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Effect of Emerging Major Infectious Diseases on Sleep Quality of Medical Workers: Findings from Medical Workers Providing Support During the COVID-19 Pandemic

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Statistical Analysis C
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Background: The coronavirus disease 2019 (COVID-19) outbreak has exerted immense pressure on medical systems in China and abroad. This study aimed to compare the sleep quality of medical personnel conscripted to the Wuhan Union Cancer Centre to offer support during the early stages of the COVID-19 pandemic to the sleep quality of those who remained at Anhui Medical University Hospital and to determine the role of interventions in improving sleep quality.

Material/Methods: Questionnaires were completed by 369 individuals who were conscripted to support Wuhan (N=137) and others who were not (the control group; N=232). The Pittsburgh Sleep Quality Index (PSQI) was used to measure the duration and quality of sleep. The Anhui Provincial Health Commission organized a comprehensive intervention, consisting of physical-psychological-social dimensions, over the course of 2 weeks.

Results: Only 34.21% of the Wuhan support workers reported better sleep quality, as opposed to the 55.60% of the control group at stage 1 (t/χ^2=14.005, P<.001). Furthermore, despite the Wuhan support group being more prone to poor sleep quality, their sleep quality significantly improved after the interventions.

Conclusions: The findings from this study showed that medical staff who were conscripted to offer support during the early stages of the COVID-19 pandemic suffered from impaired quality of sleep. The use of questionnaire-based sleep assessments may provide individualized approaches to supporting medical personnel during future epidemics and pandemics. Furthermore, our results indicate that relevant interventions can significantly improve sleep quality, while a prolonged break after interventions does not affect sleep quality.

Keywords: COVID-19 • Medical Staff, Hospital • Sleep

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Background

The coronavirus disease 2019 (COVID-19) first broke out in Wuhan, China, in December 2019 and rapidly spread, thus becoming a global pandemic [1-4]. This outbreak has had a huge impact on global health and medical systems [5]. COVID-19 is one of the several newly identified forms of coronaviruses that can infect humans; it is a respiratory pathogen, just like SARS CoV, which causes the severe acute respiratory syndrome (SARS), and MERS-CoV, which causes the Middle-East respiratory syndrome (MERS) [6]. The World Health Organization officially named this virus the 'novel coronavirus', on February 11, 2020, and declared it a global pandemic on March 11 [7,8]. China responded quickly by halting public transportation and announcing large-scale quarantine measures in many areas, starting from late January [9]. In particular, the China National Health Commission put a series of emergency measures in place, including the establishment of emergency isolation points, infectious disease hospitals, and China-specific 'Fang cang' or makeshift hospitals, to deal with the outbreak. In addition, external emergency medical teams were quickly established nationwide and medical assistance was assigned to Hubei Province [10]. By February 26, volunteer medical workers (N=32 395) and over 178 crisis response teams were dispatched to the province to join forces during the medical emergency [11]. As each hospital serves millions of people, the First Affiliated Hospital of Anhui Medical University organized a group of 137 medical personnel to support Wuhan and take over one intensive care unit of the Wuhan Union Cancer Centre.

Epidemiological studies on the SARS and Ebola viruses indicate that newly emerging major infectious diseases can exert great pressure on medical workers [12]. Due to the limited understanding, awareness, and prevention measures in the early stages of the COVID-19 outbreak, 3387 health professionals were infected at 476 clinical support points, 26 of whom died [11]. Additional healthcare workers were deployed to support the front-line workers of Wuhan city. However, the daily infection risk in an unfamiliar environment, as well as the limited medical protective equipment and clinical experience, may have potentially increased fatigue and sleep disturbances, thereby affecting the output of the medical staff [13-15].

Locally, China managed to stabilize the situation and contain the epidemic, thus entering a post-epidemic stage. Since July 14, 2020, the number of related infected cases and deaths (4634 at that stage) has gradually decreased [16]. Simultaneously, the number of infected cases and 576 496 deaths globally reflected a situation that was increasingly detrimental to the physical and psychological wellbeing of medical workers.

