DOI:10.11817/j.issn.1672-7347.2024.240137

A cross-sectional study on healthcare workers' sleep and psychological resilience

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ABSTRACT

Objective: Healthcare workers, as a high-stress professional group, face long-term high-intensity workloads and complex medical environments, resulting in increasingly prominent mental health issues. In particular, the widespread presence of anxiety symptoms and somatic pain has become a major factor affecting both the quality of care and the career development of healthcare workers. This study aims to investigate the mediating and moderating roles of psychological resilience and sleep in the relationship between somatic pain and anxiety among healthcare workers.

Methods: A cross-sectional questionnaire survey was conducted among 1 661 healthcare workers. The instruments used included the Generalized Anxiety Disorder-7 (GAD-7), item 3 from the Patient Health Questionnaire-9 (PHQ-9), the 10-item Connor-Davidson Resilience Scale (CD-RISC-10) for psychological resilience, and the Visual Analogue Scale (VAS) for assessing anxiety, sleep disturbance, psychological resilience, and somatic pain.

Results: The detection rate of anxiety symptoms among healthcare workers was 38.95%. Psychological resilience was significantly negatively correlated with anxiety symptoms (r=−0.451, P<0.01), sleep disturbance (r=−0.313, P<0.01), and somatic pain (r=−0.214, P<0.01). Moreover, psychological resilience partially mediated the relationship between somatic pain and anxiety (β=−0.103, P<0.01), and sleep quality moderated the latter part of the mediation model ("somatic pain-psychological resilience-anxiety").

Date of reception: 2024-03-11

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Foundation item: This work was supported by the Natural Science Foundation of Hunan Province, China (2023JJ60076).

Conclusion: Under high-intensity workloads, healthcare workers generally experience severe anxiety symptoms. Psychological resilience plays an important protective mediating role in their mental health, and sleep quality serves as a moderator in this relationship. Enhancing healthcare workers' psychological resilience and improving their sleep may promote both their physical and mental well-being.

KEY WORDS anxiety; healthcare workers; mediation effect; psychological resilience; sleep disturbance; somatic pain

基于医务人员睡眠和心理弹性的横断面研究

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[摘 要] 目的：医务人员作为高压力职业群体，长期面临高强度工作负荷和复杂医疗环境，其心理健康问题日益凸显，尤其是焦虑症状和躯体疼痛的普遍存在已成为影响医疗质量和医务人员职业发展的重要问题。本研究旨在检验心理弹性和睡眠在医务人员躯体疼痛和焦虑中的中介和调节作用。**方法：**对1 661名医务人员进行横断面问卷调查。分别采用广泛焦虑量表(Generalized Anxiexy Disorder-7，GAD-7)、患者健康问卷-9(Patient Health Questionaire-9，PHQ-9)中的Q3条目、心理弹性量表简版(10-item Connor-Davidson Resilience Scale，CD-RISC-10)、视觉模拟评分法(Visual Analogue Scale，VAS)评估参与者的焦虑状况、睡眠障碍、心理弹性及躯体疼痛。**结果：**医务人员焦虑症状的检出率为38.95%；心理弹性与焦虑症状(r=−0.451，P<0.01)、睡眠障碍(r=−0.313，P<0.01)和躯体疼痛(r=−0.214，P<0.01)均呈显著负相关；心理弹性部分中介医务人员躯体疼痛和焦虑的关系(β=−0.103，P<0.01)；睡眠状况调节了中介模型“躯体疼痛-心理弹性-焦虑”的后半段路径。**结论：**在高强度工作负荷下，医务人员普遍存在较为严重的焦虑症状，心理弹性作为中介效应对医务人员的心理健康具有重要的保护作用；睡眠在其中发挥调节作用，可以通过提高医务人员的心理弹性，改善其睡眠来促进其生理心理健康。

[关键词] 焦虑；医务人员；中介效应；心理弹性；睡眠障碍；躯体疼痛

Shift work, long working hours, occupational stress, high work intensity, and low healthcare worker-to-population ratios are common among healthcare workers, and these factors often negatively impact their psychosomatic health, including the development of psychological stress and somatic pain[1-2]. These conditions are not only a problem for individual health, but also constitute a major public health issue[3]. A Meta-analysis has indicated that anxiety is the most commonly reported psychological stress reaction among healthcare workers[4]. Several studies[5-7] conducted in China have shown that the prevalence of anxiety among medical staff ranges from 11.4% to 41.1%.

