Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Journal of Infection and Public Health 14 (2021) 1263–1267

Contents lists available at ScienceDirect

Journal of Infection and Public Health

journal homepage: http://www.elsevier.com/locate/jiph

Original Article

Physical health complaints among healthcare workers engaged in the care of critically ill COVID-19 patients: A single tertiary-care center prospective study from Japan

Hiroki Namikawa[a], Yoshihiro Tochino[a,b,*], Akiko Okada[b], Keiko Ota[c], Yasuyo Okada[d], Kazuya Fujioka[d], Koichi Yamada[d,e], Tetsuya Watanabe[f], Yu Nakagama[g], Yasutoshi Kido[g], Yasuhiko Takemoto[a], Yasumitsu Mizobata[h], Hiroshi Kakeya[d,e], Yumiko Kuwatsuru[i], Toshihiko Shibata[j], Taichi Shuto[a]

[a] *Department of Medical Education and General Practice, Osaka City University,Graduate School of Medicine, 1-4-3, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*
[b] *Office of Institutional Research, Osaka City University, Faculty of Medicine, 1-4-3, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*
[c] *Center for Clinical Research and Innovation, Osaka City University Hospital, 1-5-7, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*
[d] *Department of Infection Control and Prevention, Osaka City University Hospital, 1-5-7, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*
[e] *Department of Infection Control Science, Osaka City University, Graduate School of Medicine, 1-4-3, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*
[f] *Department of Respiratory Medicine, Osaka City University, Graduate School of Medicine, 1-4-3, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*
[g] *Department of Parasitology, Osaka City University, Graduate School of Medicine, 1-4-3, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*
[h] *Department of Traumatology and Critical Care Medicine, Osaka City University, Graduate School of Medicine, 1-4-3, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*
[i] *Department of Nursing, Osaka City University Hospital, 1-5-7, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*
[j] *Department of Cardiovascular Surgery, Osaka City University, Graduate School of Medicine, 1-4-3, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan*

ARTICLE INFO

Article history:
Received 24 November 2020
Received in revised form 12 August 2021
Accepted 22 August 2021

Keywords:
COVID-19
Physical health
Healthcare workers
Nurse

ABSTRACT

Background: Healthcare workers (HCWs) who manage patients with the novel coronavirus disease 2019 (COVID-19) are at an increased risk and fear of contracting the infection themselves. Hospitals must reduce both the physical and mental burden of HCWs on the front lines and ensure their safety. No prospective study has focused on the physical health complaints among HCWs engaged in the care of critically ill COVID-19 patients. This study aimed to evaluate the prevalence of various physical symptoms experienced by HCWs following their exposure to COVID-19 patients and investigate the association between occupation and the manifestation of physical symptoms among HCWs at a tertiary hospital in Japan during the current ongoing COVID-19 pandemic.
Methods: A twice-weekly questionnaire targeting HCWs who care for COVID-19 patients was performed at Osaka City University Hospital from April 30 to May 31, 2020. The demographic characteristics of the participants, frequency of exposure to at-risk care, and physical complaints were evaluated.
Results: Seventy-six HCWs participated in this study, of whom 24 (31.6%) were doctors, 43 (56.6%) were nurses, and 9 (11.8%) were technicians. The frequency of experiencing any physical symptom was 25.0% among HCWs. Exposure to at-risk care was significantly higher among nurses than among doctors ($p < 0.001$). Notably, the frequency of physical symptoms among the nurses was very high at 39.5% and obviously higher than that of physical symptoms among the doctors ($p < 0.01$).
Conclusions: Our results indicate that hospital occupational health care must be provided to HCWs who are engaged in the care of COVID-19 patients and are thus highly exposed to at-risk care.

Abbreviations: COVID-19, coronavirus disease 2019; HCW, healthcare worker; PCR, polymerase chain reaction; PPE, personal protective equipment; REDCap, Research Electronic Data Capture; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

* Corresponding author at: Department of Medical Education and General Practice, Osaka City University, Graduate School of Medicine, 1-4-3, Asahi-machi, Abeno-ku, Osaka 545-8585, Japan.
E-mail address: m1152721@med.osaka-cu.ac.jp (Y. Tochino).

https://doi.org/10.1016/j.jiph.2021.08.023

Introduction

The novel coronavirus disease 2019 (COVID-19) was first identified in Wuhan, Hubei Province, China, in late December 2019 [1]. It has since spread rapidly throughout the world, causing a global pandemic [2]. Consequently, this infectious disease is currently attracting the most attention in clinical practice. Healthcare workers (HCWs) in charge of COVID-19 patients have to work very hard daily and are always at a high risk of infection, particularly while managing critically ill patients with pneumonia caused by COVID-19. Some studies have reported cases of HCWs infected with COVID-19 [3–5].

