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Original Article

Job-related factors associated with changes in sleep quality among healthcare workers screening for 2019 novel coronavirus infection: a longitudinal study

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ABSTRACT

Background: Sleep disorders may exacerbate many physical and mental health conditions, causing difficulty function in a healthcare setting. Workers screening for the 2019 novel coronavirus (2019-nCoV) infection have a high risk of not only occupational exposure to the virus but also sleep disorders. However, the job-related factors associated with reduced sleep quality remain unclear.

Methods: All healthcare workers temporarily scheduled to screen the 2019-nCoV patients were asked to complete a self-administered questionnaire that included questions on demographics, job-related factors, and sleep quality as assessed using the Pittsburgh Sleep Quality Index (PSQI). Sleep quality was assessed over a one-month follow-up period.

Results: A total of 116 doctors and 99 nurses were recruited for this study. The total scheduled work time was 14.78 ± 6.69 days during follow-up. Some job-related factors, such as number of work days, years of work experience, and subjective psychological stress, were associated with changes in the PSQI score. During the study, some workers tried out cognitive behavioral therapy (CBT) for sleep disorders using methods that were available online and easily accessible. Adopting online CBT was shown to be associated with scores of components of sleep quality, sleep latency, and sleep disturbance ($\beta = -0.152$, $P = 0.01$; $\beta = -0.175$, $P = 0.008$; and $\beta = -0.158$, $P = 0.011$, respectively).

Conclusions: Healthcare workers involved in screening for 2019-nCoV experienced reduced sleep quality, and a reasonable work schedule may help with maintaining sleep quality. In addition, interventions for healthcare workers should target self-help sleep assistance.

1. Introduction

In early December 2019, the first cases of pneumonia of unknown origin due to 2019 novel coronavirus (2019-nCoV) infection were identified in Wuhan City, Hubei Province, China [1]. Evidence of person-to-person transmission in hospital and household settings has been accumulating [2,3]. The World Health Organization (WHO) has recently declared the 2019-nCoV a public health emergency of international concern [4]. As of February 15, 2020, 66,492 laboratory-confirmed cases and 1,523 deaths associated with the virus infection have been documented in China [5]. The number of confirmed cases outside of Hubei Province has been increasing. This novel coronavirus pneumonia has caused serious economic problems in Hubei Province and in China.

The Chinese Health Authority dispatched a total of 217 medical teams consisting of 25,633 medical workers from other regions of China to Wuhan for medical support, and 1,716 medical workers have been infected by 2019-nCoV as of February 14, 2020 [6]. This phenomenon has placed a serious psychological burden on the population in general and on healthcare workers in particular. Sleep disorders are important issues in healthcare, particularly in

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emergency medicine, primary-care physicians, and infectious disease departments [7]. Sleep disorders have negative consequences for physicians, their patients, and healthcare facilities due to disturbed moods in the medical staff, daytime dysfunction, medical errors, absenteeism, high rates of turnover, and patient dissatisfaction as a result of the effects on quality of care [7,8]. These healthcare specialists are at high risk of sleep disorders because of work overload, high work-related demands, and complex work environments [8]. The 2019-nCoV healthcare workers have an excessive workload and experience high levels of stress and poor working conditions due to the high infectivity and mortality rates of the 2019-nCoV. Given the greater risk of poor sleep quality, sleep consultation and treatment are necessary for 2019-nCoV healthcare workers.

Working in emergency medicine with febrile patients is stressful for both doctors and nurses as they are the key workers in control of the outbreak and spread of 2019-nCoV throughout China. The work involves the screening of patients for 2019-nCoV infection and being responsible for virus specimen collection. Many non-job-related factors (demographics and lifestyle factors) have been shown to be associated with sleep disorders among healthcare workers [8]. However, there is a lack of consensus regarding the associations of some job-related factors and work schedule (eg, number of years of practice, total work time, work experience related to other infectious diseases, psychological stress regarding illness) with sleep disturbance [9–11]. Therefore, it is difficult for institutions to predict which members of their staff will experience sleep disorders. A clear understanding of the relationships between these factors and sleep disorders would be helpful for taking precautions or providing relatively inexpensive and easily accessible therapy [eg, self-help sleep treatment such as online cognitive behavioral therapy (CBT)] to build an effective workforce [12].