Sleep quality is a key indicator of health. Good sleep quality not only helps medical staff to work better when treating patients, but it also maintains their optimal immune function to prevent infections [17]. In addition, sleep quality is affected by physical-psychological-social dimensions and factors [18]. Previous studies showed that during pandemics, people are more likely to experience sleep disorders [19-22]. Environmental stressors, physical illness, separation from family and friends, and other comorbid psychological problems can contribute to this problem.

Most studies about the anxiety and sleep quality of front-line medical workers have had a cross-sectional design, neglecting longitudinal, comparative research [23-26]. Consequently, in the context of COVID-19, we first aimed to analyze the factors influencing the sleep quality of the medical workers who were dispatched to support Wuhan vs those who were not (control group). We based these assessments on the Pittsburgh Sleep Quality Index (PSQI), which we used to measure the duration of sleep and sleep quality during the early stages of the outbreak [25,27,28]. Second, we aimed to assess changes in sleep quality following an intervention by comparing sleep results before and after the intervention, which consisted of physical-psychological-social dimensions, over the course of 2 weeks. Third, we aimed to assess whether, with effective interventions, medical workers can resume their jobs at a post-epidemic stage, following their return from Wuhan, rather than continue to rest and adjust their sleep patterns. This study enhances our own understanding of poor sleep quality and the understanding among Wuhan support staff returning to work in the post-epidemic era.

Material and Methods

Ethics Approval

This study was conducted in accordance with the Declaration of Helsinki. All participants provided signed informed consent to participate in the study. The First Affiliated Hospital of Anhui Medical University Ethics Committee approved the study procedures (Approval number: Quick -PJ 2021-04-10).

Study Sample

We surveyed 369 medical workers; some were dispatched to support front-line medical workers at the Wuhan Union Cancer Centre (N=137) and others remained at the Anhui Medical University Hospital to support front-line medical staff during the outbreak (control group, N=232). All of the medical workers who participated in the survey did so voluntarily, and the principles of confidentiality were upheld.

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Study Design

This was an observational study, in which an online questionnaire link was posted on WeChat, the most common and widely used social media in China, with relatively good confidentiality [29]. We used WeChat to investigate and understand the medical workers (including the front-line medical staff supporting Wuhan and those who remained behind) of the First Affiliated Hospital of Anhui Medical University, from February 12 to May 8, 2020. At the beginning of the questionnaire, we informed the participants that completion of the survey indicated informed consent. Subsequently, the team leader would send links to each member to fill in the questionnaire.

Measures

Sleep Quality

The PSQI was used to evaluate sleep quality [27,28]. This index evaluates the sleep quality over the previous month. It consists of 19 self-evaluation items and 7 dimensions: sleep quality, onset latency, duration, efficiency, sleep disturbance, use of sleeping medications, and daytime dysfunction. The score ranges from 0 to 3 for each dimension, and the summed score of the 7 dimensions is the global score (range: 0-21) for subjective sleep quality. Higher scores reflect poorer subjective sleep quality. Researchers found that a PSQI score >7 cut-off point, with a sensitivity of 98% and a specificity of 90% (kappa=0.89, *P*<.01), is suitable for determining sleep disturbance among Chinese people [30].

Other Variables

We collected information about demographic characteristics, including gender, age, occupation, years of work experience, departments, and titles.

Procedure

Pittsburgh Sleep Quality Index (PSQI)

The survey was administered in 3 stages. Among the Wuhan support staff, 114 completed the questionnaire (effective response rate=83.21%) in the first stage (March 1) after supporting Wuhan front-line personnel for nearly 3 weeks. During the second stage (March 19), questionnaires were administered to Wuhan support workers after they had been withdrawn from the front line for quarantine; 110 workers responded (effective response rate=80.29%). During stage 3 (May 8), 114 Wuhan support personnel completed the questionnaire (effective response rate=83.21%).

Intervention

The Anhui Provincial Health Commission organized a comprehensive intervention, consisting of physical-psychological-social dimensions, over the course of 2 weeks. The content reflected 4 categories: (a) arranging a resting place for the medical staff evacuated from Wuhan, which completely differs from the high-intensity working environment that they had experienced there; (b) employing psychological experts to offer centralized psychological counselling 3 times a week; (c) improving medical workers' daily diet and promoting outdoor exercise to enhance their physical condition and return it to normal (pre-pandemic) life; and (d) establishing a welcoming and positive public opinion and social environment to provide recognition and encouragement to the medical staff. The intervention was only for medical personnel who had supported Wuhan, not for those who had not. The intervention was used to compare the changes in sleep quality of health care workers in Wuhan, before and after the intervention, based on the PSQI.