HCWs are chronically exposed to very intense stress, both and physically and mentally. Such an allostatic load may lead to disease over time [6]. Therefore, it is essential that hospitals reduce both the physical and mental burden of HCWs on the front lines and protect their safety.

A few clinical studies have reported on the management of mental health among HCWs during the COVID-19 pandemic [7–9]. However, to the best of our knowledge, no prospective studies have focused on the physical health care of medical workers caring for critically ill patients with COVID-19 pneumonia. This study aimed to evaluate the prevalence of the various physical symptoms experienced by HCWs following exposure to COVID-19 patients and investigate the association between occupation and the manifestation of physical symptoms among HCWs at a tertiary hospital in Japan during the current ongoing COVID-19 pandemic.

Methods

Study setting, population, and procedure

This prospective cohort study was performed from April 30 to May 31, 2020 using a shareable Research Electronic Data Capture (REDCap) tool [10]. During this study period, HCWs were actively involved in the care of critically ill patients with COVID-19 pneumonia who were admitted to Osaka City University. We defined patients who were admitted to the intensive care unit (ICU) and required mechanical ventilation as critically ill patients [11]. The study participants included doctors, nurses, and technicians (radiological and biomedical equipment technicians). Questionnaires were delivered to the study participants twice a week via REDCap. When the study participant did not perform patient care for 14 days in a row, we stopped delivering the questionnaire to them. Finally, we targeted the people who completed these questionnaires. This study was approved by the Ethics Committee of Osaka City University (approval number 2020-024).

Screening questionnaire items

The questionnaire was developed for this study. The questionnaire assessed three main components: demographic characteristics, exposure, and physical complaints of postexposure. Demographic characteristics included age, gender, and occupation (doctor, nurse, or technician). Exposure included consecutive period and frequency (days a week, 1–7). Physical complaints consisted of attention-requiring and observation-requiring symptoms. Attention-requiring symptoms included fever, intense fatigue, dyspnea or shortness of breath, and dysosmia or dysgeusia (yes or no). Observation-requiring symptoms included sore throat, myalgia or arthralgia, headache, cough or sputum production, diarrhea or stomachache, nasal discharge or sneeze or nasal obstruction, and congestion or ophthalmalgia or low vision (yes or no). We also confirmed whether the participants requested an internal medical examination. The effectiveness of the questionnaire was initially verified on a small sample.

Table 1
Baseline characteristics of the study participants.

Variables	
Age (years)[a]	36.2 ± 9.5
Sex (male/female)	34/42
Occupation	
Doctor	24 (31.6%)
Nurse	43 (56.6%)
Technician	9 (11.8%)
Exposure	
Consecutive period	
Within 2 weeks	14 (18.4%)
Longer than 2 weeks	62 (81.6%)
Frequency (days a week)	
1 day	6 (7.9%)
2 days	15 (19.7%)
3 days	19 (25.0%)
4 days	15 (19.7%)
5 days	13 (17.1%)
6 days	2 (2.6%)
7 days	6 (7.9%)
Physical complaint	19 (25.0%)
Attention-requiring	5 (6.6%)
Fever	1 (1.3%)
Intense fatigue	4 (5.3%)
Dyspnea or shortness of breath	0 (0%)
Dysosmia or dysgeusia	0 (0%)
Observation-requiring	18 (23.7%)
Sore throat	4 (5.3%)
Myalgia or arthralgia	4 (5.3%)
Headache	10 (13.2%)
Cough or sputum production	5 (6.6%)
Diarrhea or stomachache	6 (7.9%)
Nasal discharge or sneeze or nasal obstruction	7 (9.2%)
Congestion or ophthalmalgia or low vision	2 (2.6%)
Applicant for internal medical examination	0 (0%)

[a] Data are presented as means ± standard deviation.