2. Methods

2.1. Study site and screening procedures for 2019-nCoV patients in departments handling febrile patients

This study was conducted in the department that handles febrile patients at Sichuan Provincial People's Hospital, Chengdu, Sichuan Province, China, which was one of districts with the greatest number of cases of 2019-nCoV exported from Wuhan. On admission of febrile patients, nurses first collected the epidemiological history (any exposure to a febrile or confirmed patient, wild animals, or visits to wet markets, including the seafood market in Wuhan) and performed a preliminary examination that included measurements of temperature and vital signs (respiratory rate, pulse, and blood pressure) in the reception room. The nurses then guided the suspected 2019-nCoV patients to the diagnosis room for examination by a doctor. The doctor was responsible for detailed medical history collection, physical examination, and writing a prescription. In the sample-collection room, one nurse took nasal and pharyngeal swabs and blood specimens for real-time reverse-transcriptase polymerase chain reaction (RT-PCR) assays and laboratory assessments, respectively. Laboratory assessments consisted of the coagulation test, tests of liver and renal function, and analyses of blood chemistry, complete blood count, and levels of electrolytes, C-reactive protein, procalcitonin, lactate dehydrogenase, and creatine kinase. The patient was then examined using chest X-ray or computed tomography at another location. Laboratory confirmation of 2019-nCoV infection was performed through the Chinese Center for Disease Prevention and Control in Qing Yang District, Chengdu, based on WHO interim guidelines [13]. The RT-PCR assay was conducted in accordance with the protocol established by the WHO. After diagnosis, the patient was hospitalized in the isolation ward. Patients confirmed to not be infected with the 2019-nCoV received further treatment and was isolated at home for at least 14 days from contact with the source of transmission.

2.2. Study population and data collection

The 2019-nCoV healthcare workers were concentrated in designated departments dealing with febrile patients in makeshift tents to screen for the 2019-nCoV in patients between January 18 and February 18, 2020 in the hospital. Healthcare workers, including doctors and nurses, were recruited for this study from all internal and surgical departments. We personally contacted the healthcare workers, invited them to participate in the study, and clearly explained the aims and significance of the study, as well as the method for completing the questionnaires. We ensured confidentiality and immediately provided an explanation without inducement for any unclear questionnaire items. The self-administered questionnaire was directly distributed to the participants on January 18, 2020. The second sleep quality assessment was performed one month later; ie, February 18, 2020. We checked the questionnaires to avoid errors and ensure quality. A total of 240 questionnaires were distributed. Ten invalid questionnaires (4.16%) were returned, and therefore a total of 230 completed questionnaires were collected (response rate, 95.83%). Fifteen workers were excluded for the following reasons: 1) history of sleep disorders, such as insomnia or sleep apnea, or currently undergoing therapy for any sleep-related issues ($n = 7$); 2) presence of another systemic disease, such as respiratory disease, endocrine disease, or psychiatric disease ($n = 3$); or 3) missing data ($n = 5$). Finally, the data from 215 participants were used in the present study. This study was conducted in accordance with the Declaration of Helsinki and received approval from the Internal Review Board of the Institutional Ethics Committee of Sichuan Provincial People's Hospital.

2.3. Job-related and demographic factors

The following job-related factors were examined in the present study: 1) years of work experience; 2) number of work days in the department handling febrile patients during the month; 3) work experience related to other infectious diseases, such as epidemic virus infections (SARS-CoV and MERS-CoV) (yes or no); 4) number of nightshift days per month before screening for 2019-nCoV; 5) subjective psychological stress related to 2019-nCoV infection; and 6) use of online CBT to manage sleep disorders. Factor 5 was scored using one item consisting of the question “Are you worried about being infected with the 2019-nCoV infection in this first-line clinical work?” The response for this question ranged from not worried (1 point) to very worried (10 points). Factor 6 was scored based on the response to the question “Which type of online sleep cognitive behavioral therapy have you used during the last month?” With regard to demographic data, each participant provided a self-report of his or her gender, age, body mass index (BMI), marital status (married or single), educational level (university or below, or postgraduate), health status, monthly personal income, and smoking and alcohol status.