Statistical Analysis

Continuous variables are expressed as mean±standard deviation. We used the χ^2 test and *t* test to compare the 2 groups. Two logistic regression models were fitted to estimate the factors influencing the sleep quality of medical workers. Moreover, we presented the results in the logistic regression model as odds ratios and relative 95% confidence intervals. We used SPSS 16.0 (SPSS Inc., Chicago, IL, USA) software for statistical analysis, and the statistical significance was set at $P<0.05$.

Results

The average ages of the medical workers that supported Wuhan and those in the control group were 32.09±5.75 and 30.87±7.31 years, respectively. The average years of clinical work experience for the Wuhan support staff and for the control group were 9.81±6.03 and 8.94±8.47, respectively (**Table 1**). Our results showed statistically significant differences in occupational category ($t/\chi^2=21.272$, *P*<.001), gender ($t/\chi^2=16.603$, *P*<.001), education level ($t/\chi^2=15.082$, *P*<.001), department ($t/\chi^2=52.461$, *P*<.001), and sleep quality ($t/\chi^2=14.005$, *P*<.001) between the group that provided support to Wuhan and the control group.

According to the logistic regression analysis of the front-line medical staff's sleep quality (**Table 2**), providing support to Wuhan was a risk factor, and the risk of poor sleep quality was 2.41 times higher than that in the control group (*P*<.001) and 3.44 times higher than the control group in the adjusted model (*P*<.001). The second variable was gender, with no statistical difference in Model 1, and the odds ratio of poor quality was 2.07 times higher than that of the control group

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Table 1. General information of respondents.

Characteristics	Support Wuhan medical workers (N=114)	Control group (N=232)	t/χ^2	P value
Age	32.09±5.75	30.87±7.31	-1.555	.121
Clinical work experience (years)	9.81±6.03	8.94±8.47	-0.988	.324
Professional category			21.272	<.001***
Doctor	16 (14.0%)	4 (1.7%)		
Nurse	98 (86.0%)	228 (98.3%)		
Title			5.104	.164
Senior	1 (0.9%)	2 (0.9%)		
Deputy senior	6 (5.3%)	7 (3.0%)		
Intermediate	41 (36.0%)	61 (26.3%)		
Junior and below	66 (19.1%)	162 (69.8%)		
Gender			16.603	.001**
Male	29 (25.4%)	21 (9.1%)		
Female	85 (74.6%)	211 (90.9%)		
Education			15.082	<.001***
Master and above	18 (15.8%)	10 (4.3%)		
Bachelor	91 (79.8%)	201 (86.6%)		
Under bachelor	5 (4.4%)	21 (9.1%)		
Department			52.461	<.001***
Respiratory and critical illness	14 (12.3%)	48 (20.7%)		
Infection	4 (3.5%)	41 (17.7%)		
ICU and Emergency	37 (32.5%)	46 (19.8%)		
Internal Medicine	18 (15.8%)	31 (13.4%)		
Surgical	17 (14.9%)	1 (0.4%)		
Other	24 (21.1%)	65 (28.0%)		
PSQI score				
PSQI ≤7	39 (34.2%)	129 (55.6%)	14.005	<.001***
PSQI >7	75 (65.8%)	103 (44.4%)		

* <0.05, ** <0.01, *** <0.001. PSQI – Pittsburgh Sleep Quality Index; M±SD – mean±standard deviation.

in Model 2 (*P*<.05). The work years, education level, and professional title did not show statistically significant differences in the multi-factor analysis.

A total of 92 people participated in the questionnaire after matching. As shown in **Table 3**, the sleep quality score of Wuhan support staff before and after the intervention was 8.02±3.78 and 6.84±3.09, respectively. Furthermore, the sleep score decreased and the sleep quality improved significantly after the inventions were implemented, with statistically significant differences (T=2.773, *P* <.05).

