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ORIGINAL ARTICLE

Sleep quality and mental health of medical workers during the coronavirus disease 2019 pandemic

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Abstract

The purpose of this study is to assess the sleep quality, mental health status, and associated factors among medical workers during the coronavirus disease 2019 (COVID-19) pandemic. A cross-sectional study was conducted and medical workers in Ningbo, China were recruited. Sleep quality was evaluated by Pittsburgh Sleep Quality Index (PSQI). Mental health status was evaluated by Symptom Checklist 90 (SCL-90). Logistic regression and generalized multi-factor dimensionality reduction (GMDR) analysis were utilized to explore the risk factors and their interactions on sleep quality and mental health status. 207 participants were surveyed, and 34.30% were found with poor sleep quality (total PSQI score > 10), mainly manifested as sleep disturbance (92.75%). 27.05% were found with mental symptoms (Global severity index > 1.50), mainly manifested as obsessive–compulsive (25.60%). Multivariate logistic analysis showed that male (OR 3.89, 95% CI 1.06–14.24, $P = 0.04$), working years > 15 years (OR 4.51, 95% CI 1.56–13.00, $P = 0.01$), nurse (OR 5.64, 95% CI 1.35–23.63, $P = 0.02$), more night shifts (OR 3.10, 95% CI 1.31–7.34, $P = 0.01$), and supporting Wuhan (OR 3.41, 95% CI 1.12–10.40, $P = 0.03$) were associated with poor sleep quality. GMDR analysis showed that there was a two-factor interaction between working years and working shifts ($P = 0.01$). No significant factors and interactions were found associated with mental symptoms. In conclusions, about one-third of medical workers suffered from sleep and mental problems during the COVID-19 pandemic in the current study. Interventions for sleep and mental problems among medical workers were needed based on related factors.

Keywords Sleep quality · Mental health · Medical workers · COVID-19

Introduction

Coronavirus disease 2019 (COVID-19), formerly known as 2019 novel coronavirus (2019-nCoV) and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has spread internationally. According to data published by the World Health Organization, a total of 25,541,380 cases were confirmed worldwide, 852,000 patients died as of September 2, 2020 [1].

The COVID-19 pandemic not only caused great public concern, but also led to huge mental burden and sleep disturbances, especially for medical workers [2–8]. Previous studies have indicated adverse mental reactions to the 2003 SARS outbreak among health care workers [9, 10]. Recently, studies showed that more than one-third of the medical workers suffered from insomnia symptoms [2], 26.67% of front-line medical workers suffered from severe insomnia [3], 60% suffered from insomnia combined with moderate–severe stress [11] during the COVID-19 pandemic. However, the prevalence rates of sleep and mental

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problems were significantly different among various studies and groups.

In addition, sleep quality and mental health of medical workers were associated with lots of factors during the COVID-19 pandemic. Chenxi Zhang et al. showed that occupation, education level, an isolation environment, and psychological worry about the COVID-19 pandemic were related to insomnia [2]. Those in Wuhan, nurses, women, and front-line medical workers suffered from psychological problems [6]. Professional background and female were the predictors of poor sleep quality combined with moderate–severe stress [11]. Although several insomnia-related and mental-related factors have been reported, there was no consistent conclusion on the type of factors, the size of factor effect. Furthermore, sleep and mental problems are complex multifactorial problems, the interactions of multiple factors should be concerned, but there was little research on this aspect. Therefore, we aimed to assess the sleep quality and mental health status, and explore the related factors among medical workers during the COVID-19 pandemic.

Materials and methods

Study participants

A cross-sectional, survey-based study was performed among medical workers from multiple hospitals in Ningbo City, Zhejiang province, China, including medical workers who supported Wuhan. Data were collected with a self-rated, anonymous questionnaire by Wenjuanxing (www.wjx.cn) which was delivered through the internet from 1st March 2020 to 15th March 2020. Wenjuanxing is a professional online questionnaire survey platform in China, focusing on providing users with powerful and humanized online questionnaire design, data collection, and data analysis services. The people with valid telephone number can register. All subjects provided informed consent electronically prior to survey. Only subjects who chose yes on the informed consent page were surveyed, and subjects could quit the process at any time. This study was approved by the ethics committee of Ningbo Medical Center Lihuili Hospital (KY2020PJ066).

