weekly (times)	0	582	32.5
	1	361	20.1
	2	544	30.3
	3	224	12.5
	4	83	4.6
Whether directly participated in the rescue of patients with COVID-19	Yes	476	26.5
	No	1,318	73.5
Whether received professional protection training	Yes	1,677	93.5
	No	117	6.5
Whether received any professional psychological assistance	Yes	183	10.2
	No	1,611	89.8

(Continues)

TABLE 1 (Continued)

Characteristics		<i>n</i>	%
Whether had occupational exposure	Yes	168	9.4
	No	1,626	90.6
Whether had any experience with negative events	Yes	381	21.2
	No	1,413	78.8
Degree of fear with COVID-19	None	125	7.0
	Mild	515	28.7
	Moderate	704	39.2
	Severe	450	25.1
Fatigue	No	1,185	66.1
	Yes	609	33.9
Perceived stress	No	1,005	56.0
	Yes	789	44.0

test and Kruskal–Wallis test were used to analyse the insomnia status of nurses with different general data, working conditions, fatigue and perceived pressure on insomnia among front-line nurses. Then, we took the insomnia score as the dependent variable and the single-factor analysis as the independent variables, constructed a multiple linear regression equation and analysed the influencing factors of insomnia. All tests were conducted with $\alpha = 0.05$.

3 | RESULTS

3.1 | Participant characteristics

Participant characteristics are presented in Table 1. The majority of participants were women (97.0%), and 50.9% of participants were in the 26- to 35-year age group. In terms of working experience, 40% of the participants had no more than 5 years of working experience. 45.2% of the participants gained the professional title of nurse practitioner, and most participants had a bachelor's degree (78.3%). During work, 41.4% of the participants had midday nap duration of 30–60 min per day. Most participants did not exercise more than once a week (79.8%). Additionally, most nurses did not have chronic diseases (91.2%). Regarding the frequency of night shifts, 32.5% and 30.3% of the participants have 0 and 2 night shifts per week, respectively. More than 70% of the participants did not directly participate in the rescue of patients with COVID-19. Furthermore, 93.5% of the participants received professional protection training, and more than 90% of the participants had no occupational exposure. Approximately 90% of participants did not receive professional psychological assistance. Only 78.8% of participants did not have any experience with negative events. For the degree of fear with COVID-19, 39.2% was moderate and 28.7% was mild. As for fatigue and perceived stress, 66.1% of the nursing staff were not in a state of fatigue, and 56% of the nursing staff had no perceived stress.

3.2 | Insomnia, fatigue and perceived stress condition of front-line nurses

As Table 2 shows, the average AIS score (Mean \pm SD = 6.30 \pm 4.61) of front-line nurses was higher than normal level, and 948 nurses (52.8%) had insomnia problems. The average FS-14 score (Mean \pm SD = 5.20 \pm 3.75) and average CPSS score (Mean \pm SD = 22.35 \pm 7.63) were within their normal range, and the mean sub-dimension scores of FS-14 for physical and mental fatigue were found as 3.39 (SD = 2.67) and 1.81 (SD = 1.67), respectively. There were 609 nurses (33.9%) and 789 nurses (44.0%) in fatigue and stress state, respectively.

3.3 | Factors affecting insomnia among front-line nurses

3.3.1 | Single-factor analysis between sociodemographic variables and insomnia

As Table 3 shows, female nurses had significantly higher mean AIS score than male nurses ($z = -3.038, p = .002$), and there were significant differences in the mean scores of AIS among nurses of different ages ($\chi^2 = 13.306, p = .010$). Nurses with more working experience had higher mean AIS scores ($\chi^2 = 27.054, p = .000$), and nurses' mean AIS scores decreased as midday nap duration time increased ($\chi^2 = 28.253, p = .000$). The mean AIS score of nurses who exercised no more than once a week was significantly higher than that of nurses who exercised 2 to 3 times and 4 times or more per week ($\chi^2 = 29.622, p = .000$). Nurses with chronic diseases had a higher mean AIS score than those without chronic diseases ($z = -6.317, p = .000$).

3.3.2 | Single-factor analysis between work-related variables and insomnia

Table 4 shows that the mean AIS scores of nurses who directly participated in the rescue of patients with COVID-19, or had occupational exposure during contagion rescue work, or experienced negative events during the rescue period were significantly higher ($z = -7.322, p = .000; z = -3.935, p = .000; z = -7.897, p = .000$). In addition, the mean AIS scores of nurses who had received professional protection training or professional psychological assistance were significantly

lower ($z = -2.752, p = .006; z = -4.424, p = .000$). The more night shifts nurses had, the higher the mean AIS scores were ($\chi^2 = 35.838, p = .000$). Moreover, the more severe the nurse's fear of COVID-19, the higher the mean AIS scores were ($\chi^2 = 217.159, p = .000$).