Furthermore, studies[8-9] have shown that, due to the high-intensity workloads, healthcare workers commonly experience somatic pain, and this pain can further exacerbate psychological stress reactions. It has been found that individuals experiencing somatic pain are at a higher risk of developing anxiety compared to the general population[10].

Psychological resilience refers to a person's ability to quickly adapt and return to a state of equilibrium when faced with stress, frustration, and adversity[11]. Research has demonstrated that increased psychological resilience enables healthcare workers to mitigate negative emotions such as anxiety while enhancing their productivity and work quality in demanding work environments[12]. Additionally, individuals with higher

levels of resilience may experience less mood disturbance under somatic pain[13].

It is a noteworthy fact that healthcare workers frequently experienced sleep disturbance[14]. However, good sleep contributes to an individual's psychological resilience[15]. In contrast, individuals with poor sleep quality have a poor psychological stress capacity, which increases the likelihood of anxiety[16].

In summary, healthcare workers face the dual challenge of somatic pain and anxiety symptoms[13]. Current knowledge suggests that higher levels of psychological resilience are a potential protective factor against anxiety symptoms, though this protection can be influenced by sleep disorders[13, 15]. However, the current study has not been able to confirm the above hypotheses and the applicability to medical staff has not been fully explored. Therefore, we proposed the following hypotheses (Figure 1): 1) Psychological resilience may mediate the relationship between somatic pain and anxiety. 2) Sleep plays a moderating role in the relationship between psychological resilience and anxiety.

This study aims to examine the potential mediating effects and discuss the development of targeted psychological interventions for medical personnel. The findings of this research may have implications for promoting rational health practices for both medical institutions and healthcare workers, including education and intervention about sleep and psychological resilience.

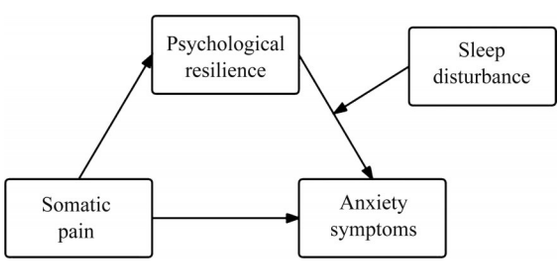

Figure 1 Study hypothesis model

1 Materials and methods

1.1 Study sample

Participants were recruited through convenience sampling in February 2023 at the Second Xiangya Hospital of Central South University, and an online questionnaire survey was conducted among healthcare workers. Participation was voluntary, and informed consent was obtained at the beginning of the survey after providing a brief introduction to the study's content and purpose. Incomplete answers for any question were excluded, only fully completed questionnaires were included in the final statistical analysis. The final sample consisted of 1 661 individuals.

1.2 Methods

1.2.1 Demographic characteristics

A self-designed questionnaire was used to collect demographic information from healthcare workers, including gender, age, job position, occupation, professional title, years of work, education, whether their current job is related to COVID-19, and the duration of their participation in COVID-19-related work. We integrated the above information into 5 covariates, which were later categorized. In this study, gender was classified as male and female; age in years was classified into 18−30 years, 31−40 years, 41−50 years, 51 years and above; education was classified as specialized and below, undergraduate, postgraduate student, doctor and above; years of experience was classified into <2 years, 3−5 years, 6−10 years, >10 years; position in pandemic was classified as ICU/critical care areas, general ward for COVID-19, Emergency, other wards.

1.2.2 Visual Analogue Scale

A Visual Analogue Scale (VAS) was used to assess somatic pain. The VAS is a simple and rapid measure of subjective pain intensity that has been widely used in various populations, including patients with major depressive disorder experiencing somatic symptoms. It utilizes a scoring ranging from 0 to 10, with higher scores indicating greater pain intensity[17].

1.2.3 Generalized Anxiety Disorder-7 questionnaire

The Generalized Anxiety Disorder-7 (GAD-7) is a 7-item screening measure used to assess symptoms of generalized anxiety over the past 2 weeks[18]. Participants were asked to rate the frequency of experiencing symptoms described in each item on a 4-point Likert scale ranging from 0 (not at all) to 3 (nearly every day). The GAD-7 has been widely tested and used, with the reliability and validity of the Chinese version documented in Chinese general hospital

patients[19]. In previous research[18, 20], a cut point of 5 can be interpreted as representing mild levels of anxiety. The internal consistency of the scale in this study was 0.940.

