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Effect of occupational stress and resilience on insomnia among nurses during COVID-19 in China: a structural equation modelling analysis

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ABSTRACT

Objectives To explore the effects of occupational stress and resilience on insomnia among Chinese nurses during the COVID-19 pandemic.

Design, settings and participants A quantitative description study. The data were collected via a cross-sectional survey. A total of 725 front-line nurses at three tertiary hospitals in western China were included from December 2022 to January 2023. The Connor-Davidson Resilience Scale, Job Content Questionnaire, and Athens Insomnia Scale were used to collect data from a self-reported online questionnaire.

Outcome measures The outcome variable was insomnia, and structural equation modelling was used to assess the associations among resilience, occupational stress and insomnia.

Results The prevalence of insomnia among the participants was 58.76%. The structural equation model showed that resilience had a negative direct effect on insomnia and occupational stress, and occupational stress had a positive direct effect on insomnia. Involvement in COVID-19-related work has a positive effect on insomnia through occupational stress. In contrast, higher education levels improved insomnia through increased resilience.

Conclusion A significantly higher prevalence of insomnia has been observed among Chinese nurses during the COVID-19 pandemic. Our study suggests that better resilience may improve insomnia by relieving occupational stress, and implementing measures to promote resilience is essential to reduce occupational stress in nurses and improve their sleep quality.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study used structural equation modelling to reveal the complex relationships among occupational stress, resilience and insomnia.
⇒ The main study variables were measured using validated scales.
⇒ The study was conducted only in western China, which may limit the extrapolation of the findings.
⇒ This study was based on a cross-sectional design and could not reveal a causal relationship.

INTRODUCTION

Insomnia is a prevalent sleep disturbance that refers to sleep symptoms such as difficulty initiating or staying asleep, irregular wake-sleep patterns and early morning awakening with no resumption of sleep.[1] The outbreak of COVID-19 has been confirmed to significantly exacerbate the physical and psychological burden on hospital staff, especially among nurses, due to the highly demanding and stressful working conditions and the extremely uncertain and infectious nature of this virus.[2] Because of increased workload and shiftwork, nurses are exposed to restricted sleep opportunities, fewer sleep hours and poorer sleep quality.[3] Studies have reported that prevalence the of insomnia is 40% (95% CI 36.9% to 42.0%) around the world and 36.36% (95% CI 33.36% to 39.36%) among Chinese healthcare workers.[4 5] In December 2022, China declared a nationwide loosening of COVID-19 restrictions and then officially ended its zero-COVID-19 policy in January 2023.[6] The management of COVID-19 was downgraded from class A to class B, leading to the outspread of the Omicron variant and triggering another cascade of infections.[7] Facing another abrupt outbreak of COVID-19 was an unprecedented challenge in this new phase, hospitals were overwhelmed due to the increased numbers of people with fever attending clinics and antifever drugs were out of stock for weeks.[8] Large numbers of medical staff were infected while still going to work sick, staying on the front line and coping with the surge in patients with fever.[9] Given that Chinese healthcare workers are experiencing another round of COVID-19 attacks, it is necessary to understand the current situation of insomnia and propose relevant coping strategies. The risk factors for insomnia among nurses have been widely discussed, including female sex, genetics, familial history of insomnia, psychiatric history, educational background, length of service, position,

hospital level, night shifts, family income, high-risk units and contact with affected patients.[10 11] Among these risk factors, stressful experience is the most common precipitating factor of insomnia, and research has revealed that environmental stress influences the sleep system.[12]