Serological and molecular analysis

We performed antibody testing and real-time polymerase chain reaction (PCR) to identify severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. We subjected HCWs engaged in the care of critically ill COVID-19 patients to antibody testing and those who were strongly suspected of having COVID-19 to PCR testing. We performed antibody testing two to four weeks after the HCWs were engaged. We used the SARS-CoV-2 IgM/IgG Quantum Dot immunoassay (Mokobio Biotechnology, MD, United States of America) for antibody testing according to the manufacturer's instructions. SARS-CoV-2 real-time PCR was performed on the BD MAX^{TM} platform.

Study outcomes

We evaluated the prevalence of physical symptoms of postexposure reported by the HCWs. Additionally, we investigated the association between occupation and the manifestation of physical symptoms among the HCWs.

Statistical analyses

Participant characteristics, exposure, physical complaints, and laboratory data were compared between doctor, nurse, and technician groups. Fisher's exact test and the Kruskal–Wallis test were used for the univariate comparison of categorical data. Additionally, the Bonferroni correction method was used for p value adjustment. All statistical analyses were performed with EZR [12], which is for R software. EZR is a modified version of the R commander that

includes the statistical functions frequently used in biostatistics. A p value of <0.05 was considered statistically significant.

Results

A total of 35 doctors, 88 nurses, and 35 technicians were engaged in the care of these critically ill COVID-19 patients. During our study period, 91 HCWs were enrolled in REDCap. Seventy-six HCWs were eligible for this study. Fifteen HCWs did not respond to the questionnaire. The baseline characteristics of the participants who were eligible for this study are summarized in Table 1. The 76 HCWs included 34 men and 43 women with a mean age of 36.2 years. Of the 76 HCWs, 24 (31.6%) were doctors, 43 (56.6%) were nurses, and 9 (11.8%) were technicians (radiological: 7, biomedical equipment: 2). Sixty-two (81.6%) HCWs were engaged for longer than two weeks. The participants reported a mean of 3.6 maximum exposure days per week. Nineteen HCWs (25.0%) had physical complaints, one (1.3%) had fever, four (5.3%) had intense fatigue, ten (13.2%) had headaches, and seven (9.2%) had nasal symptoms. A comparison of the baseline characteristics and laboratory findings between occupations is summarized in Table 2. There were significant differences in age ($p < 0.01$), exposure period ($p < 0.001$), physical complaints ($p < 0.01$), and headache ($p < 0.01$) among the three groups. In addition, the nurses were noticeably younger ($p = 0.03$, the average age of the nurses working in hospitals tended to be lower than that of doctors in Japan) and had a longer exposure period ($p < 0.001$, more than half of the doctors worked less than 2 weeks based on our hospital's medical system) than the doctors. Notably, the frequency of physical symptoms among the nurses was very high at 39.5% and obviously higher than that of physical symptoms among the doctors ($p < 0.01$). Conversely, no HCWs were suspected of being infected according to the laboratory findings. None of the HCWs developed COVID-19.

Discussion

Our single-center, prospective cohort study of 76 HCWs caring for critically ill patients with COVID-19 pneumonia revealed that 25.0% of such HCWs developed physical symptoms. It also determined that the frequency of physical symptoms from working with COVID-19 patients among the nurses was very high at 39.5% and obviously higher than that of physical symptoms among the doctors.

In our study, the most common symptoms in HCWs were headache (13.2%), nasal symptoms (9.2%), and gastrointestinal symptoms (7.9%); less common symptoms included fever (1.3%), intense fatigue (5.3%), and cough or sputum production (6.6%). One HCW tested positive for SARS-CoV-2 IgG in this study. Previous studies have reported that the incubation period for COVID-19 was less than 14 days, with most cases occurring within approximately five days of exposure [1,13]. Both IgM and IgG antibody levels against SARS-CoV-2 begin to increase from the second week after symptom onset [14]. Further, Xiao et al. reported that IgM levels almost disappeared by week seven, whereas IgG levels were persistently detectable beyond seven weeks [15]. In our study, this HCW did not complain of any physical symptoms while working with COVID-19 patients. Furthermore, this HCW underwent the SARS-CoV-2 IgM/IgG antibody test two weeks after beginning to work with COVID-19 patients and tested negative for SARS-CoV-2 IgM. Additionally, this HCW's PCR testing result was negative. Based on the above findings, we considered the HCW to have had a prior infection with SARS-CoV-2 or a pseudo-positive test result, and consequently it was not considered a nosocomial infection. We believed that the physical symptoms experienced by HCWs were caused due to psychological stress or other factors. We, as HCWs, must work under extreme pressure during the pandemic. Infectious disease outbreaks are known to have a strong psychological impact on HCWs. A recent study showed that HCWs facing excessive workloads and life-threatening conditions experienced psychological pressure and even worse mental illness during the SARS-CoV-2 outbreak [16]. Furthermore, psychological stress from the occurrence of infections can lead to both mental manifestations and various physical symptoms [17]. Recent studies have reported that there was a significant association between psychological outcomes and physical symptoms in HCWs during the current COVID-19 pandemic [17–19]. Chew et al. reported that common physical symptoms associated with the psychological impact of the COVID-19 outbreak among HCWs included headache (31.9%), throat pain (30.0%), joint/muscle pain (20.6%), cough (16.9%), coryza (14.0%), and sputum (11.3%) [17]. In fact, Ong et al. reported that the longer the duration of personal protective equipment (PPE) exposure among frontline HCWs during COVID-19, the more frequent they experienced headaches, which were known as PPE-associated headaches [20]. In light of the above findings, we believe that the various physical symptoms in our study were not caused by COVID-19 but rather by psychological stress and other factors including PPE exposure. Therefore, we should evaluate the association of physical symptoms with psychological stress or other factors in the future.