1.2.4 Psychological resilience assessment

Psychological resilience was assessed through the 10-item Connor-Davidson Resilience Scale (CD-RISC-10). The CD-RISC-10 is a self-report measure consisting of 10 items used to assess psychological resilience, defined as the ability to cope with adversity[21]. Each item on the CD-RISC-10 is scored on a 5-point Likert scale, ranging from 0 (not true at all) to 4 (true nearly all the time). The total score on the CD-RISC-10 ranges from 0 to 40, with higher scores indicating a higher level of resilience[22-23]. In this study, the internal consistency of the CD-RISC-10 was considered excellent, with a Cronbach's α of 0.965 calculated.

1.2.5 Sleep disturbance assessment

Sleep disturbance was assessed through the Q3 item of Patient Health Questionnaire-9 (PHQ-9). We utilized one question for sleep disturbance (Q3: "Over the last 2 weeks, how often have you been bothered by the following problems: Trouble falling or staying asleep, or sleeping too much?") from the PHQ-9[24]. Responses were scored on a 4-point scale (0 for "never", 3 for "almost daily"). Higher Q3 scores indicate greater sleep disturbance.

1.3 Statistical analyses

For data processing, this study employed Statistical Product and Service Solutions (SPSS) version 26.0. Principal component analysis was used to evaluate common method bias[25]. Covariate tests derived from demographic information were conducted using χ^2 tests, with statistically significant variables being considered as confounders and included in the analysis of mediating effects. Pearson correlation analyses were conducted to examine the correlations among the predictors in this study, and the mediating effect hypothesis was built upon the results of the correlation analysis.

In order to investigate the mediating effects, we employed "Model 4" and "Model 14" of the PROCESS macro program, implementing the bootstrap method. To examine the mediating effect of psychological resilience between somatic pain and anxiety symptoms, we utilized Model 4 in the PROCESS macro program to estimate 95% confidence intervals (*CI*) for the mediating effect through 5 000 iterations of Bootstrap sampling. The mediation effect tests were conducted with somatic pain as the independent variable, psychological resilience as the mediator variable, and anxiety symptoms as the dependent variable[26]. Furthermore, to analyze the mediating role of sleep disturbance between psychological resilience and anxiety symptoms, we used Model 14 of the PROCESS macro program for regression analysis. $P<0.05$ was considered statistically significant.

2 Results

2.1 Control and test of common method deviation

The common method bias test was performed by Harman single factor method, taking the characteristic root greater than 1 as the standard. The results showed that the exploratory factor analysis extracted 2 factors with a characteristic root greater than 1, and the first factor explained 46.62% of the total variance. Therefore, this study can be considered that there is no obvious common method bias.

2.2 Descriptive statistics

A total of 1 661 participants were included in this study, consisting of 213 (12.82%) males and 1 448 (87.18%) females. Using a cutoff point of 5 for the GAD-7, 647 (38.95%) healthcare workers were found to exhibit symptoms of anxiety. There were statistically significant differences in all covariates between the anxiety and non-anxiety groups (all $P<0.05$). Using a cutoff point of 20 for psychological resilience, 393 (23.66%) healthcare workers were classified into the low-resilience group, while the remaining participants were in the high-resilience group. Significant differences in gender, age, and education were observed between the low-resilience and high-resilience groups ($P<0.05$). Using a cutoff of 4 to determine the severity of somatic pain, 681 (41.00%) participants reported experiencing severe somatic pain. A statistically significant difference in gender was observed between participants reporting mild and severe somatic pain ($P<0.05$, Table 1).

Table 1 Demographic characteristics (*n*=1 661)