3.3.3 | Single-factor analysis between fatigue, perceived stress variables and insomnia

The result in Table 5 shows that FS-14 scores and CPSS scores were significantly related to the AIS scores of the front-line nurses ($z = -22.856, p = .000; z = 16.194, p = .000$).

3.3.4 | Multiple linear regression of factors affecting insomnia

The variables that were found to have an effect on the insomnia score of front-line nurses were used as independent variables, and the insomnia scores were used as the dependent variables to construct a multiple linear regression equation. Table 6 shows the results of the multiple linear regression model, illustrating that front-line nurses' insomnia scores could be predicted by the gender ($\beta = 0.04, p = .035$), working experience ($\beta = 0.113, p = .004$), midday nap duration ($\beta = -0.082, p = .000$), chronic diseases ($\beta = -0.046, p = .019$), frequency of night shifts ($\beta = -0.049, p = .015$), direct participation in the rescue of patients with COVID-19 ($\beta = -0.112, p = .000$), status of receiving professional psychological assistance ($\beta = 0.063, p = .001$), experience with negative events ($\beta = -0.061, p = .002$), the degree of fear of COVID-19 ($\beta = 0.179, p = .000$), fatigue ($\beta = 0.379, p = .000$) and perceived stress ($\beta = 0.16, p = .000$).

4 | DISCUSSION

The aim of this study was to investigate the prevalence of insomnia among Chinese front-line nurses fighting against COVID-19 in Wuhan and analyse its influencing factors.

In this study, the mean score of AIS was 6.30 (SD = 4.61), which exceeded the critical value. The incidence of insomnia was 52.8%, which was consistent with the result of 51.7% reported by Qi et al. (2020), but higher than the result of 43.1% reported during a non-epidemic period in China (Lai, Huang, & Xie, 2018).

TABLE 2 Insomnia, fatigue and perceived stress among front-line nurses

Scales	Dimensions	Minimum	Maximum	Mean	SD
AIS	—	0	24	6.30	4.61
FS-14	—	0	14	5.20	3.75
	Physical fatigue	0	6	3.39	2.67
	Mental fatigue	0	8	1.81	1.67
CPSS	—	1	52	22.35	7.63

Variables		Insomnia	
		M (SD)	$^*Z/^{**}\chi^2$ ***p
Gender	Male	4.46 (3.82)	-3.038
	Female	6.35 (4.63)	.002
Age groups (years)	≤25	5.82 (4.42)	13.306
	26-35	6.22 (4.51)	.010
	36-45	6.82 (4.82)	
	46-55	7.28 (5.22)	
	>56	5.75 (3.40)	
Working experiences (years)	≤5	5.66 (4.41)	27.054
	6-10	6.41 (4.48)	.000
	11-15	6.91 (4.77)	
	16-20	6.95 (4.58)	
	≥21	6.98 (5.06)	
Professional title	Nurse	6.00 (4.48)	5.338
	Nurse practitioner	6.21 (4.47)	.149
	Nurse-in-charge	6.73 (4.97)	
	Deputy chief nurse and above	6.88 (4.78)	
Educational level	Technical secondary school	5.00 (3.33)	6.861
	Junior college	6.67 (4.81)	.076
	Undergraduate course	6.25 (4.57)	
	Master's degree and above	4.61 (4.37)	
Midday nap duration (minutes)	Never	7.21 (4.89)	28.253
	<30	6.45 (4.50)	.000
	30-60	5.94 (4.56)	
	>60	4.85 (4.05)	
Frequency of exercise weekly (times)	≤1	6.54 (4.57)	29.622
	2-3	5.10 (4.55)	.000
	≥4	5.96 (4.90)	
Have chronic disease or not	yes	8.62 (4.92)	-6.317
	no	6.07 (4.52)	.000

Note: $^{**}\chi^2$, Kruskal-Wallis test; $^{***}p$, level of statistical significance; significant ($p < .05$); *Z , Mann-Whitney test.

Abbreviations: M, mean; SD, standard deviation.