Questionnaire

The questionnaire consisted of three parts: basic demographic information, sleep quality assessment (the Pittsburgh Sleep Quality Index), and mental health assessment (the Symptom Checklist 90).

Basic demographic information included age (≤ 30 years or > 30 years), gender (male or female), working years (1–5 years, 6–10 years, 11–15 years, > 15 years), educational level (college, undergraduate, postgraduate), occupation (doctor, nurse, and technician), type of hospital (Grade I hospital or community, Grade II hospital, Grade III hospital), working shifts (as usual, more night shifts, and more day shifts), working position (front line or second line), and whether to support Wuhan (yes or no). Grade I hospital or community is the primary health care institution that directly provided comprehensive services of treatment, prevention, and rehabilitation for the community. Grade II hospital is the regional hospital that provided medical services across several communities and is the technical center of regional medical prevention. Grade III hospital is the hospital that provided medical services across regions, cities, provinces, and the whole country. It is the medical prevention technology center with comprehensive medical, teaching, and scientific research capabilities. Medical workers who were directly engaged in clinical activities of diagnosing, treating, or providing nursing care to COVID-19 confirmed or suspected patients were defined as frontline workers.

Sleep quality assessment

Sleep quality was evaluated with the Pittsburgh Sleep Quality Index (PSQI) [12, 13]. The PSQI includes 7 components and 18 entries in total. Each entry is scored with a 0–3 scale. The 7 components include subjective sleep quality (positive: 2–3 score, negative: 0–1 score), time to sleep (positive: 2–3 score, negative: 0–1 score), sleep time (positive: 2–3 score, negative: 0–1 score), sleep efficiency (positive: 2–3 score, negative: 0–1 score), sleep disturbance (positive: 1–3 score, negative: 0 score), hypnotic drugs (positive: 1–3 score, negative: 0 score), and daytime dysfunction (positive: 1–3 score, negative: 0 score). Of them, the positive for subjective sleep quality indicates subjective sleep quality is poor, the positive for time to sleep indicates time to sleep is long, the positive for sleep time indicates sleep time is < 6 h, and the positive for sleep efficiency indicates sleep efficiency is poor. The cumulative score of each component is the total PSQI score varying from 0 to 21. The higher scores the people get, the worse the sleep quality is. 0–5 scores indicate good sleep quality, 6–10 scores indicate average sleep quality, 11–15 scores indicate poor sleep quality, and 16–21 scores indicate very poor sleep quality. Thus, a total score > 10 was identified as poor sleep quality in the current study. The PSQI has been widely used in previous studies with high reliability and validity, and the Cronbach's alpha was 0.811 [14].

Mental health assessment

Mental health was evaluated with the Symptom Checklist 90 (SCL-90) [15, 16]. There are 90 items in total. 90 items made up 10 factors. Each item is scored with a 5-point Likert scale, ranging from 0 (none) to 4 (severe). Items are calculated and converted to get the total score and subscale scores.

The 10 factors include somatization (positive: ≥ 24 score, negative: < 24 score), obsessive–compulsive (positive: ≥ 20 score, negative: < 20 score), interpersonal sensitivity (positive: ≥ 18 score, negative: < 18 score), depression (positive: ≥ 26 score, negative: < 26 score), anxiety (positive: ≥ 20 score, negative: < 20 score), hostility (positive: ≥ 12 score, negative: < 12 score), photic anxiety (positive: ≥ 14 score, negative: < 14 score), paranoididefition (positive: ≥ 12 score, negative: < 12 score), psychotieism (positive: ≥ 20 score, negative: < 20 score), and other (positive: ≥ 14 score, negative: < 14 score). If any subscale score is higher than 2, positive items are higher than 43, or the total score is higher than 160, it suggests psychological abnormality. The Global Severity Index (GSI) ranging from 1 to 5 is calculated as the mean of all 90 items, which is considered the overall index of mental symptoms. The higher scores the people get, the worse the mental health is. 1–1.5 scores indicate none mental symptom, 1.5–2.5 scores indicate mild mental symptom, 2.5–3.5 scores indicate moderate mental symptom, 3.5–4.5 scores indicate moderate-to-severe mental symptom, and 4.5–5 points indicate severe mental symptom. Thus, GSI > 1.5 is defined with mental symptom in the current study. The SCL-90 has been widely used in the previous studies with high reliability and validity, and the Cronbach's alpha was 0.983 [17].