Characteristics	No. (%)	Anxiety symptoms/[No. (%)]		*P*	Psychological resilience/[No. (%)]		*P*	Somatic pain/[No. (%)]		*P*
		<5 (*n*=1 014)	≥5 (*n*=647)		<20 (*n*=393)	≥20 (*n*=1 268)		<4 (*n*=980)	≥4 (*n*=681)	
Gender				0.003			0.005			<0.001
Male	213(12.8)	150(70.4)	63(29.6)		34(16.0)	179(84.0)		154(72.3)	59(27.7)	
Female	1 448(87.2)	864(59.7)	584(40.3)		359(24.8)	1089(75.2)		826(57.0)	622(43.0)	
Age/year				<0.001			0.010			0.054
18−30	419(25.2)	256(61.1)	163(38.9)		117(27.9)	302(72.1)		266(63.5)	153(36.5)	
31−40	702(42.3)	398(56.7)	304(43.3)		173(24.6)	529(75.4)		412(58.7)	290(41.3)	
41−50	320(19.3)	188(58.8)	132(41.2)		64(20.0)	256(80.0)		171(53.4)	149(46.6)	
51 and above	220(13.2)	172(78.2)	48(21.8)		39(17.7)	181(82.3)		131(59.5)	89(40.5)	
Education				<0.001			<0.001			0.062
Specialized and below	170(10.2)	133(78.2)	37(21.8)		58(34.1)	112(65.9)		95(55.9)	75(44.1)	
Undergraduate	970(58.4)	516(53.2)	454(46.8)		253(26.1)	717(73.9)		553(57.0)	417(43.0)	
Postgraduate student	326(19.6)	228(69.9)	98(30.1)		64(19.6)	262(80.4)		205(62.9)	121(37.1)	
Doctor and above	195(11.8)	137(70.3)	58(29.7)		18(9.2)	177(90.8)		127(65.1)	68(34.9)	
Experience				<0.001			0.108			0.050
<2 years	171(10.3)	121(70.8)	50(29.2)		45(26.3)	126(73.7)		116(67.8)	55(32.2)	
3−5 years	168(10.1)	110(65.5)	58(34.5)		46(27.4)	122(72.6)		104(61.9)	64(38.1)	
6−10 years	392(23.6)	201(51.3)	191(48.7)		103(26.3)	289(73.7)		231(58.9)	161(41.1)	
>10 years	930(56.0)	582(62.6)	348(37.4)		199(21.4)	731(78.6)		529(56.9)	401(43.1)	
Position in Pandemic				<0.001			0.074			0.245
ICU/critical care areas	362(21.8)	162(44.8)	200(55.3)		100(27.6)	262(72.4)		212(58.6)	150(41.4)	
General ward for COVID-19	484(29.1)	289(59.7)	195(40.3)		120(24.8)	364(75.2)		303(62.6)	181(37.4)	
Emergency	88(5.3)	44(50.0)	44(50.0)		22(25.0)	66(75.0)		48(54.6)	40(45.4)	
Other wards	727(43.8)	519(71.4)	208(28.6)		151(20.8)	576(79.2)		417(57.4)	310(42.6)	

2.3 Correlation analyses

Correlation analysis showed that there were statistically significant correlations between the main predictors in this study (all $P<0.01$). Among them, psychological resilience showed negative correlation with sleep disturbance ($r=-0.313$), anxiety symptoms ($r=-0.451$), and somatic pain ($r=-0.214$); anxiety symptoms and sleep disturbance ($r=0.638$), anxiety symptoms and somatic pain ($r=0.344$), sleep disturbance and somatic pain ($r=0.325$) all showed a positive correlation (Table 2).

Table 2 Correlation analyses between rating of the main predictors (n=1 661)

	Sleep disturbance	Anxiety symptoms	Psychological resilience	Somatic pain
Sleep disturbance				
Anxiety symptoms	0.638**			
Psychological resilience	−0.313**	−0.451**		
Somatic pain	0.325**	0.344**	−0.214**	

**$P<0.01$.

2.4 Analysis of moderated mediator

2.4.1 Effect of psychological resilience between somatic pain and anxiety symptoms

The results showed that in Model I, the effect of somatic pain on psychological resilience was statistically significant ($\beta=-0.753$, $P<0.01$); in Model II, when both somatic pain and psychological resilience were included in the regression analyses, the effect of both somatic pain ($\beta=12.620$) and psychological resilience ($\beta=-14.126$) on the anxiety symptoms was statistically significant ($P<0.01$, Table 3).

The interaction term between somatic pain and psychological resilience (results of path analysis) indicated that the mediating effect of psychological resilience between somatic pain and anxiety levels was statistically significant (Table 4).