Occupational stress is an alarming phenomenon worldwide and has been acknowledged as a major public health problem due to its negative impact on the physical, mental, emotional and psychological well-being of employees in various occupations.[13] Nurses are at high risk of exposure to workplace stress, which may result in compromising capacity to practice, inducing burn-out, compassion fatigue and higher turnover intention.[14] Occupational stress among nurses is usually brought by heavy workloads, frequent night shifts and long working hours, and these stressors come from patients, their relatives and their colleagues.[15] Unfortunately, the occurrence of the COVID-19 pandemic imposed an unprecedented burden on nurses globally, resulting in a higher level of occupational stress than that of other healthcare providers due to the shortage of nursing staff.[16 17] Many studies have investigated the correlation between insomnia and stressors in the workplace.[18–20] The correlation between insomnia symptoms and occupational stress was identified based on a comprehensive appraisal of 17 pertinent studies with an OR of 1.73 (95% CI 1.46 to 2.05).[21] However, whether the relationship is direct remains unclear.

Resilience is a dynamic process of positive adaptation and recovery from adversity.[22] Resilience is the ability to bounce back or cope successfully despite adverse circumstances, plays a key role in the development of stress to emotional response and is an important attribute for surviving and adapting to stressful working environments, optimising personal abilities and establishing supportive systems.[11 17] The process of stress response involves affective, cognitive and behavioural self-regulatory processes, in which resilience can be a vital indicator or mediating factor.[23] Previous studies have found that resilience is consistently a protective factor for nurses during disasters and help them transform adversities into positive growth experiences, which contributes to nurses' professional development and better mental and physical health.[24 25] Recently, the concept of resilience has been proven to play a vital role in mediating stressors and correspondence.[26 27] However, the effect of resilience on insomnia among nurses during the spread of the Omicron variant in China has remained obscure.

The study

There is a lack of studies on the effects of occupational stress and resilience on insomnia in nurses, especially during the COVID-19 pandemic. This study aimed to investigate occupational stress and insomnia among nurses in western China during the COVID-19 pandemic and explore the effects of occupational stress and resilience on insomnia among Chinese nurses during the COVID-19 pandemic.

METHODS

Study design and participants

This cross-sectional study was conducted from December 2022 to January 2023 at tertiary hospitals in Sichuan Province, China. The convenience sampling method was used to obtain samples from three tertiary hospitals in the cities of Chengdu, Luzhou and Yibin in Sichuan Province. The survey was web based and was communicated to the department through each hospital. The nurses voluntarily completed the survey after being informed of the purpose and content of the study. The sample size was estimated based on two strategies prior to the survey. One is that the minimum sample size should be 10–20 times the number of estimated parameters[28] and taking into account 10%–15% invalid questionnaires, the sample size for this survey ranged from 200 to 424. The other is calculated by the formula for a cross-sectional study.[29] We assumed a 95% CI, a 5% precision and a 55% prevalence of insomnia among nurses during the COVID-19 pandemic[30 31]; thus, the minimum sample size needed for the survey was 380.

Information on general demographics, work-related characteristics, resilience, occupational stress and insomnia was obtained from a self-reported online questionnaire provided by www.wjx.cn (an online crowdsourcing platform in mainland China). A total of 945 questionnaires were collected, and after excluding 220 invalid questionnaires, 725 participants were ultimately enrolled in the study. The flow chart of the participant selection process is presented in online supplemental figure 1. The inclusion criteria were as follows: (1) licensed registered nurses; (2) currently working in the hospital we surveyed (including regular staff and refresher nurses) and (3) informed consent and voluntary participation. The participants were excluded if they (1) were not clinical nurses; (2) were intern nurses or had received standardised training; (3) were not working in the hospitals during our survey period or (4) did not complete the questionnaire (the questionnaire must have been completed before it could be submitted by default).

Measures

General demographic characteristics and work-related information

The demographic characteristics included in the study were age, sex, education level and marital status. The work-related information associated with resilience, occupational stress and insomnia, including the names of hospitals, departments, frequency of night shifts and years of working as clinical nurses, was collected. Moreover, the experience of COVID-19-related work was assessed by a single question 'Have you ever been involved in any work for COVID-19 control? Such as collecting or detecting nucleic acids, treating patients with COVID-19 or temporarily working in a fever clinic?' Participants were considered to have attended work related to COVID-19 if they had any of the above experiences during the COVID-19 pandemic.