Statistical analysis

The original scores of above two measurement tools were not normally distributed and so were presented as medians with interquartile ranges (IQRs). Categorical variables were presented as percentages and analyzed using the Chi-square test. To explore the associations among demographic factors and sleep quality, and mental health, logistic regression was used. In addition, the generalized multi-factor dimensionality reduction (GMDR) method was used to explore potential high-order interactions [18, 19]. Due to the influence of "dimension disaster", traditional statistical models were not suitable for exploring potential high-order interactions. As a non-parametric testing method, GMDR could overcome the influence of "dimension disaster" and correct the confounding factors, which significantly improved the accuracy of prediction. Through GMDR method, high-dimensional data were finally transformed into one-dimensional data with two levels ("high risk", "low risk"), and the confounding factors were adjusted. In our analysis, the data were randomly divided into 10 equal parts, 9 of which were used as training samples for the construction of the interaction model, and the remaining one was used as a test sample for the test of the model. According to the analysis results, the model with P value less than 0.05 and the largest cross-validation consistency and maximum prediction accuracy was selected as the best model. A P value of < 0.05 was considered statistically significant. Data analysis was performed using SPSS statistical software version 20.0 (IBM Corp) and GMDR v0.7 program (http://ibi.zju.edu.cn/software/GMDR/download.html).

Results

Characteristics of the study population

A total of 207 participants were surveyed in our study, 131 (63.29%) aged > 30 years, 175 (84.54%) were females, 38 (18.36%) were doctors, 155 (74.88%) were nurses, and 14 (6.76%) were technicians. Additionally, most of them came from Grade III hospital [167 (80.68%)], had worked for 6–10 years [85 (41.06%)], and had an educational level of undergraduate [166 (80.19%)]. During the survey, 132 (63.77%) subjects were in the front line, 101 (48.79%) were supporting Wuhan, and 87 (42.03%) mainly worked in the day shift (Table 1).

Assessment of sleep quality and associated factors

As a result, the average total PSQI score was 9 in the 207 studied subjects, and 71 (34.30%) subjects had the total PSQI score > 10 and defined as poor sleep quality. 91 (43.96%) were positive for subjective sleep quality, 125 (60.39%) were positive for time to sleep, 70 (33.82%) were positive for sleep time, 98 (47.34%) were positive for sleep efficiency, 192 (92.75%) were positive for sleep disturbance, 49 (23.67%) were positive for hypnotic drugs, and 162 (78.26%) were positive for daytime dysfunction.

Univariate logistic analysis showed that working years (11–15 years) (OR 5.28, 95% CI 2.03–13.76, $P = 1.00 \times 10^{-3}$), working shifts (more night shifts) (OR 2.94, 95% CI 1.37–6.31, $P = 0.01$), working position (front line) (OR 1.92, 95% CI 1.02–3.59, $P = 0.04$), and whether to support Wuhan (yes) (OR 2.71, 95% CI 1.49–4.92, $P = 1.00 \times 10^{-3}$) were associated with poor sleep quality. After adjusting for confounding factors, multivariate logistic analysis showed that gender (male) (OR 3.89, 95% CI 1.06–14.24, $P = 0.04$), working years (> 15 years) (OR 4.51, 95% CI 1.56–13.00, $P = 0.01$), occupation (nurse) (OR 5.64, 95% CI 1.35–23.63, $P = 0.02$), working shifts (more night shifts) (OR 3.10, 95% CI 1.31–7.34, $P = 0.01$), and supporting Wuhan (yes) (OR 3.41, 95% CI 1.12–10.40, $P = 0.03$) were associated with poor sleep quality (Table 2).