Table 3 Bootstrap analysis of the test of the mediating effect of psychological resilience between somatic pain and anxiety

Model	Predictor	Outcome	R	R^2	β	*LLCI*	*ULCI*	t
I	Somatic pain	Resilience	0.237	0.056	−0.753	−0.987	−0.519	−6.307**
II	Somatic pain	Anxiety	0.494	0.244	0.608	0.513	0.702	12.620**
	Resilience	—	—	—	−0.138	−0.158	−0.119	−14.126**
III	Somatic pain	Anxiety	0.391	0.153	0.712	0.613	0.818	14.137**

**$P<0.01$. *LLCI:* Lower level of confidence interval; *ULCI:* Upper level of confidence interval.

Table 4 Mediating effect of psychological resilience between somatic pain and anxiety symptoms

Effect type	Effect value	Boot *SE*	95% *CI*	Relative effect size/%
Total effect	0.712	0.050	0.613−0.811	—
Direct effect	0.608	0.048	0.513−0.702	85.39
Mesomeric effect	0.104	0.022	0.066−0.150	14.61

2.4.2 Effect of sleep disturbance between psychological resilience and somatic pain

The results showed a statistically significant effect of the interaction between sleep disturbance and psychological resilience on anxiety symptoms ($\beta=-0.103$, $P<0.01$; Table 5).

In order to visualize the effect of sleep disturbance moderating psychological resilience on anxiety

symptoms, we grouped the values of sleep disturbance scores in high and low groups at ± 1 standard deviation (±1SD) and performed a simple slope effect analysis. The results showed that sleep disturbance had a moderating on the relationship between psychological resilience and anxiety symptoms (Figure 2).

Table 5 Mediation model with regulation

Predictor	Psychological resilience			Anxiety symptoms		
	β	*SE*	*t*	*β*	*SE*	*t*
Somatic pain	−0.753	0.119	−3.656	0.254	0.041	6.231**
Resilience	—	—	—	−0.116	0.008	−13.995**
Sleep disturbance	—	—	—	2.440	0.096	25.401**
Resilience & Sleep	—	—	—	−0.103	0.010	−10.803**
R^2		0.056			0.507	
F		16.358**			188.694**	

**P<0.01.

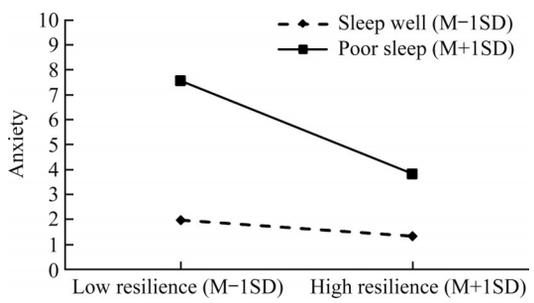

Figure 2 Regulatory effect of sleep disturbance on psychological resilience and anxiety symptoms

M: Mean; SD: Standard deviation.

3 Discussion

In this study, the prevalence of anxiety symptoms was 38.95%. Notably, this prevalence rate is higher than the findings reported in a previous study conducted by Wang, et al[27] in 2022 among Chinese healthcare workers, where the prevalence of anxiety symptoms was reported to be 24.4%. This difference can be attributed to various factors, such as the unique working environment, particularly the complete lifting of pandemic control measures, which has resulted in an enormous workload for healthcare workers, along with the ongoing risk of infection. The participants in this phase may have experienced heightened levels of stress compared to the control phase, which subsequently impacted their anxiety levels[28].

Medical personnel have long hours and heavy workloads, because they often work overtime, yet there are some imbalances in terms of effort and reward[29]. In addition, due to the large population, healthcare workers have to serve more patients compared to other developed countries. Finally, the relationship between healthcare workers and patients is very tense, which may also contribute to healthcare workers' anxiety[30]. In conclusion, these facts show that medical personnel have more chances to face illness and death, which negatively affects their mental health.

Psychological resilience was found to have a significant negative correlation with the risk of anxiety, consistent with the findings of Moritz, et al[31]. In a work environment where pandemic control measures have been fully lifted, healthcare workers with higher psychological resilience exhibit better adaptability, leading to reduced stress responses and lower levels of anxiety.

Furthermore, anxiety symptoms were observed to have a significant negative correlation with psychological resilience, aligning with the findings of the previous studies[32-33]. Anxiety lowers the level of psychological resilience among healthcare workers, impairing their ability to regulate their adaptive capacity when faced with significant stressors, thus hindering their quick recovery.

Moreover, a significant negative correlation was

identified between sleep disturbance and psychological resilience, corresponding to the findings of Tu, et al[34]. Medical personnel with better sleep quality demonstrate higher scores of psychological elasticity and stronger psychological resilience, enabling them to effectively manage stress and cope with demanding workloads in a high-intensity setting.