TABLE 3 Descriptive and univariate analyses of the factors between sociodemographic and insomnia ($n = 1,794$)

The incidence rate of sleep disorders among nurses in Wuhan has been higher during the COVID-19 crisis. Due to its characteristics of high human-to-human transmission, being highly contagious, having a long incubation period and sometimes resulting in fatality, COVID-19 has caused social panic to some extent (World Health Organization, 2020). At the beginning of the outbreak, nurses were faced with unfamiliar viruses, high-intensity work, significant responsibilities, insufficient medical resources and infected colleagues, and the experienced tremendous psychological pressure. After the lockdown of the city, living materials were insufficient,

separating from close relatives, while physical and mental needs could not be met, resulting in a series of traumatic stress, leading to sleep disorders and psychological disorders of medical staff (Xiao, Zhang, Kong, Li, & Yang, 2020).

As revealed in this study, females' insomnia level was higher than males', which was similar to the findings reported in previous studies (Drake et al., 2014; Tang et al., 2017). The gender differences in the prevalence of insomnia might be related to biological, psychosocial and sociological factors. Hormone fluctuations are the main biological factors, and sleep quality changes with the biological life cycle of

TABLE 4 Descriptive and univariate analyses of the factors between work-related variables and insomnia ($n = 1,794$)

Variables		Insomnia	
		M (SD)	$^*Z/^{**}\chi^2$ *** <i>p</i>
Frequency of night shifts weekly (times)	0	5.78 (4.43)	35.838
	1	6.06 (4.56)	.000
	2	6.18 (4.44)	
	3	7.44 (4.88)	
	4	8.63 (5.38)	
Whether participated in the rescue of patients with COVID-19	Yes	7.64 (4.84)	-7.322
	No	5.81 (4.43)	.000
Whether received professional protection training	Yes	6.20 (4.53)	-2.752
	No	7.68 (5.48)	.006
Whether received any professional psychological assistance	Yes	5.01 (4.48)	-4.424
	No	6.44 (4.61)	.000
Whether had occupational exposure	Yes	7.75 (5.04)	-3.935
	No	6.15 (4.54)	.000
Whether had any experience with negative events	Yes	7.94 (4.78)	-7.897
	No	5.85 (4.47)	.000
Degree of fear with COVID-19	None	3.89 (4.32)	217.159
	Mild	4.46 (3.67)	.000
	Moderate	6.75 (4.24)	
	Severe	8.35 (5.13)	

Note: *H , Kruskal-Wallis test; ****p*, level of statistical significance; significant ($p < .05$); *Z , Mann-Whitney test.

Abbreviations: M, mean; SD, standard deviation.

menstruation, pregnancy and menopause (Pengo, Won, & Bourjeily, 2018). The research of Van Eycken, Neu, Newell, Kornreich, and Mairesse (2020) showed that under stress, the fluctuation of oestrogen might affect the emotional regulation area in the brain, which made females more likely to sense pressure and have symptoms of depression and anxiety, which was also an important factor for insomnia. In addition, there were differences in the family responsibilities of women and men. Due to the sudden change in women's social roles, the conflict between work and family was exacerbated, and it was easy for female to feel guilty about the family, so the level of psychological distress was higher than that of men (Chandola et al., 2004).

The results also revealed that nurses with more working experience had higher mean AIS scores. The main reason was considered to be that nurses with more working experience had a higher ability to balance and deal with emergencies, but at the same time, their own standards and expectations for themselves were higher than nurses with less experience. They played an important role in the pandemic rescue work, constantly faced and adopted to different

TABLE 5 Descriptive and univariate analyses of the factors between insomnia and fatigue and perceived stress variables ($n = 1,794$)

Variables		Insomnia	
		M (SD)	*Z *** <i>p</i>
Fatigue	No	4.51 (3.53)	-22.856
	Yes	9.77 (4.49)	.000
Perceived stress	No	4.70 (3.59)	-16.194
	Yes	8.32 (4.97)	.000

Note: ****p*, level of statistical significance; significant ($p < .05$); *Z , Mann-Whitney test.

Abbreviations: M, mean; SD, standard deviation.

pressure challenges, and the higher levels of job stress made them more prone to insomnia (Yang et al., 2018). The current study is the first to report the effect of working experience on insomnia. More attention should be paid to the mechanism of working experience affecting insomnia.