Furthermore, GMDR interaction analysis of sleep quality was conducted among those factors which were significant by multivariate logistic regression analysis, including gender, working years, occupation, working shifts, and supporting Wuhan. According to the screening principle of the best model (with a sign test P value of < 0.05, and the highest

Table 1 Characteristics of the study population ($n = 207$)

Variables	Number ($n = 207$)	Percentage
Age (years)		
≤ 30	76	36.71
> 30	131	63.29
Gender		
Male	32	15.46
Female	175	84.54
Working years (years)		
1–5	43	20.77
6–10	85	41.06
11–15	39	18.84
> 15	40	19.32
Educational level		
College	29	14.01
Undergraduate	166	80.19
Postgraduate	12	5.80
Occupation		
Doctor	38	18.36
Nurse	155	74.88
Technician	14	6.76
Type of hospital		
Grade I hospital or community	8	3.86
Grade II hospital	32	15.46
Grade III hospital	167	80.68
Working shifts		
As usual	60	28.99
More night shifts	60	28.99
More day shifts	87	42.03
Working position		
Frontline	132	63.77
Second line	75	36.23
Supporting Wuhan		
Yes	101	48.79
No	106	51.21
Total PSQI score, *M* (IQR)	–	9.00 (7.00)
Sleep quality		
Poor (total PSQI score > 10)	71	34.30
Good (total PSQI score ≤ 10)	136	65.70
Total SCL-90 score, *M* (IQR)	–	106.00 (47.00)
GSI, *M* (IQR)	–	1.18 (0.52)
Mental symptom		
Positive (GSI > 1.5)	56	27.05
Negative (GSI ≤ 1.5)	151	72.95

PSQI Pittsburgh sleep quality index, *GSI* global severity index, *IQR* interquartile range

cross-validation consistency, prediction accuracy), the two-factor interaction model of working years with working shifts was selected (Table 3).

Assessment of mental health and associated factors

As shown in Table 4, the total SCL score was 106, global severity index (GSI) was 1.18 in the studied population, and 56 (27.05%) subjects had mental symptom (GSI > 1.5). 26 (12.56%) were positive for somatization, 53 (25.60%) were positive for obsessive–compulsive, 34 (16.43%) were positive for interpersonal sensitivity, 30 (14.49%) were positive for depression, 30 (14.49%) were positive for anxiety, 31 (14.98%) were positive for hostility, 20 (9.66%) were positive for photic anxiety, 25 (12.08%) were positive for paranoididefition, 25 (12.08%) were positive for psychotieism, and 56 (27.05%) were positive for other. However, no significant factors were found associated with mental symptom by logistic analysis (Table 5), and no interactions were found by GMDR analysis (data not shown).

Discussion

Our research found that about one-third of medical workers suffered from sleep problems (mainly manifested as sleep disturbance) and mental problems (mainly manifested as obsessive–compulsive). Male, working years > 15 years, nurse, more night shifts, supporting Wuhan, and a two-factor interaction between working years and working shifts were all risk factors for sleep quality. Interventions for sleep and mental problems among medical workers were needed.

Previous studies indicated that the insomnia rate was 34.2–37% during the SARS pandemic [20, 21] and 36.1% among medical staff during the COVID-19 pandemic [2]. Similarly, the present study found that the prevalence rate of poor sleep quality was 34.30%, and the average PSQI score of medical workers was 9, which meant that the overall sleep quality of medical workers during the COVID-19 pandemic was poor. The poor sleep quality might be due to the overload work and intense psychological pressure of medical workers. Of note, Haitham Jahram et al. [11] found that 75–76% healthcare workers were poor sleepers, which was higher than ours. The difference might be related to the different populations and different definitions of poor sleep quality. In a word, medical institutions should improve infectious disease prevention and control system, strengthen psychological counseling and humanistic care for medical workers, and improve their sleep quality and mental health status.

The current study demonstrated that male, working years > 15 years, nurse, more night shifts, and supporting Wuhan were risk factors for poor sleep quality. Similarly, previous studies found that nurses were more susceptible to insomnia [2]. The reasons were as follows: in clinical work, doctors often work in the daytime, while nurses may have to work the whole night with frequent night shifts [22],

Table 2 Logistic regression analysis of risk factors associated with sleep quality