2.4. Sleep quality assessment

Sleep quality was measured at the beginning and end of our one-month study period using the Pittsburgh Sleep Quality Index (PSQI), a 19-item self-reporting instrument designed to measure sleep quality and disturbances [9]. The 19 items of the questionnaire generate scores for seven “components”: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction. The component scores range from 0 (indicating no difficulty) to 3 (indicating severe

difficulty). The sum of the seven component scores yields one total score ranging between 0 and 21, with higher scores representing poorer sleep quality. A total PSQI score >5 indicates poor sleep quality, whereas a PSQI score <5 indicates good sleep.

2.5. Online CBT

Healthcare workers with difficulty sleeping or other sleep problems during the one-month survey period could consult with a sleep professional and access online CBT provided via smartphone. The healthcare workers could obtain access to instructions from the Chinese Medical Doctor Association committee that specializes in sleep medicine [14]. The CBT protocols typically included sleep restriction, stimulus control, psychoeducation, relaxation techniques, and cognitive restructuring [12]. Sleep restriction refers to voluntary mild sleep deprivation by limiting the time in bed to the average actual sleep time, thus increasing homeostatic sleep pressure and decreasing sleep fragmentation, until the participant's sleep efficiency increases to a satisfying degree (typically ≥85%). Stimulus control refers to establishing a regular sleep–wake schedule and using the bed only for sleeping and sexual activity, thus retraining the patient to disassociate the sleeping environment from activities such as smartphone use, television viewing, or work. Relaxation techniques, such as progressive muscle relaxation, breathing exercises, or listening to relaxing music, are used to reduce physiological hyperarousal and intrusive thoughts. Psychoeducation and cognitive restructuring entail providing guidelines regarding helpful versus detrimental thoughts and behaviors as well as the modification of faulty beliefs about sleep and insomnia and its consequences. The participants were able to contact the researchers by phone if they had technical difficulties or specific questions about the online CBT.

2.6. Statistical analysis

Data are presented as means with standard deviations, medians with interquartile ranges, or percentages, according to whether they had a normal distribution, a skewed distribution, or were categorical, respectively. Differences in baseline characteristics among subgroups were examined using the Kruskal–Wallis H-test, one-way analysis of variance, Fisher's exact test, or the χ^2 test according to the data distribution. Further statistical analysis was preceded by collinearity diagnostics to eliminate possible multicollinearity among variables. The two steps of the collinearity analyses were: (1) preliminary analysis using Spearman's correlation; and (2) collinearity diagnostics to determine the selected covariates in multivariate regression analyses. Stepwise multivariate linear regression analyses were performed to determine which job-related factors were independently associated with changes in sleep quality before and during screening for 2019-nCoV infections, which were adjusted for demographic factors. Differences in sleep quality due to differences between baseline and work time were examined using the paired Student's *t* test, Wilcoxon's signed-rank test, Kruskal–Wallis test, or the χ^2 test as appropriate. All analyses were performed using SPSS software (ver. 20.0; SPSS Inc., Chicago, IL). In all analyses, $P < 0.05$ was taken to indicate statistical significance.

3. Results

3.1. Baseline characteristics of the healthcare workers in this study

A total of 240 questionnaires were distributed, and 230 were completed and collected (response rate, 95.83%). We excluded 15 questionnaires for reasons outlined in the Methods section, and data from 215 healthcare workers were included in the study. The baseline and job-related characteristics of the participants are shown in Table 1. Doctors were older, with higher percentages of married and male individuals, and had higher personal monthly incomes, higher educational levels, and higher rates of alcohol drinkers compared to nurses. There were no significant differences between doctors and nurses for some job-related factors, but a higher percentage of nurses were willing to use online CBT to treat

Table 1
Demographic characteristics and job-related attributes of the 2019-nCoV healthcare workers.