Resilience

The psychological resilience of the participants was assessed using the Chinese version of the 10-item Connor-Davidson Resilience Scale (CD-RISC-10), a widely used tool for measuring the ability to cope with adversity and to thrive in the face of stress.[32] The scale uses a 5-point Likert scale with each item ranging from 0 (never) to 4 (always). The total score ranges from 0 to 40, with higher scores indicating better resilience. The CD-RISC-10 has been well validated in previous studies in the Chinese population, including medical staff.[33]

Occupational stress

Occupational stress was assessed using the 22-item Chinese version of the Job Content Questionnaire (C-JCQ-22). The scale consists of three dimensions: job demand (five items), job control (nine items) and social support (eight items), in which each item is recorded using a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree).[34 35] The total scores for each dimension range from 5 to 20, 9 to 36 and 8 to 32, respectively. Based on the job demand-control model, occupational stress was defined as working in an environment with high job demand and low job control; thus, the ratio of occupational stress was calculated by dividing the job demand score by the job control score (weighted by the number of items).[36] A higher ratio indicates a higher level of occupational stress. As one of the most commonly used tools to measure job strain among Chinese people, especially hospital workers, the validity and reliability of the C-JCQ-22 have been proven in prior studies.[34 35 37]

Insomnia

Sleep disorders and subjective insomnia were screened using the Athens Insomnia Scale (AIS), a widely used self-administered psychometric tool for the diagnosis and treatment of insomnia.[38] The AIS consists of eight items, and each item is rated using a 4-point Likert scale ranging from 0 (no problem) to 3 (severe problem). The total score ranges from 0 to 24, with higher scores indicating more severe sleep disorders and insomnia symptoms. Consistent with prior publications,[39–41] participants were divided into three groups based on their AIS score: non-insomnia (<4), suspected insomnia (4–5) and insomnia (≥6). This study used the Chinese-language-validated AIS and the diagnostic accuracy of the Chinese version has been validated previously.[42]

Statistical analyses

The characteristics of the participants were described as mean and SD for continuous variables and count and percentages for categorical variables. The Kruskal-Wallis test or analysis of variance was used for continuous variables, and the χ^2 test or Fisher's exact test was used for categorical variables to examine differences across non-insomnia, suspected insomnia and insomnia subgroups. We then analysed the factors associated with insomnia using an ordinal logistic regression model with insomnia as the dependent variable and we tested the assumption of proportional odds of the model (a premise for ordinal logistic regression) before the regression analysis. To compare the effect of diverse levels, the resilience scores and occupational stress ratio were divided into three parts according to the tertiles, that is, the upper tertile was defined as 'high', the middle tertile was defined as 'moderate', and the lower tertile was defined as 'low'. The OR and 95% CI were reported.

To assess the associations among resilience, occupational stress, and insomnia, the structural equation modelling (SEM) was fitted using the lavaan R package.[43] The diagonally weighted least squares estimator was preferred, as the ordinal variables were included in our model, and all continuous variables were z-standardised.[44] We controlled for age, gender and marital status when estimating the hypothesis model. The direct and indirect effects of predictors for insomnia were estimated with bootstrapping (1000 simulations), with non-standardised and standardised estimates and 95% CI presented to confirm the significance and magnitude of the effects. The following model fit indices were used to verify the hypothesis model: χ^2 (df and p value), root-mean-square error of approximation (RMSEA), comparative fit index (CFI), goodness of fit index (GFI), normed fit index (NFI) and standardized root mean square residual (SRMR).

All statistical analyses were conducted by using R V.4.1.1, and $p<0.05$ indicated statistical significance.

Patient and public involvement

No patients were involved in designing, conducting or reporting the research.