A previous study reported that HCWs, particularly those working in emergency rooms, ICUs, and infectious isolation wards, are at a higher risk of developing adverse psychological outcomes [21]. HCWs are expected to be exposed to a significant degree of stress due to the COVID-19 pandemic and face various psychological symptoms. One important reason for the psychological distress experienced by HCWs exposed to patients with COVID-19 is their long-term workload [9]. Furthermore, Lai et al. [22] reported that nurses experience greater depression, anxiety, insomnia, and distress compared with doctors. Cai et al. [23] also reported that nursing staff felt more nervous and anxious compared with other frontline medical staff during the COVID-19 outbreak. Nurses, in particular, are likely to have many opportunities of intense contact with COVID-19 patients compared with other healthcare professionals owing to procedures involving extensive physical contact, such as repositioning and suctioning. Therefore, nurses may be more likely to have physical symptoms related to psychological stress. However, there are two points to be noted in this interpretation: age and sex. Liang et al. [24] reported that younger (age, $\leq$30 years) medical staff had higher self-rated depression scores than older medical staff during the COVID-19 outbreak. Lai et al. [22] showed that women had a higher risk of experiencing symptoms of distress among HCWs exposed to COVID-19. In our study, the nurses tended to be younger than other healthcare professionals, and most of the nurses were women (93.0%). We should thus be considering these confounding factors in our future research to identify risk factors for the manifestation of physical symptoms.

The present study has several limitations. First, the study population was relatively small, and the study was conducted in only one tertiary hospital. Therefore, there was selection bias. Future studies including more participants working with COVID-19 patients in both community and tertiary hospital settings are required to address this limitation. Second, physical assessment was based on a self-reported online survey using a REDCap tool. Physical examination is recommended in future studies to conduct a more detailed assessment of the physical problems. Third, we examined 11 physical complaints and performed serological and molecular biological analyses, but we did not examine psychological problems in HCWs caring for COVID-19 patients. Psychological problems should be analyzed to assess the association between these physical symptoms and psychological outcomes. Fourth, we investigated the duration and frequency (days per week) of exposure to COVID-

Table 2
Comparison of baseline characteristics and laboratory findings between occupations.