Furthermore, the results of this study showed that nurses' mean AIS scores decreased as midday nap duration increased. Liao, Hao, and Sui (2018) also concluded in a study on athletes that a 60-minute nap was conducive to shortening the sleep latency at night and prolonging the length of deep sleep, but the study only compared the 60-min nap with 120-min nap. At present, there are few studies on the effects of midday nap duration on night sleep. However, previous studies have shown that 20–30 min of nap time can relieve fatigue and drowsiness, and improve reaction and cognitive ability, and reduce the incidence of obesity. If the nap time exceeds 30 min, the person would be prone to sleep inertia, and their alertness, calculation ability, reaction speed and short-term memory will be weakened in several minutes or even a few hours after awakening, and sometimes resulting in upset and depression (Hilditch, Centofanti, Dorrian, & Banks, 2016; Lovato & Lack, 2010; Trotti, 2017). Therefore, it is suggested that the time of midday nap duration on working days should be 20–30 min.

With regard to chronic diseases, the findings found that nurses with chronic diseases were more likely to suffer from insomnia than those without chronic diseases, which was consistent with the results of Taylor et al. (2007). The chronic diseases related to insomnia include lung disease, diabetes, hypertension and chronic pain (Tang et al., 2015; Taylor et al., 2007; Vgontzas et al., 2009). In addition, insomnia can aggravate the condition of chronic diseases, which can create a vicious circle. Therefore, nursing managers should pay more attention to nurses with chronic diseases.

The results also revealed that the more night shifts nurses had, the higher the mean AIS scores were. Irregular shift work causes nurses' biological clocks to be disturbed, causing the body and mind to be in a state of stress, making them prone to shift work disorder, which is mainly manifested as insomnia and drowsiness (Ai & Guan, 2015). It had also been pointed out that shift nurses tend to show low sleep quality, which has been shown to activate

TABLE 6 Multiple linear regression of insomnia and sociodemographic, work-related factors, fatigue and perceived stress variables of the nurses ($n = 1,794$)

Variables	Regression coefficients		Standardized coefficients			95% Confidence interval	
	B	Standard error	Beta	t	p	Lower limit	Upper limit
Gender	1.069	0.506	0.04	2.112	.035	0.076	2.062
Age groups (years)	-0.149	0.204	-0.028	-0.731	.465	-0.548	0.25
Working experiences (years)	0.373	0.129	0.113	2.887	.004	0.12	0.626
Midday nap duration (minutes)	-0.437	0.1	-0.082	-4.38	.000	-0.633	-0.242
Frequency of exercise weekly (times)	-0.12	0.161	-0.014	-0.746	.456	-0.436	0.196
Have chronic disease or not	-0.744	0.318	-0.046	-2.34	.019	-1.367	-0.12
Frequency of night shift weekly (times)	-0.143	0.058	-0.049	-2.446	.015	-0.258	-0.028
Whether directly participated in the rescue of patients with COVID-19	-1.167	0.197	-0.112	-5.909	.000	-1.554	-0.78
Whether received professional protection training	0.058	0.35	0.003	0.165	.869	-0.629	0.744
Whether received any professional psychological assistance	0.959	0.283	0.063	3.392	.001	0.404	1.513
Whether had occupational exposure	-0.045	0.298	-0.003	-0.15	.881	-0.629	0.54
Whether had any experience with negative events	-0.691	0.218	-0.061	-3.166	.002	-1.119	-0.263
Degree of fear with COVID-19	0.932	0.102	0.179	9.183	.000	0.733	1.131
Fatigue	3.688	0.21	0.379	17.524	.000	3.275	4.101
Perceived stress	1.49	0.196	0.16	7.6	.000	1.106	1.875
Constant	3.591	1.527		2.352	.019	0.596	6.585

Note: t, Student's t test; p, level of statistical significance; significant ($p < .05$).

the hypothalamic-pituitary-adrenal axis and was related to sleep arousal (Tsai, Chou, Tsai, Yen, & Niu, 2019). Previous research has shown that more than 5 night shifts per month and long working hours will seriously affect sleep quality. In reality, it was necessary to control night shift frequency and working hours and avoid overtime as much as possible (Li, 2019). In addition, individuals can try to go to bed at the same time every night when they are not on night shift to solve the sleep problem caused by night shifts (UpToDate, 2019).

In our research results, nurses who directly participated in the rescue of patients with COVID-19, or experienced negative events, or had a high degree of fear of COVID-19 accompanied by higher insomnia scores. Events including directly participating in the rescue of patients with COVID-19 and experiencing negative events increased the emotional and psychological pressure of nurses' tension, sadness and fear. Perogamvros, Castelnovo, Samson, and Dang-Vu (2020) reported that a real or individual perceived stress source can induce fear and stress responses that cause acute insomnia symptoms. Physiological research has also found that in an environment with fear and stress, the awakening and

high-frequency EEG power during non-rapid eye movement sleep increased, leading to the occurrence of short-term insomnia (Cano, Mochizuki, & Saper, 2008).