RESULTS

Participant characteristics

Among the 725 participants included in our final analyses, 182 (25.10%) were considered to have non-insomnia symptoms, 117 (16.14%) were suspected insomniacs and 426 (58.76%) were insomniacs. The majority (93.52%) of the clinical nurses were female. The mean age of the sample was 32.89 (SD=7.72) years. A total of 345 (47.59%) individuals reported that they had engaged in COVID-19 control during the pandemic. Among all participants, the mean score of the CD-RISC scale was 29.47 (SD=7.12), and the mean ratio score of occupational stress was 0.94 (SD=0.14). The detailed characteristics of the full sample and the three subgroups are presented in table 1.

Factors associated with insomnia

The results of the ordinal regression model for insomnia predictors are shown in table 2. The model satisfied the proportional odds assumption with a p value of 0.709. The model coefficients also indicated that nurses with higher educational levels were at a lower risk of insomnia (OR 0.593, 95% CI 0.404 to 0.863), and more than two-night shifts a week were associated with a higher risk of insomnia than those who did not work night shifts (OR

Table 1 Characteristics of the participants

Characteristics	All (N=725)	Non-insomnia (N=182)	Suspected insomnia (N=117)	Insomnia (N=426)	P value
Age (years)	32.89 (7.72)	33.24 (8.38)	32.24 (7.84)	32.91 (7.40)	0.550
Gender					0.352
Male	47 (6.48%)	14 (7.69%)	10 (8.55%)	23 (5.40%)	
Female	678 (93.52%)	168 (92.31%)	107 (91.45%)	403 (94.60%)	
Marital status					0.242
Married	452 (62.34%)	109 (59.89%)	67 (57.26%)	276 (64.79%)	
Others	273 (37.66%)	73 (40.11%)	50 (42.74%)	150 (35.21%)	
Education level					0.024
Below undergraduate	189 (26.07%)	36 (19.78%)	24 (20.51%)	129 (30.28%)	
Undergraduate	511 (70.48%)	138 (75.82%)	87 (74.36%)	286 (67.14%)	
Postgraduate	25 (3.45%)	8 (4.40%)	6 (5.13%)	11 (2.58%)	
Night shift					<0.001
No	179 (24.69%)	56 (30.77%)	38 (32.48%)	85 (19.95%)	
Once a week or less	234 (32.28%)	72 (39.56%)	33 (28.21%)	129 (30.28%)	
Twice a week or more	312 (43.03%)	54 (29.67%)	46 (39.32%)	212 (49.77%)	
Attendance in COVID-19-related work					0.204
No	380 (52.41%)	105 (57.69%)	56 (47.86%)	219 (51.41%)	
Yes	345 (47.59%)	77 (42.31%)	61 (52.14%)	207 (48.59%)	
AIS scores	6.82 (4.65)	1.46 (1.14)	4.51 (0.50)	9.75 (3.72)	<0.001
CD-RISC scores	29.47 (7.12)	32.23 (6.38)	30.74 (6.58)	27.95 (7.16)	<0.001
Occupational stress	0.94 (0.14)	0.91 (0.13)	0.93 (0.14)	0.97 (0.14)	<0.001

AIS, Athens Insomnia Scale; CD-RISC, 10-item Connor-Davidson Resilience Scale.

2.411, 95% CI 1.634 to 3.562). After adjusting for age, sex, marital status, education level, night shift and COVID-19, nurses with high occupational stress were associated with a high risk of insomnia. Compared with nurses with low occupational stress, the risk of insomnia in nurses with moderate and high occupational stress was 1.529 (95% CI 1.057 to 2.223) and 2.038 times (95% CI 1.400 to 2.983), respectively. In addition, higher levels of resilience were associated with a lower risk of insomnia. The risk of insomnia in nurses with moderate and high resilience was 0.551 (95% CI 0.374 to 0.809) and 0.342 times (95% CI 0.231 to 0.502), respectively, greater than that in nurses with low resilience.