	Doctors	Nurses	*P*-value
	n = 116	*n* = 99	
Demographics			
Age, years	37.39 ± 0.724	34.44 ± 0.669	0.004
No. of females, *n* (%)	69 (59.50)	95 (96.0)	<0.001
BMI, kg/m^2	21.88 ± 0.53	22.59 ± 1.08	0.543
Marital status, *n* (% married)	96 (82.8)	93 (93.9)	0.012
Monthly personal income (RMB)	7,600 ± 795	5,860 ± 857	<0.001
Educational level (%)			<0.001
University or below	41.4	96	
Postgraduate	58.6	4	
Health status, % healthy	90.5	94.9	0.450
Nightshift days per month	5.01 ± 0.03	4.96 ± 0.03	0.329
Current smoker, *n* (%)	8 (6.9)	2 (2)	0.112
Alcohol drinker, *n* (%)	16 (13.8)	4 (4)	0.017
Job-related attributes			
Work time, days	14.41 ± 0.72	15.22 ± 0.51	0.374
Years of work experience	4.36 ± 0.12	4.64 ± 0.11	0.098
Work experience for SARS or MERS, *n* (%)	16 (13.8)	17 (17.2)	0.570
Subjective psychological stress score for 2019-nCoV infection	6 ± 0.22	5.53 ± 0.25	0.174
Online cognitive behavioral therapy use (%)	11.2	31.3	<0.001
Sleep restriction	1.7	6	
Stimulus control	1.7	4	
Relaxation techniques	11.2	31.3	
Mixed therapy	1.7	6	

Continuous data are presented as the means ± standard deviation (SD) and categorical data are presented as numbers with percentages in parentheses. Differences in baseline characteristics among the subgroups were examined using the Kruskal–Wallis H test or χ^2 test according to the characteristics of the data distribution. Abbreviations: BMI, body mass index; 2019-nCoV, 2019 novel coronavirus; SARS, severe acute respiratory syndrome; MERS, Middle East respiratory syndrome.

sleep problems compared to doctors during the one-month follow-up period (31.3% vs. 11.2%, respectively).

3.2. Sleep quality results

During the follow-up period, the participants typically had one nightshift per five work days on their work schedule. The mean total number of work days was 14.78 ± 6.69 days. The number of nightshifts for all healthcare workers decreased from 4.99 ± 0.35 per month to a usual number of 2.97 ± 1.37 during the one-month follow-up period. In addition, the PSQI components were measured again at the end of the one-month follow-up, and the changes were calculated (Table 2). Compared with the baseline scores (paired Student's *t* test), significantly higher scores were obtained for sleep quality (0.83 ± 0.035 vs. 1.06 ± 0.052, respectively, $P = 0.001$), sleep latency (1.7 ± 0.107 vs. 2.22 ± 0.127, respectively, $P = 0.002$), sleep efficiency (0.76 ± 0.05 vs. 1.46 ± 0.073, respectively, $P < 0.001$), use of medication (0 ± 0 vs. 0.12 ± 0.032, respectively, $P < 0.001$), daytime dysfunction (1.45 ± 0.089 vs. 1.92 ± 0.119, respectively, $P = 0.002$), and the total score (6.54 ± 0.196 vs. 8.24 ± 0.326, respectively, $P < 0.001$). However, sleep duration and sleep disturbance did not differ significantly between the two timepoints ($P = 0.514$ and $P = 0.289$, respectively) (Table 2). These results demonstrated that a high percentage of healthcare workers experienced poor sleep during the one-month follow-up period (PSQI score >5) (61.9% vs. 69.3%, respectively).