Variables	No. of cases/no. of total cases (%)	Model 1		Model 2	
		OR (95% CI)	*P*	OR (95% CI)	*P*
Age (years)					
≤ 30	21/76 (27.63)	1.00 (reference)	NA	1.00 (reference)	NA
> 30	50/131 (38.17)	1.62 (0.88–2.99)	0.13	1.67 (0.59–4.73)	0.33
Gender					
Male	12/32 (37.50)	1.18 (0.54–2.58)	0.68	3.89 (1.06–14.24)	0.04
Female	59/175 (33.71)	1.00 (reference)	NA	1.00 (reference)	NA
Working years (years)					
1–5	10/43 (23.26)	1.00 (reference)	NA	1.00 (Reference)	NA
6–10	27/85 (31.76)	1.54 (0.66–3.57)	0.32	0.99 (0.22–4.44)	0.99
11–15	24/39 (61.54)	5.28 (2.03–13.76)	1.00×10^{-3}	1.32 (0.48–3.60)	0.59
> 15	10/40 (25.00)	1.10 (0.40–3.01)	0.85	4.51 (1.56–13.00)	0.01
Educational level					
College	11/29 (37.93)	1.00 (reference)	NA	1.00 (reference)	NA
Undergraduate	54/166 (32.53)	0.79 (0.35–1.79)	0.57	0.48 (0.18–1.27)	0.14
Postgraduate	6/12 (50.00)	1.64 (0.42–6.36)	0.48	2.52 (0.37–17.43)	0.35
Occupation					
Doctor	11/38 (28.95)	1.00 (reference)	NA	1.00 (reference)	NA
Nurse	59/155 (38.06)	1.51 (0.70–3.27)	0.30	5.64 (1.35–23.63)	0.02
Technician	1/14 (7.14)	0.19 (0.02–1.62)	0.13	0.49 (0.04–5.62)	0.57
Type of hospital					
Grade I hospital or community	2/8 (25.00)	1.00 (reference)	NA	1.00 (reference)	NA
Grade II hospital	11/32 (34.38)	0.63 (0.12–3.20)	0.57	2.13 (0.29–15.56)	0.46
Grade III hospital	58/167 (34.73)	0.98 (044–2.18)	0.97	1.34 (0.22–8.22)	0.75
Working shifts					
As usual	16/60 (26.67)	1.00 (reference)	NA	1.00 (reference)	NA
More night shifts	31/60 (51.67)	2.94 (1.37–6.31)	0.01	3.10 (1.31–7.34)	0.01
More day shifts	24/87 (27.59)	1.05 (0.50–2.20)	0.90	1.34 (0.58–3.09)	0.50
Working position					
Frontline	52/132 (39.39)	1.92 (1.02–3.59)	0.04	0.34 (0.10–1.15)	0.08
Second line	19/75 (25.33)	1.00 (reference)	NA	1.00 (reference)	NA
Supporting Wuhan					
Yes	46/101 (45.54)	2.71 (1.49–4.92)	1.00×10^{-3}	3.41 (1.12–10.40)	0.03
No	25/106 (23.58)	1.00 (reference)	NA	1.00 (reference)	NA

Model 1: univariate logistic analysis; model 2: multivariate logistic analysis

Table 3 GMDR models of sleep quality

Model	Prediction accuracy	Sign test (*P*)	Cross-validation consistency
Working shifts	0.55	5 (0.62)	7/10
Working years, working shifts	0.65	9 (0.01)	10/10
Working years, occupation, working shifts	0.55	7 (0.17)	8/10
Working years, occupation, working shifts, supporting Wuhan	0.56	7 (0.17)	7/10
Gender, working years, occupation, working shifts, supporting Wuhan	0.61	8 (0.05)	10/10

P was adjusted for age, educational level, type of hospital, and working position using logistic regression in GMDR analysis

Table 4 Assessment of mental health status using the SCL-90

Variables	Total (207), *n* (%)	Mental symptom, *n* (%)	
		Positive (56)	Negative (151)
Somatization			
Positive	26 (12.56)	24 (42.86)	2 (1.32)
Negative	181 (87.44)	32 (57.14)	149 (98.68)
Obsessive–compulsive			
Positive	53 (25.60)	49 (87.50)	4 (2.65)
Negative	154 (74.40)	7 (12.50)	147 (97.35)
Interpersonal sensitivity			
Positive	34 (16.43)	31 (55.36)	3 (1.99)
Negative	173 (83.57)	25 (44.64)	148 (98.01)
Depression			
Positive	30 (14.49)	30 (53.57)	0 (0.00)
Negative	177 (85.51)	26 (46.43)	151 (100.00)
Anxiety			
Positive	30 (14.49)	30 (53.57)	0 (0.00)
Negative	177 (85.51)	26 (46.43)	151 (100.00)
Hostility			
Positive	31 (14.98)	30 (53.57)	1 (0.66)
Negative	176 (85.02)	26 (46.43)	150 (99.34)
Photic anxiety			
Positive	20 (9.66)	20 (35.71)	0 (0.00)
Negative	187 (90.34)	36 (64.29)	151 (100.00)
Paranoididefition			
Positive	25 (12.08)	25 (44.64)	0 (0.00)
Negative	182 (87.92)	31 (55.36)	151 (100.00)
Psychotieism			
Positive	25 (12.08)	25 (44.64)	0 (0.00)
Negative	182 (87.92)	31 (55.36)	151 (100.00)
Other			
Positive	56 (27.05)	38 (67.86)	18 (11.92)
Negative	151 (72.95)	18 (32.14)	133 (88.08)