Effects of occupational stress and resilience on insomnia

The SEM was performed to evaluate the associations between resilience, occupational stress, and insomnia, and the standardised regression estimates of the hypothesised model are presented in figure 1. The model fit indices were acceptable: χ^2=13.056, df=3, p=0.005, RMSEA=0.068, CFI=0.938, GFI=0.990, NFI=0.921 and SRMR=0.000. According to the model, resilience had a negative direct effect on occupational stress and insomnia, and the β values (standardised regression estimates) were −0.32 and −0.24 (both p<0.001), respectively. Instead of insomnia, COVID-19 was positively associated with occupational stress (β=0.10, p<0.01). Moreover, night shift and educational level were also significant predictors of insomnia, indicating that a greater frequency of night shift (β=0.22, p<0.001) and lower educational levels (β=−0.11, p<0.01) were associated with a higher risk of insomnia symptoms.

The results of the mediation analysis and the coefficients of the path model for insomnia are shown in table 3. In path 1 from resilience to insomnia, in addition to the significant direct effect, an indirect effect mediated by occupational stress was observed (β=0.053, p=0.002). In contrast, no significant direct effect of COVID-19 on insomnia was found, but it can affect insomnia through occupational stress (β=0.016, p=0.03), as shown in path 2. For other possible factors, the night shift was directly associated with insomnia while the pathway through occupational stress was non-significant (path 3). In path 4 from education level to insomnia, the effects of three indirect paths were estimated; however, only the significant mediating effect of resilience on the association between education level and insomnia was observed.

DISCUSSION

This study offered evidence of the interrelationship between insomnia, resilience and occupational stress

Table 2 Ordinal logistic regression analysis of the predictors of insomnia

	Model 1			Mode 2		
Variables	OR	95% CI	P value	OR	95% CI	P value
Age (years)						
≤30	1.000	–	–	1.000	–	–
31–40	1.315	0.883 to 1.960	0.177	1.471	0.969 to 2.237	0.070
41–50	1.750	1.006 to 3.087	0.050	1.929	1.090 to 3.467	0.026
≥51	1.030	0.454 to 2.369	0.944	1.052	0.458 to 2.457	0.905
Marital status						
Married	1.000	–	–	1.000	–	–
Others	0.783	0.533 to 1.147	0.374	0.747	0.502 to 1.111	0.151
Education level						
Below undergraduate	1.000	–	–	1.000	–	–
Undergraduate	0.545	0.376 to 0.783	0.001	0.593	0.404 to 0.863	0.007
Postgraduate	0.438	0.193 to 1.000	0.047	0.452	0.196 to 1.056	0.063
Night shift						
No	1.000	–	–	1.000	–	–
Once a week or less	1.324	0.901 to 1.949	0.153	1.433	0.963 to 2.136	0.077
Twice a week or more	2.411	1.634 to 3.562	<0.001	2.239	1.498 to 3.355	<0.001
COVID-19*						
No	1.000	–	–	1.000	–	–
Yes	1.147	0.854 to 1.543	0.363	1.114	0.820 to 1.513	0.490
Resilience						
Low	–	–	–	1.000	–	–
Moderate	–	–	–	0.551	0.374 to 0.809	0.002
High	–	–	–	0.342	0.231 to 0.502	<0.001
Occupational stress						
Low	–	–	–	1.000	–	–
Moderate	–	–	–	1.529	1.057 to 2.223	0.025
High	–	–	–	2.038	1.400 to 2.983	<0.001

Model 1 was adjusted for age, sex, marital status, education level, night shift and COVID-19. Model 2 was additionally adjusted for resilience and occupational stress.
*Whether the participants took part in work related to COVID-19.

among Chinese nurses during the outbreak of COVID-19. The study also provided an understanding of the relevant predictors that may potentially have a relationship with insomnia. Overall, the SEM illustrated the effect of resilience, the experience of COVID-19-related work, the frequency of night shift and education level, highlighting the importance of institutional policies and guidelines in improving nurses' mental health and working environment. The results also highlighted the importance of a well-balanced night shift and education level among nurses, thus paving the way for better sleep quality among nurses.