This study revealed a mediating role of psychological resilience between somatic pain and anxiety symptoms. The findings indicate that somatic pain among healthcare workers positively influences anxiety levels, and this effect can be indirectly mediated by psychological resilience. A high level of psychological resilience often acts as a buffer against the negative impact of somatic pain. In other words, medical workers experiencing somatic pain but possessing good psychological resilience are typically more adept at regulating their emotions and adjusting their work status accordingly. Heightened anxiety levels may amplify the experience of pain, making it more intense or persistent. Resilient individuals tend to exhibit more adaptive responses to stressors, which can buffer the relationship between anxiety and physical pain and enhance an individual's capacity to employ effective coping strategies[22], potentially reducing the influence of anxiety on the perception and experience of physical pain.

This study also explored the mediating role of sleep disturbance in the hypothesized model. The results indicate that sleep disturbance moderates the latter part of the proposed model, specifically the relationship between psychological resilience and anxiety levels. Sleep, being a normal physiological process, mitigates the risk of anxiety symptoms associated with lower psychological resilience. Psychological resilience often mitigates the perception of physical pain. Individuals with higher resilience might exhibit better coping mechanisms, reducing the impact of pain on their overall well-being[22]. Adequate sleep contributes to emotional regulation and resilience. It enables individuals to manage stress more effectively and enhances their ability to cope with adversity and recover from challenges[35].

In summary, the relationship between psychological resilience and anxiety is strengthened when sleep disturbance is intensified. As psychological resilience decreases, healthcare workers become more susceptible to anxiety. Conversely, for healthcare workers with better sleep, the impact of psychological resilience on anxiety is weakened, resulting in lower anxiety levels. Thus, it is crucial to address sleep deprivation and improve sleep quality for healthcare workers in order to promote better mental well-being.

The findings of this study have significant implications for enhancing the psychological resilience of healthcare workers and mitigating their anxiety levels in the face of sudden and intense workloads in the future. Conducting early assessments among medical personnel to detect sleep problems, mental health issues, and physical discomfort, along with implementing effective intervention strategies for these problems, is crucial. Additionally, timely intervention to address serious negative thoughts experienced by medical staff can help reduce adverse mental health outcomes[36]. Furthermore, it is essential to provide care for healthcare workers and implement interventions aimed at improving their psychological resilience. Studies[3, 37] suggests that social support is critical to increasing psychological resilience, and that strengthening emotional regulation or providing psychotherapy may help to increase their resilience. This will enhance their adaptability and promote their physical and mental well-being recovery. Additionally, improving sleep quality for medical staff can play a role in alleviating anxiety and should be considered as an intervention to reduce anxiety levels. The best way to improve one's sleep is to maintain sleep hygiene by changing one's sleep habits. Good sleep hygiene practices can promote better quality and duration of sleep and have significant physical and psychological benefits[38].

There are several limitations to this study. First, sleep disturbance in this study was assessed with only one question, which may have led to under-representation. In subsequent studies, sleep status could be taken to a better questionnaire to increase the confidence of the findings. Second, covariate inclusion could have been more. Finally, the surveys and scales we used in this study were based on respondents' self-reports, which reflect only subjective evaluations, and future studies based on objective evaluations could be conducted.

Contributions: ZHANG Yuexin Literature retrieval and manuscript writing; MO Hongfei and TANG Jingqiong Literature search and manuscript revision; FENG Zhiling Study design, manuscript writing and review; YU Mengqiang Supervision and revision. The final version of the manuscript has been approved and read by all authors.

Conflict of interest: The authors declare that they have no conflicts of interest to disclose.

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(Edited by CHEN Liwen)

本文引用：张悦欣, 莫鸿飞, 唐婧琼, 冯志凌, 喻孟强. 基于医务人员睡眠和心理弹性的横断面研究[J]. 中南大学学报(医学版), 2024, 49(10): 1556-1565. DOI: 10.11817/j. issn. 1672-7347.2024.240137

Cite this article as: ZHANG Yuexin, MO Hongfei, TANG Jingqiong, FENG Zhiling, YU Mengqiang. A cross-sectional study on healthcare workers' sleep and psychological resilience[J]. Journal of Central South University. Medical Science, 2024, 49(10): 1556-1565. DOI:10.11817/j.issn.1672-7347.2024.240137