and more night shifts may lead to insomnia, which was found in our study. Furthermore, more contact with patients with higher-severity illness was demonstrated to result in higher IES scores [23]. Nurses often have more contact with patients than doctors, which resulted in poor sleep quality of nurses [2]. Consistent with our finding, Jianbo Lai et al. [6] found medical workers in Wuhan showed more severe symptoms of insomnia compared with those outside Wuhan. These findings suggested more stress among medical workers in Wuhan, the epicenter of the pandemic in China, and their sleep quality might require special attention.

In addition, previous studies reported that females were more susceptible to insomnia [11, 24]. However, in some studies, males were reported to be prone to poor sleep quality [25, 26]. In the current study, we found that the sleep quality of males was worse than that of females, as well. The reasons might be that the percentage of male supporting Wuhan (72%, 23 out of 32) was larger than females (45%, 78 out of 175) in the current study, and the medical workers supporting Wuhan were more likely to suffer from insomnia, which led to the sleep quality of males was worse than that of females. Of note, although we tried our best to control the confounding factors through multivariate logistic analysis, potential confounding factors might still exist. This study also found that people with working years > 15 years were more likely to suffer from insomnia, which might be related to the decline of physiological function. Moreover, medical workers with long working years often act as department directors or head nurses, so they need to coordinate and manage the work of the department, and consider more things, leading to the decline of sleep quality. Consistent with the study by Haitham Jahram et al. [11], there was no statistical correlation between front-line medical staff and insomnia after multivariate logistic analysis in the present study, but we found that front-line medical staffs were more prone to insomnia in univariate logistic analysis, suggesting that more attention should also be paid to the sleep problems of front-line medical staff [2].

As sleep and mental problems are complex multifactorial problems, the effect of a single factor may be weak, so we should focus on the interactions of multiple factors. However, due to the influence of "dimension disaster", the traditional statistical models are not suitable for exploring potential high-order interactions. Generalized multivariate dimension reduction (GMDR), as a non-parametric testing method, can overcome the influence of dimension and correct the confounding factors, which significantly improves the accuracy of prediction. With this method, a three-factor interaction among red meat intake, pickled vegetable, and cured meat intake was reported to increase the risk of colorectal cancer [27]. In this study, we found that there was a two-factor interaction of sleep quality among working years and working shifts, which means that more attention should be paid on the subjects with more night shifts and working years longer than 15 years. However, it is different between statistical interaction and biological interaction [18], whether these statistical interactions obtained in the current study have biological effects, and the specific mechanisms are still unclear, which should be explored in future research.

Owing to the sudden outbreak of the pandemic, strong infectivity, and the occurrence of multiple clinical medical staff infection, medical workers are susceptible to psychological burden. A cross-sectional study reported that the prevalence of psychological abnormality was 14.5% in medical workers during the COVID-19 [17]. Similarly, our study also showed the mental abnormality of medical workers, and the prevalence of mental abnormality was 27.05%, mainly manifested as obsessive–compulsive symptom, indicating that the mental status of medical staff during the COVID-19

Table 5 Logistic regression analysis of risk factors associated with mental health