Variables	Doctor (n = 24)	Nurse (n = 43)	Technician (n = 9)	p Value[a]
Characteristics				
Age (years)[b]	38.9 ± 9.3	33.3 ± 8.2	42.6 ± 10.3	<0.01[c]
Male	22 (91.7%)	3 (7.0%)	9 (100%)	<0.001[d]
Exposure				
Consecutive period				
Longer than 2 weeks	10 (41.7%)	43 (100%)	9 (100%)	<0.001[e]
Frequency (days a week)[b]	3.6 ± 2.0	3.8 ± 1.4	2.6 ± 1.2	0.07
Physical complaint	1 (4.2%)	17 (39.5%)	1 (11.1%)	<0.01[f]
Attention-requiring	1 (4.2%)	4 (9.3%)	0 (0%)	0.82
Fever	0 (0%)	1 (2.3%)	0 (0%)	1.00
Intense fatigue	1 (4.2%)	3 (7.0%)	0 (0%)	1.00
Dyspnea or shortness of breath	0 (0%)	0 (0%)	0 (0%)	NA
Dysosmia or dysgeusia	0 (0%)	0 (0%)	0 (0%)	NA
Observation-requiring	1 (4.2%)	16 (37.2%)	1 (11.1%)	<0.01[g]
Sore throat	0 (0%)	4 (9.3%)	0 (0%)	0.42
Myalgia or arthralgia	1 (4.2%)	3 (7.0%)	0 (0%)	1.00
Headache	0 (0%)	10 (23.3%)	0 (0%)	<0.01[h]
Cough or sputum production	0 (0%)	5 (11.6%)	0 (0%)	0.23
vDiarrhea or stomachache	1 (4.2%)	5 (11.6%)	0 (0%)	0.47
Nasal discharge or sneeze or nasal obstruction	0 (0%)	6 (14.0%)	1 (11.1%)	0.13
Congestion or ophthalmalgia or low vision	0 (0%)	2 (2.6%)	0 (0%)	0.64
Applicant for internal medical examination	0 (0%)	0 (0%)	0 (0%)	NA
SARS-CoV-2 IgM positive[i]	0 (0%)	0 (0%)	0 (0%)	NA
SARS-CoV-2 IgG positive[i]	1 (5.0%)	0 (0%)	0 (0%)	NA
SARS-CoV-2 real-time PCR positive[j]	0 (0%)	0 (0%)	NA	NA

IgG: immunoglobulin G, IgM: immunoglobulin M, NA: not available, PCR: polymerase chain reaction, SARS-CoV-2: severe acute respiratory syndrome coronavirus 2.
[a] Continuous variable: Kruskal–Wallis test with the Bonferroni correction method. Categorical variable: Fisher's exact test with the Bonferroni correction method.
[b] Data are presented as means ± standard deviation.
[c] Doctor versus Nurse, p = 0.03, Doctor versus Technician, p = 0.97, Nurse versus Technician, p = 0.08.
[d] Doctor versus Nurse, p < 0.001, Doctor versus Technician, p = 1.0, Nurse versus Technician, p < 0.001.
[e] Doctor versus Nurse, p < 0.001, Doctor versus Technician, p = 0.01, Nurse versus Technician, p = 1.0.
[f] Doctor versus Nurse, p < 0.01, Doctor versus Technician, p = 1.0, Nurse versus Technician, p = 0.42.
[g] Doctor versus Nurse, p < 0.01, Doctor versus Technician, p = 1.0, Nurse versus Technician, p = 0.72.
[h] Doctor versus Nurse, p = 0.03, Doctor versus Technician, p = 1.0, Nurse versus Technician, p = 0.53.
[i] 72 healthcare workers were tested (doctors: 20, nurses: 43, technicians: 9).
[j] Two healthcare workers were tested (doctors: 1, nurses: 1).

19 patients; however, contact time per day or the details of patients' treatment procedures, such as aerosol-generating procedures, including airway suctioning and endotracheal intubation, were not investigated. We should include these items in our future research.

Conclusion

In summary, the present study demonstrated that the frequency of physical symptoms in HCWs caring for critically ill patients with COVID-19 pneumonia was 25.0%. The frequency of physical symptoms from working with COVID-19 patients among the nurses was very high at 39.5% and obviously higher than that of physical symptoms among the doctors. Therefore, we must manage the health care of both the physical and mental symptoms of HCWs, particularly nurses, who work with COVID-19 patients. We believe that this study is the first step toward establishing a physical health management strategy for HCWs with COVID-19 patients.

Authors' contributions

NH, TYO, and STO designed this study. OA and OK set up the survey system. FK, NY, and KYA conducted the serological and molecular analysis. OY, YK, WT, MY, KH, KYU, and STO conducted the infection management in our hospital. NH, TYO, YK, TYA, KH, STO, and STA conducted the clinical interpretation. NH and TYO drafted the manuscript and critically revised it. All authors contributed to the final version of the manuscript and approved its submission.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Osaka City University (approval number 2020-024). The need for written informed consent was waived owing to the clinical research using opt-out.

Funding

None.

Competing interests

We declare no conflicts of interest.

Acknowledgments

We thank Hisako Yoshida (Department of Medical Statistics, Osaka City University, Graduate School of Medicine) for her technical support and advice in medical statistics.