The paired chi-square test results before and after the intervention show that the sleep quality of 92 medical workers who supported Wuhan improved significantly (χ^2=11.831, *P*<.001) (**Table 4**).

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Table 2. Multivariate logistic regression analysis of factors influencing sleep quality of medical staff.

Characteristics	Model 1		Model 2	
	OR (95% CI)	P value	AOR (95% CI)	P value
Age	1.02 (0.98-1.05)	.334	0.97 (0.86-1.10)	.645
Working years	1.02 (0.99-1.05)	.162	1.06 (0.96-1.18)	.262
Professional category				
Doctor	1		1	
Nurse	1.32 (0.53-3.26)	.553	0.75 (0.13-4.40)	.754
Title				
Senior	1		1	
Deputy senior	2.33 (0.17-32.58)	.529	1.22 (0.06-25.78)	.897
Intermediate	2.34 (0.21-26.63)	.493	1.91 (0.08-45.23)	.688
Junior and below	2.04 (0.18-22.76)	.564	2.59 (0.08-81.44)	.589
Gender				
Male	1		1	
Female	1.56 (0.85-2.86)	.151	2.07 (1.03-4.19)	.042*
Education				
Master and above	1		1	
Bachelor	1.87 (0.85-4.14)	.121	2.89 (0.64-13.07)	.169
(Pregrad) Under bachelor	0.57 (0.18-1.80)	.338	0.85 (0.15-4.98)	.858
Department				
Respiratory and Critical Illness	1.19 (0.62-2.28)	.593	1.25 (0.63-2.48)	.527
Infection	1.53 (0.74-3.16)	.248	2.14 (0.99-4.64)	.053
ICU and Emergency	1.26 (0.69-2.30)	.446	1.35 (0.70-2.62)	.371
Internal Medicine	0.91 (0.45-1.84)	.796	0.73 (0.34-1.54)	.403
Surgical	2.24 (0.77-6.49)	.138	0.90 (0.27-2.96)	.865
Other	1		1	
Dispatched to Wuhan				
No	1		1	
Yes	2.41 (1.51-3.84)	<.001	3.44 (1.93-6.13)	<.001***

* <0.05, ** <0.01, *** <0.001. PSQI – Pittsburgh Sleep Quality Index; OR – odds ratio; CI – confidence interval; SDB – sleep disorder behaviour; AOR – adjusted odds ratio.

Table 3. Comparison of sleep quality scores among Wuhan medical support workers before and after intervention (N=92).

	Comparison before and after intervention			
	Before the intervention	After the intervention	T	*P*
PSQI	8.02±3.78	6.84±3.09	2.773	.007**

** <0.01. PSQI – Pittsburgh Sleep Quality Index; M±SD – mean±standard deviation; the data shown represent the scores of the questionnaires.

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Table 4. Comparison of sleep disorder rates before and after intervention among medical workers in Wuhan (N=92).

		After the intervention		χ^2	*P*
		PSQI ≤7	PSQI >7		
Before the intervention	PSQI ≤7	34	8	11.831	.001**
	PSQI >7	23	27		

** <0.01. PSQI – Pittsburgh Sleep Quality Index.

Table 5. Influence of continuous break on sleep quality after intervention (N=92).

Improved sleep quality	N	The break time (day) [M(IQR)]	Z	*P*
Poor	41	2(2.5)	-0.800	.424**
Good	51	2(1.0)		

** <0.01; M[IQR] – mean [interquartile range].

However, the improved sleep quality was unrelated to the rest period duration after intervention by comparison between the groups (Z=-0.800, *P*>.05) (**Table 5**).

Discussion

The findings from this study indicate that, during the early stages of the COVID-19 pandemic, medical staff who were conscripted to the Wuhan Union Cancer Centre to offer support and those who remained at Anhui Medical University Hospital, between March and May 2020, suffered from impaired quality of sleep. In our study, alleviating the sleep disorders of the medical support staff in Wuhan effectively improved their physical and mental health. We supported the returning medical workers (N=137) with effective treatments provided through a series of physical and psycho-social interventions, which included adjusting their work, rest, and daily diet, as well as providing mental health guidance and physical activity recommendations. In particular, the interventions significantly improved their sleep quality, as indicated by the sleep quality scores, which were significantly reduced. This demonstrates that interventions can significantly improve the sleep quality of medical staff.