Interestingly, more than 58.76% of respondents had insomnia during the second outbreak of COVID-19 in China, and the results were higher than those in previous studies (33.36%–39.36%).[45–47] We found an increased rate of insomnia compared with the first outbreak period in 2019, possibly because the number of people involved in the second outbreak of COVID-19 was much higher despite the decreased severity of the coronavirus.[48] Another possible explanation was that a significant proportion of nurses who returned to work had long-term COVID-19 symptoms, and these uncomfortable feelings might affect their sleep quality.[49] Experiences with various symptoms across multiple organ systems contribute to invisible labour shortages, which might indirectly cause sleep disorders.

The current results showed that the ratio of occupational stress among nurses with insomnia was statistically greater than that among nurses with suspected or no insomnia. In comparison, the CD-RISC score was statistically lower than those with suspected insomnia or no insomnia, which was consistent with previous reports.[36 47 50–52] These results could be explained by the

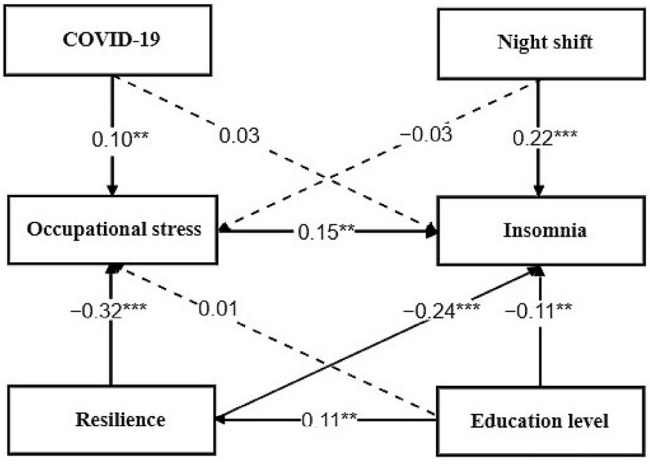

Figure 1 Hypothesised model and model estimation results. Standardised estimates are shown. The solid line indicates statistical significance, and the dashed line indicates non-significance. **p<0.01, ***p<0.001.

fact that individuals who are exposed to high stressors exacerbated by the COVID-19 pandemic and limited recovery resulted in increased fatigue and decreased psychological well-being. Therefore, hospital nurses who experienced stressful working conditions had higher risks of insomnia. The results also proved that individuals with a lower level of resilience perform poorly in responding adaptively and recovering in a timely manner from stress and thus cannot protect against adverse outcomes via reduced intensity and duration of symptoms, resulting in insomnia.

The ordinal logistic regression showed that age (41–50 years), undergraduate education, night shift (>2 times per week), resilience (moderate to high) and occupational stress (moderate to high) were statistically significant predictors of insomnia after controlling for covariates. Our study was similar to that of Taylor *et al*,[53] revealing that stress significantly predicted insomnia. However, unlike army personnel targeted in their study, we found that educational level, night shift and personal resilience played essential roles in developing insomnia among nurses. These results were consistent with previous results.[54] Nurses aged 41–50 years likely lack enough energy to cope with complex clinical scenarios, especially during the COVID-19 outbreak. The association between night shift and insomnia may be explained by the fact that nurses comprise the most significant proportion of shift workers (15%–20%), and they often experience reduced sleep quality, duration and/or excessive sleepiness due to the imposed conflict between work and the circadian