Variables	No. of cases/no. of total cases (%)	Model 1		Model 2	
		OR (95% CI)	*P*	OR (95% CI)	*P*
Age (years)					
≤ 30	21/76 (27.63)	1.00 (reference)	NA	1.00 (reference)	NA
> 30	35/131 (26.72)	0.96 (0.51–1.80)	0.89	1.88 (0.66–5.37)	0.24
Gender					
Male	10/32 (31.25)	1.28 (0.56–2.89)	0.56	3.22 (0.96–10.79)	0.06
Female	46/175 (26.29)	1.00 (reference)	NA	1.00 (reference)	NA
Working years (years)					
1–5	13/43 (30.23)	1.00 (reference)	NA	1.00 (reference)	NA
6–10	25/85 (29.41)	0.96 (0.43–2.14)	0.92	2.62 (0.62–11.17)	0.19
11–15	9/39 (23.08)	0.69 (0.26–1.86)	0.47	1.82 (0.67–4.94)	0.24
> 15	9/40 (22.50)	0.67 (0.25–1.80)	043	1.43 (0.46–4.42)	0.53
Educational level					
College	11/29 (37.93)	1.00 (reference)	NA	1.00 (reference)	NA
Undergraduate	43/166 (25.90)	0.57 (0.25–1.31)	0.19	0.71 (0.28–1.79)	0.47
Postgraduate	2/12 (16.67)	0.33 (0.06–1.78)	0.20	0.45 (0.06–3.16)	0.42
Occupation					
Doctor	9/38 (23.68)	1.00 (reference)	NA	1.00 (reference)	NA
Nurse	43/155 (27.74)	1.24 (0.54–2.83)	0.61	2.18 (0.62–7.65)	0.22
Technician	4/14 (28.57)	1.29 (0.32–5.12)	0.72	0.76 (0.14–4.23)	0.75
Type of hospital					
Grade I hospital or community	2/8 (25.00)	1.00 (reference)	NA	1.00 (reference)	NA
Grade II hospital	13/32 (40.63)	1.02 (0.20–5.27)	1.00	3.71 (0.54–25.57)	0.18
Grade III hospital	41/167 (24.55)	2.10 (0.96–4.63)	0.07	1.39 (0.24–8.10)	0.72
Working shifts					
As usual	13/60 (21.67)	1.00 (reference)	NA	1.00 (reference)	NA
More night shifts	18/60 (30.00)	1.54 (0.68–3.54)	0.30	2.05 (0.83–5.04)	0.12
More day shifts	25/87 (28.74)	1.46 (0.68–3.15)	0.34	1.68 (0.72–3.94)	0.23
Working position					
Frontline	32/132 (24.24)	0.68 (0.36–1.27)	0.23	0.87 (0.32–2.40)	0.79
Second line	24/75 (32.00)	1.00 (reference)	NA	1.00 (reference)	NA
Supporting Wuhan					
Yes	22/101 (21.78)	0.59 (0.32–1.10)	0.10	0.53 (0.20–1.40)	0.20
No	34/106 (32.08)	1.00 (reference)	NA	1.00 (reference)	NA

Model 1: univariate logistic analysis; model 2: multivariate logistic analysis

pandemic was poor. However, no significant factors were found associated with mental symptom by logistic analysis and no interactions were found by GMDR analysis, which should be explored in future research.

Our study assessed the sleep quality and mental health status among medical workers during the COVID-19 pandemic, and explored associated factors and their interactions, which could help to provide precise interventions of sleep and mental problems for medical workers. However, there were several limitations. First, the causal association between demographic data and sleep quality or mental health status was not certain because of the cross-sectional design. Second, owing to the severe pandemic situation, no large scale was carried out, only the subjects in Ningbo were investigated, and the sample size was limited. Third, due to the time limitation of the pandemic, we conducted a rapid survey based on the Wenjuanxing program, no long-term survey was carried out, which might lead to a potential risk of bias in the way the data collected. Therefore, a prospective study with a large sample size is expected to be conducted, and more objective data on sleep quality and mental health status should be collected.

Conclusion

The findings indicated that about one-third of the medical workers suffered from sleep and mental problems during the COVID-19 pandemic. Sleep-related factors included gender,

working years, occupation, working shifts, whether to support Wuhan, and a two-factor interaction between working years and working shifts. Interventions for sleep and mental problems among medical workers are needed.

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Compliance with ethical standards

Conflict of interest The authors declare no competing interests.

Ethical approval The study design was approved by the ethics committee of Ningbo Medical Center Lihuili Hospital.

Informed consent Informed consent was obtained from all individual participants included in the study.

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