We examined the impact of COVID-19 on the sleep quality of medical workers who engaged in the treatment of infected patients and the role of relevant interventions to improve sleep quality. In doing so, we applied the PSQI, a brief instrument that can be administered through WeChat and which has shown good predictive value in previous studies [31-33]. Previous studies found that the Wuhan area – the centre of the outbreak – saw many patients in emergency care and fever clinics, exhausted medical resources, and had limited personal protective equipment. These factors affected Wuhan's medical support staff, who continuously engaged in high-impact work and heavy workload, with little time to rest sufficiently, which affected their sleep time and quality [34]. Our results indicated that the sleep quality of the medical workers supporting Wuhan was significantly worse than that of the control group. This is consistent with a previous study that suggested that being at the center of the epidemic greatly affected the sleep quality of medical workers [35-37].

Although the medical workers supporting Wuhan had left the city, the epidemic was still ongoing, entering the post-epidemic stage, and medical workers needed to return to their posts and still deliver front-line medical service [38]. Some of the medical staff in our study who had supported Wuhan did not return to the hospital immediately, but rather chose to recuperate. However, the enhanced sleep quality after the unified intervention was unrelated to the rest duration after the intervention by comparison between groups. The intervention was the same except for the rest period, which means that the difference in sleep quality may be influenced by factors other than the rest period; in other words, sleep quality was not affected by the length of the rest period. Thus, the results indicated that after administration of the effective intervention, there was no meaningful improvement in sleep quality, even if the medical staff continued to recuperate on their own.

Notably, the medical workers who did not provide support in Wuhan (the control group) were at the front line of the medical services during the epidemic but had not worked at the core of the outbreak. Therefore, they could gradually adapt to the impact of the epidemic, which means that their sleep quality problems were not as serious as those of the medical workers who had supported Wuhan. Previous studies have found obvious psychological stress and sleep disorders among medical workers during the SARS outbreak in 2003 and the Ebola epidemic in Africa in 2014. Research has also shown sleep disorders among Chinese medical workers who provided support

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in Africa [12,39-43]. This is consistent with the results of our study, suggesting that providing support in Wuhan affected the sleep quality of medical workers. Furthermore, various studies showed that effective interventions for medical staff in an epidemic situation could significantly enhance their psychological state and sleep quality, effectively improve their work enthusiasm, and make their return to work in the post-epidemic stage easier [44-47]. Importantly, after effective interventions, front-line medical staff do not need to continue recuperating and can quickly return to work to ensure basic medical needs are met in the post-epidemic stage.

One of the advantages of this study is that, unlike other cross-sectional design studies, we continuously observed and then supported the medical staff assigned to Wuhan after they had left the area. They were able to return to normal clinical work after the 2-week intervention. By following a systematic process, we were able to fully understand the changes in the quality of sleep of the front-line support staff. Furthermore, we have shown that effective interventions considerably improved the sleep quality of front-line medical workers who participated in our study in Wuhan. The support group no longer required continuous rest, which helps ensure that good medical care is available in the stages immediately following a pandemic.

Our study has some limitations. First, the baseline data on the control group and the medical personnel who were dispatched to Wuhan were not available due to the sudden COVID-19 outbreak. Second, due to the epidemic, it was impossible to carry out field investigations, and investigations are only conducted through online questionnaires; however, the authenticity and reliability of the data can be guaranteed. Third, participants included medical personnel from a hospital in Anhui Province, and the data volume was small, which limits the generalizability of our study. More studies with multicenter study designs and large sample sizes are needed.

Conclusions

The findings from this study showed that medical staff who were conscripted to offer support during the early stages of the COVID-19 pandemic suffered from impaired quality of sleep. Using questionnaire-based sleep assessments can provide individualized approaches to supporting medical personnel during future epidemics and pandemics. Furthermore, the study results indicated that relevant interventions could significantly improve sleep quality, while a prolonged break after interventions does not affect sleep quality. Therefore, the sleep quality of medical personnel should be emphasized and interventions implemented because sleep quality played an important role in the overall treatment and prognosis of medical personnel during the pandemic.

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Conflict of Interest

None.

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