Table 3 The coefficients of the path model for insomnia

Model	B	SE	*β*	P value	95% CI
Path 1					
Direct effect					
Resilience→insomnia	−0.247	0.050	−0.235	<0.001	−0.327 to −0.143
Indirect effect					
Resilience→occupational stress→insomnia	−0.053	0.017	−0.050	0.002	−0.082 to −0.018
Path 2					
Direct effect					
COVID-19→insomnia	0.057	0.093	0.027	0.540	−0.06 to 0.115
Indirect effect					
COVID-19→occupational stress→insomnia	0.034	0.016	0.016	0.030	0.002 to 0.031
Path 3					
Direct effect					
Night shift→insomnia	0.284	0.058	0.220	<0.001	0.136 to 0.304
Indirect effect					
Night shift→occupational stress→insomnia	−0.006	0.010	−0.004	0.545	−0.018 to 0.010
Path 4					
Direct effect					
Education level→insomnia	−0.234	0.093	−0.111	0.011	−0.197 to −0.026
Indirect effect					
Education level→occupational stress→insomnia	0.002	0.013	0.001	0.845	−0.01 to 0.012
Education level→resilience→insomnia	−0.056	0.022	−0.027	0.010	−0.047 to −0.007
Education level→resilience→occupational stress→insomnia	0.001	0.003	0.000	0.845	−0.001 to 0.001

B, unstandardised estimate; *β*, standardised estimate.

system. What worsened the situation is that factors such as an increase in population and an outbreak of pandemics will further increase the demand for healthcare. The first wave of the COVID-19 pandemic in 2019 revealed that nurses who were female, married and had children experienced higher anxiety and stress mainly due to the city/hospital's lockdown, shortage of personal protection equipment, unavoidably increased workloads, insufficient experience with the new virus, the uncertainty of curative treatment and risk of infection/death.[54 55] In contrast, nurses were not required to quarantine in designated hotels in the second wave of the COVID-19 pandemic in 2022. Instead, their main stressors came from increased facility burden and self-uncomfortable feelings.[56 57] Highly stressful work environments and traumatic situations exacerbate unignorable sleep-related impairments. Therefore, we recommend that more attention should be given to middle-aged nurses since they might be more fragile and anergia when they come across rush outbreaks, although they are facilitated in dealing with clinical scenarios.

The findings generally supported our hypothesis despite some model paths being non-significant. The results of the SEM showed that resilience affected insomnia both directly and indirectly and that occupational stress mediated the association between resilience and insomnia. The findings indicated that when patients have high resilience and low occupational stress, the severity of insomnia can be relieved. Our results indicated that resilience can adjust the response to occupational stress and improving the occupational stress of nurses was a potential strategy to improve insomnia. Resilience plays an important role in managing stress since highly resilient nurses usually use positive coping skills, and their psychological characteristics allow them to continue working in stressful environments. Active coping mechanisms were thought to protect individuals from psychological overload and allow for positive adjustments among adults who have experienced trauma or depression and have been an important factor linked to a reduction in stress-related symptoms.[58]

For other possible factors associated with insomnia, the results showed that nurses who took part in work related to COVID-19 were not directly related to insomnia, whereas the mediating effect of occupational stress led to a positive relationship between COVID-19 and insomnia. In contrast, the night shift had a positive direct effect on insomnia, and the mediating effect of occupational stress was not significant between the night shift and insomnia. Intriguingly, educational level has been theoretically linked to resilience, occupational stress and insomnia, but we found a direct effect of educational level on psychological resilience and insomnia, and the indirect effect on occupational stress was statistically significant. Our findings suggested that the significant association between education level and occupational stress was most likely mediated by other potential factors. More studies are needed to verify the findings and explore whether there are any other mediators or moderators between night shift and insomnia or education level and insomnia. More importantly, COVID-19 has not been thoroughly eliminated, and the scattered outbreaks are continuing and inducing future crises. Essential strategies and policies are needed to support front-line nurses. In more general clinical practice, there is an urgent need for nurses to have access to formal psychological support and interventions, to establish comfortable communication and effective collaboration environment to reduce occupational stress, to ensure support from family, colleagues and the community to improve professional identity and to rationalise shift scheduling. It is necessary to reinforce the importance of hospital nursing organisations and suggest that hospital managers work to improve the work environment, especially by managing night shifts, decreasing occupational stress and improving the educational structure of the nursing workforce by continuing education, which might enhance psychological capital.