References

[1] Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med 2020;382:1199–207.
[2] World Health Organization. WHO characterizes COVID-19 as a pandemic. Accessed 11 March 2020. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen.
[3] Luo Y, Trevathan E, Qian Z, Li Y, Li J, Xiao W, et al. Asymptomatic SARS-CoV-2 infection in household contacts of a healthcare provider, Wuhan, China. Emerg Infect Dis 2020;26:1930–3.

[4] Rimmer A. Covid-19: two thirds of healthcare workers who have died were from ethnic minorities. BMJ 2020;369:m1621.
[5] Wang J, Zhou M, Liu F. Reasons for healthcare workers becoming infected with novel coronavirus disease 2019 (COVID-19) in China. J Hosp Infect 2020;105:100–1.
[6] Fava GA, McEwen BS, Guidi J, Gostoli S, Offidani E, Sonino N. Clinical characterization of allostatic overload. Psychoneuroendocrinology 2019;108:94–101.
[7] Greenberg N, Docherty M, Gnanapragasam S, Wessely S. Managing mental health challenges faced by healthcare workers during covid-19 pandemic. BMJ 2020;368:m1211.
[8] Xiang YT, Yang Y, Li W, Zhang L, Zhang Q, Cheung T, et al. Timely mental health care for the 2019 novel coronavirus outbreak is urgently needed. Lancet Psychiatry 2020;7:228–9.
[9] Zhang WR, Wang K, Yin L, Zhao WF, Xue Q, Peng M, et al. Mental health and psychosocial problems of medical health workers during the COVID-19 epidemic in China. Psychother Psychosom 2020;89:242–50.
[10] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42:377–81.
[11] Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med 2020;8:475–81.
[12] Kanda Y. Investigation of the freely available easy-to-use software 'EZR' for medical statistics. Bone Marrow Transplant 2013;48:452–8.
[13] Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020;382:1708–20.
[14] Lou B, Li TD, Zheng SF, Su YY, Li ZY, Liu W, et al. Serology characteristics of SARS-CoV-2 infection since exposure and post symptom onset. Eur Respir J 2020:2000763.
[15] Xiao AT, Gao C, Zhang S. Profile of specific antibodies to SARS-CoV-2: the first report. J Infect 2020;81:147–78.
[16] Tang C, Liu C, Fang P, Xiang Y, Min R. Work-related accumulated fatigue among doctors in tertiary hospitals: a cross-sectional survey in six provinces of China. Int J Environ Res Public Health 2019;16:3049.
[17] Chew NWS, Lee GKH, Tan BYQ, Jing M, Goh Y, Ngiam NJH, et al. A multinational, multicentre study on the psychological outcomes and associated physical symptoms amongst healthcare workers during COVID-19 outbreak. Brain Behav Immun 2020;88:559–65.
[18] Kang L, Ma S, Chen M, Yang J, Wang Y, Li R, et al. Impact on mental health and perceptions of psychological care among medical and nursing staff in Wuhan during the 2019 novel coronavirus disease outbreak: a cross-sectional study. Brain Behav Immun 2020;87:11–7.
[19] Li Z, Ge J, Yang M, Feng J, Qiao M, Jiang R, et al. Vicarious traumatization in the general public, members, and non-members of medical teams aiding in COVID-19 control. Brain Behav Immun 2020;88:916–9.
[20] Ong JJY, Bharatendu C, Goh Y, Tang JZY, Sooi KWX, Tan YL, et al. Headaches associated with personal protective equipment — a cross-sectional study among frontline healthcare workers during COVID-19. Headache 2020;60:864–77.
[21] Naushad VA, Bierens JJ, Nishan KP, Firjeeth CP, Mohammad OH, Maliyakkal AM, et al. A systematic review of the impact of disaster on the mental health of medical responders. Prehosp Disaster Med 2019;34:632–43.
[22] Lai J, Ma S, Wang Y, Cai Z, Hu J, Wei N, et al. Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019. JAMA Netw Open 2020;3:e203976.
[23] Cai H, Tu B, Ma J, Chen L, Fu L, Jiang Y, et al. Psychological impact and coping strategies of frontline medical staff in hunan between January and March 2020 during the outbreak of coronavirus disease 2019 (COVID-19) in Hubei, China. Med Sci Monit 2020;26:e924171.
[24] Liang Y, Chen M, Zheng X, Liu J. Screening for Chinese medical staff mental health by SDS and SAS during the outbreak of COVID-19. J Psychosom Res 2020;133:110102.