As revealed in our study, the mean score of nurses' who had received professional psychological assistance was lower, indicating that psychological support was of great importance to improving nurses' sleep. Chronic insomnia often coexists with mental illness. About half of patients with chronic insomnia suffer from mental illness, and most patients with mental illness have insomnia problems (Alvaro, Roberts, & Harris, 2013; Ohayon, 2002). It is suggested that online psychological doctors should provide professional psychological support for nursing staff during the fight against COVID-19 at any time, thus reducing their mental pressure, preventing mental disorders and insomnia, and avoiding the development of chronic insomnia from short-term insomnia.

The results of this study reported that the mean score of FS-14 was within normal levels, and the fatigue rate was lower than the fatigue rate of Chinese nurses before the pandemic (Mo & Zhou, 2016; Wang, 2012). This result might suggest the effectiveness of

the corresponding nursing management measures in the four hospitals in Wuhan during the fight against COVID-19 and proved that such measures were worthy of continued development for reducing nurses' fatigue. Previous research showed that fatigue was directly affected by working time, workload, night shift, anxiety and achievement (Chen, Zhou, Bao, & Chen, 2017). The management measures taken by the four hospitals eliminated some of the negative factors of fatigue, for example unified implementation of a flexible shift model of six hours and four shifts, reasonable human resource allocation, clear core nursing care system, encouraging nurses to keep in touch with family and friends, providing additional salary subsidies and publicizing the deeds of nurses to stimulate their sense of accomplishment. In the multiple linear regression model constructed in this study, fatigue was the most influential factors in nurses' insomnia. Skarpsno, Nilsen, Sand, Hagen, and Mork (2019) found that work-related mental fatigue was an important risk factor for insomnia symptoms. Compared with patients without severe fatigue, insomnia patients with severe fatigue showed higher symptoms of insomnia, daytime sleepiness and longer habitual sleep duration (Kim et al., 2019). Hence, it is recommended that managers can use the above nursing management measures to try to minimize the fatigue of nurses.

In regard to perceived stress, the result showed that the nurses' CPSS score in present study was slightly lower than normal level. It found that the greater the perceived stress, the higher the insomnia score. The interaction between stressors and sleep quality was complex, including direct and indirect effects, influenced by personality tendency, cognitive regulation, emotional regulation and coping style (Yan, Liu, Tang, & Lin, 2010). Therefore, we suggest that nurses could be given a simple personality trait questionnaire evaluation, and experts could form assessment reports and recommendations based on the questionnaire, which would promote nurses to understand their own personality characteristics, control emotions in a targeted manner and solve problems in a positive way. Wang and Zhou (2017) confirmed that mental decompression can also reduce the level of individual perceived stress, so as to improve sleep.

5 | LIMITATIONS OF THE STUDY

The research has several limitations. First, its cross-sectional nature constrains the ability to interpret the causal relationships between the different variables in this study. Second, the self-reporting questionnaires used in the study may have introduced bias due to individual personal understanding and judgement of the survey items. Third, the convenience sampling method may lead to the limitation of the representativeness of the research sample and the generalization of the research conclusion. Future research requires more improved research design, including layered design, and comparative analysis of samples from different regions and different countries. Other studies using qualitative research should also be done to

reveal more aspects of insomnia of front-line nurses fighting against COVID-19.

6 | CONCLUSIONS

Overall, there was a generally higher level of nurses' insomnia among Chinese front-line nurses who fought against COVID-19 in Wuhan. Fatigue, perceived stress, the degree of fear of COVID-19, working experience and direct participation in the rescue of patients with COVID-19 were the mainly predictive factors of insomnia in this study. Interventions should be created according to the influencing factors of insomnia to ensure the sleep quality of nurses.

7 | IMPLICATIONS FOR NURSING MANAGEMENT

This study explored the status of insomnia among front-line nurses fighting against COVID-19 and showed that it was affected by sociological factors, work-related factors, fatigue and perceived stress. For nursing managers, the results of this research can be used to develop and implement management strategies. The findings remind nursing managers that they need to allocate human resources reasonably, optimize work processes, arrange shift work reasonably, encourage nurses to take a midday nap, pay attention to nurses with chronic diseases, provide professional protection training for nurses, strengthen humanistic care and provide nurses with professional psychological assistance to overcome insomnia. All of this should be done to improve the status of insomnia among nurses, thus stabilizing the nursing teams, improving patient care and thereby ending the pandemic as quickly as possible.

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CONFLICT OF INTEREST

None.

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