Our study has several limitations. Although we purposefully selected nurses who experienced the second outbreak of COVID-19, these participants were mainly from hospitals in western China, which might bias the findings. We call for national and multicentre investigations in the future. Additionally, the purpose of this research was to identify differences between nurses with and without insomnia, and there was a relatively small number of indicators that were included in the model. While we adjusted for several covariates in our models, there may still be some potential confounders, such as the role of fear in COVID-19 and anxiety or depression in insomnia. Notably, even though we found occupational stress and resilience as mediators and tested a unidirectional relationship in SEM, caution is still needed when interpreting the findings because a cross-sectional design does not permit causal inferences. Future studies will be needed to clarify these issues.

CONCLUSION

The prevalence of insomnia among Chinese nurses during the COVID-19 pandemic is high. Our study confirmed that resilience had a negative direct effect on insomnia and occupational stress, and occupational stress had a positive direct effect on insomnia. Involvement in COVID-19-related work has a positive effect on insomnia through occupational stress. In contrast, higher education levels improved insomnia through increased resilience. Under the epidemic situation of COVID-19, better resilience may improve insomnia by relieving occupational stress, and implementing measures to promote resilience is essential to reduce occupational stress in nurses and improve their sleep quality.

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Patient consent for publication Not applicable.

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Data availability statement Data are available on reasonable request. Data are not available for the privacy of the participants and the corresponding author can be contacted on reasonable request.

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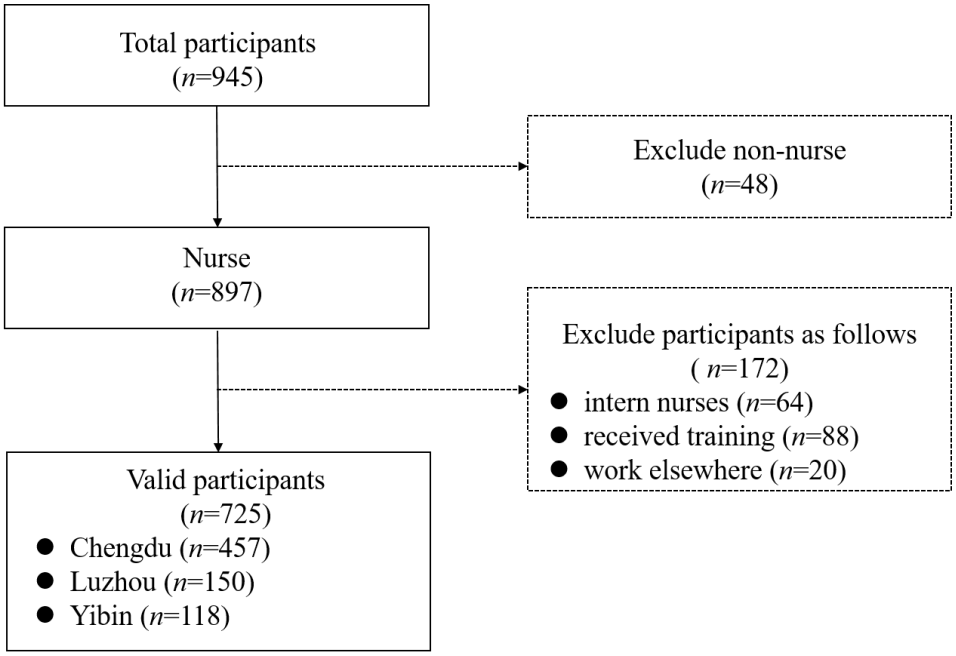

Supplementary Figure 1. The flowchart of the participant selection in the study