3.3. Associations of job-related factors with sleep quality components among healthcare workers involved in screening for 2019-nCoV infections

Regarding the relationships between job-related factors and changes in sleep quality components of the PSQI before (baseline) and after one month of screening work among healthcare workers, multiple linear regression analysis showed that longer work times in the department handling febrile patients, more years of work experience, and the use of online CBT during the study period were associated with lower PSQI scores, indicative of better sleep quality (Table 3). The number of work days in the department handling febrile patients was negatively related to sleep quality score ($\beta = -0.224$, $P = 0.008$); the number of years of work experience was inversely correlated with sleep efficiency scores, the use of medication, and the total score ($\beta = -0.151$, $P = 0.02$; $\beta = -0.220$, $P = 0.008$; $\beta = -0.220$, $P = 0.009$, respectively). In addition, online CBT use was negatively associated with sleep quality, sleep latency, and sleep disturbance scores ($\beta = -0.152$, $P = 0.010$; $\beta = -0.175$, $P = 0.008$; and $\beta = -0.158$, $P = 0.011$, respectively).

By contrast, subjective psychological stress related to 2019-nCoV infections was positively correlated with changes in daytime dysfunction scores and total PSQI scores ($\beta = 0.199$, $P = 0.006$; $\beta = 0.150$, $P = 0.0032$, respectively), indicating that a greater degree of psychological stress was associated with poorer sleep quality. All multiple linear regression models were adjusted for demographic factors, including age, sex, BMI, nightshift time per month, monthly personal income, marital status, type of work (doctor or nurse), smoking status, drinking status, educational level, and health status.

4. Discussion

The results of this study showed that healthcare workers involved in screening for the 2019-nCoV experienced poor subjective quality of sleep. Higher levels of psychological distress and greater concerns about the 2019-nCoV were independently associated with poorer quality of sleep. In addition, the number of work days and years of work experience, as well as the use of online CBT

Table 2
Comparison of sleep quality scores of healthcare workers measured using the Pittsburgh Sleep Quality Index before and after they started screening patients for the 2019-nCoV in the department handling febrile patients.

	Pre-screening	Post-screening	Difference	*P*-value
Sleep quality	0.83 ± 0.035	1.06 ± 0.052	0.23 ± 0.066	0.001
Sleep latency	1.7 ± 0.107	2.22 ± 0.127	0.53 ± 0.166	0.002
Sleep duration	0.51 ± 0.035	0.59 ± 0.058	0.0791 ± 0.065	0.514
Sleep efficiency	0.76 ± 0.05	1.46 ± 0.073	0.7 ± 0.093	<0.001
Sleep disturbances	0.80 ± 0.031	0.85 ± 0.035	0.05 ± 0.048	0.289
Use of medication	0 ± 0	0.12 ± 0.032	0.12 ± 0.032	<0.001
Daytime dysfunction	1.45 ± 0.089	1.92 ± 0.119	0.47 ± 0.15	0.002
Sleep quality total score	6.54 ± 0.196	8.24 ± 0.326	1.71 ± 0.395	<0.001

The data are presented as the means ± SD. Scores obtained pre-screening and those obtained during the screening process were compared using the paired Student's *t* test.
Abbreviations: 2019-nCoV, 2019 novel coronavirus.

Table 3
Factors associated with changes in sleep quality scores obtained before and when healthcare workers were screening for 2019-nCoV patients in the department handling febrile patients.

	Sleep quality	Sleep latency	Sleep duration	Sleep efficiency	Sleep disturbances	Use of medication	Daytime dysfunction	Total score
Job-related factors								
Number of work days	−0.224 (0.01)**	NS	NS	NS	NS	NS	NS	NS
Years of work experience	NS	NS	NS	−0.151 (0.075)*	NS	−0.220 (0.026)**	NS	−0.220 (0.311)**
Work experience for SARS or MERS	NS	NS	NS	NS	NS	NS	NS	NS
Subjective psychological stress score for 2019-nCoV infection	NS	NS	NS	NS	NS	NS	0.199 (0.058)**	0.15 (0.152)*
Online cognitive behavioral therapy (CBT)	−0.152 (0.171)*	−0.175 (0.432)**	NS	NS	−0.158 (0.022)*	NS	NS	NS

Standardized beta coefficients are displayed. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$; NS, not significant.
The multiple stepwise regression model was adjusted for age, BMI, nightshift days per month, and monthly personal income (continuous variables), as well as sex, marital status, type of work (doctor or nurse), smoking status, drinking status, educational level, and health status (categorized variables).
Abbreviations: BMI, body mass index; 2019-nCoV, 2019 novel coronavirus; SARS, severe acute respiratory syndrome; MERS, Middle East respiratory syndrome.

were negatively associated with sleep quality. This is the first study to compare changes in sleep quality in healthcare workers due to special clinical work that differs from baseline work within the context of the 2019-nCoV in China.

We found that the subjective psychological stress regarding 2019-nCoV infections was positively related to daytime dysfunction and total PSQI scores. These results were comparable to those reported previously for healthcare professionals in similar studies [15–17]. Psychological distress and concerns about the illness may be either a cause or a consequence of poor sleep or daytime dysfunction. Presumably, this is a circular process, in which higher levels of distress and concerns about the illness are related to poorer quality of sleep, which in turn leads to higher levels of dysfunction and both cognitive and emotional arousal, and vice versa [7]. Further research is needed to determine the cause–effect relationships. The results may also inform efforts to prevent depression and anxiety among healthcare workers involved in 2019-nCoV screening and treatment.

Remarkably, the number of work days was negatively related to quality of sleep. This was in contrast to our expectations as overlong work days have often been shown to be associated with the work poor sleep quality in previous studies [18,19]. This might have been related to the work schedule in the sample population analyzed in this study [20]. To reduce the population flow in the hospital and reduce the risk of infection, most of the outpatient and hospitalization procedures were suspended. Based on a flexible work schedule, doctors and nurses spent time at home waiting to go on duty and rested during the remaining time. During this period, the actual frequency of nightshifts for the healthcare workers was not as high as usual (2.97 ± 1.37 vs. 4.99 ± 0.35 days, respectively). Furthermore, because the healthcare workers still had to work a certain number of days, they still participated in moderate physical activity and experienced moderate not excessive fatigue, which might have led to better sleep quality [21]. Another possible reason was that an appropriate work time ensured the proficiency of clinical work [22], which was also supported by another observation in this study that the years of work experience were negatively associated with sleep quality. This may reduce the degree of anxiety and fear regarding 2019-nCoV infection and improve sleep quality.

Given the poor sleep quality experienced by healthcare workers involved in the screening of 2019-nCoV patients, hospital administrators should pay more attention to the identification of sleep problems and its treatment to reduce the risks of clinical incidents during work. However, waiting times for in-person treatment by a sleep specialist are long, and the risk of exposure for the sleep specialists are high. In addition, there is a lack of sleep specialists in China. It seems worthwhile to explore various readily available treatments for poor sleep quality, such as online CBT or music therapy, to improve sleep quality [23].

There were some limitations in this observational study. First, although we adjusted for several common confounders, other factors, such as exercise and dietary habits, were not taken into consideration. Second, further long-term follow-up studies are needed to track the changes in sleep quality over time and determine whether the participants benefitted from the interventions. Finally, online self-help CBT was provided without effective monitoring of the completion of the treatment to obtain more detailed information. Further studies are required to identify effective treatments for this special cohort of healthcare workers.

5. Conclusions

More attention should be paid to sleep quality and the alleviation of occupational stress among healthcare workers under epidemic conditions. For efficient and successful epidemic management and clinical work, appropriate nightshifts and work intensity, given the specialized clinical work required in these situations, should be considered when planning work schedules.

Authors' contributions

Xiaolong Zhao, Gang He and Jiangang Fan had full access to all data in the study and took responsibility for the integrity of the data and the accuracy of the data. Study design: Xiaolong Zhao; Data collection: Xiaoxu Yu, Bin Li, Yunhua Jing, Zhiyue Ma, Luhong Cao, Qingjia Gu; Statistical analysis: Xiaolong Zhao; Manuscript draft: Xiaolong Zhao and Tong Zhang.

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Conflict of interest

The authors declare no competing financial interests.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2020.07.027

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