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Evaluation of COVID-19-related musculoskeletal pain in healthcare workers during the pandemic

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ABSTRACT

Aims: To investigate the prevalence, characteristics, and musculoskeletal distribution of pain, one of the most frequently encountered complications among healthcare professionals during the COVID-19 pandemic.

Methods: The study included healthcare workers who had recovered from COVID-19 at least six months before their inclusion. Demographic data of the participants were collected. Pain levels were assessed with the Visual Analog Scale. The "Oswestry Low Back Pain Disability Questionnaire" was used to measure low back pain and disability levels, which aims to assess how pain affects activities of daily living. The "Douleur Neuropathique 4 Questionnaire" interview section was used to assess the level of neuropathic pain.

Results: A total of 101 participants with a mean age of 37.72±1.22 years were included in the study. Of these participants, 78 (77.2%) were female and 23 (22.8%) were male. Of the participants, 32 (31.7%) were physicians, 34 (33.7%) were nurses, and 35 (34.7%) were healthcare workers. The most common areas of pain reported in healthcare workers in our study were the head, lower back, and back. A statistically significant difference was observed in the analysis of Oswestry Scores between different occupational groups ($p<0.001$). Subgroup analyses showed that there was no statistically significant difference between nurses and other healthcare personnel ($p=0.082$). However, a significant difference was observed between doctors and nurses ($p<0.001$) and also between doctors and other healthcare personnel ($p=0.008$). The most frequently reported neuropathic symptoms were numbness, pinprick sensations, and tingling.

Conclusion: Our study that examines the location and character of pain in the musculoskeletal system in healthcare workers can support fundamental strategies in the protection of healthcare workers and the continuity of healthcare system delivery. Developing necessary prevention strategies is crucial to prepare healthcare workers for managing future outbreaks.

Keywords: COVID-19, Visual Analogy Scale, Oswestry Low Back Pain Disability Questionnaire, healthcare professionals

INTRODUCTION

The COVID-19 pandemic, originating from the novel coronavirus SARS-CoV-2, is an unprecedented global health crisis. This virus was initially detected in Wuhan, China, in December 2019. Its swift transmission prompted the World Health Organization (WHO) to declare it a pandemic on March 11, 2020.[1] SARS-CoV-2 research studies are still relevant as one of the 20 most important and highest-rated research article topics of 2023.[2] Subsequently, the pandemic has developed into a persistent and complex issue with far-reaching consequences, affecting healthcare systems, economies, and societies globally.

According to the latest WHO data, the global tally of confirmed COVID-19 cases has reached a staggering 769,369,823 cases, with 6,954,336 reported fatalities.[3] These figures are subject to change as healthcare systems and governments continue to contend with the persistent effects of the virus.

COVID-19 can result in a broad spectrum of clinical manifestations, spanning from mild upper respiratory symptoms to multi-organ failure. During the illness and in its aftermath, various complications may emerge. Viral infections can alter mitochondrial function. Studies in the literature have shown that the presence of SARS-CoV-2 proteins in muscle fibers causes muscle pain, fatigue, and weakness due to atrophy and necrosis.[4-6]

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Pain is a prevalent complication among individuals recuperating from COVID-19, with approximately 46.6% of COVID-19 patients identifying pain as their primary grievance. Among these patients, 69.2% experience myalgia and arthralgia, while the remainder report pain in the form of headaches, back pain, lower back pain, chest pain, throat pain, and abdominal pain.[7]

A study conducted by Su et al.[8] provides a comprehensive overview of the three primary factors contributing to pain in COVID-19 patients. These include systemic inflammatory immune mechanisms, neuropathic mechanisms, and secondary factors associated with COVID-19 pathology or its treatment.

Neuropathic pain, in particular, has been recognized as a significant symptom associated with various viral infections, including the herpes zoster virus, human immunodeficiency virus (HIV), Epstein-Barr virus, cytomegalovirus, enteroviruses, and certain tropical viruses.[9] Furthermore, neuropathic pain has been documented in patients who have recuperated from severe acute respiratory syndrome (SARS), a member of the coronavirus family, with one study revealing that fatigue, widespread myalgia, depression, and sleep disturbances persisted for up to two years following SARS.[10,11]

Throughout the pandemic, which has had profound social, economic, and psychological ramifications worldwide, healthcare professionals have exhibited exceptional dedication to their duties. Notably, healthcare workers emerged as the occupation most significantly impacted by the COVID-19 pandemic, primarily because of their heightened risk of infection, substantial job-related stress, and the necessity for social isolation.[12]

Several previous studies have established a connection between the physical and psychological consequences experienced by healthcare workers during the COVID-19 pandemic. However, our study represents leading research as it is the first to compare the prevalence of painful sites and the nature of neuropathic pain patterns among healthcare workers. Our primary research objective is to examine the prevalence, characteristics, and patterns of musculoskeletal pain, a common complication among healthcare workers who have had and recovered from COVID-19 infection.

METHODS

Ethical Considerations

The study received ethical approval from the Dr. Abdurrahman Yurtaslan Ankara Oncology Health Application and Research Center Clinical Researches Ethics Committee (Date: 08.07.2021, Decision No: 2021-07/1285). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

This research was carried out by rigorous ethical standards, and informed consent was acquired from all participants. All necessary precautions were taken to safeguard the privacy and rights of the participants.

Study Design and Participants

This study employs a prospective cross-sectional design to examine the prevalence, characteristics, and distribution of pain within the musculoskeletal system in healthcare workers who have recuperated from COVID-19 infection. Information from healthcare workers who had COVID-19 was collected by telemedicine method with the approval of the Ministry of Health (Ministry of Health approval number: 2021-05-31T11_17_18) within the scope of pandemic measures. The collection date range of the survey data sent via SMS to healthcare professionals who had COVID-19 in line with the anamnesis taken from the patient: 10.07.2021-10.12.2021'dir. Age, gender, occupation, date of COVID-19 diagnosis, date of onset of pain, pain regions, pain intensity, duration, character, and pain with neuropathy character were recorded. One hundred fourteen patients participated in the study. 13 patients were excluded because they had chronic inflammatory pain. One hundred and one patients were evaluated. There were no health personnel working in the COVID ward or intensive care unit. A single doctor questioned the patients by telemedicine method, and informed consent forms were sent to the patients via e-mail.

The recovery criteria for COVID-19 infection align with the World Health Organization's guidelines, encompassing the improvement of all COVID-19 symptoms, the absence of fever for three consecutive days, and two consecutive negative nasopharyngeal swabs (verified through real-time reverse transcriptase-polymerase chain reaction) for SARS-CoV-2, with a 24-hour interval between them.[13] Health workers who had COVID-19 at least 6 months ago Healthcare workers aged 18 years and over who had COVID-19 at least 6 months ago were included in the study. The duration of recovery is measured from the moment when the patient met the recovery criteria to their enrollment in the present study. Participants with chronic inflammatory pain, a history of endocrine/metabolic diseases or malignancies, and those who had undergone spine or joint surgery before the pandemic were excluded from the study.

Assessment Methods

The study assessed the participants' pain levels using the Visual Analog Scale.[14] Neuropathic pain was determined by conducting interviews using only the "Douleur Neuropathique 4 Questions (DN4) Scale." In addition, the "Oswestry Low Back Pain Disability Questionnaire" was used to evaluate lower back pain and measure its effect on the participants' daily life activities.

The VAS Pain Score (Visual Analog Scale)

The study utilized the VAS Pain Score, which ranges from 0 to 10, to assess the participants' pain levels. On this scale, a score of 10 represents the worst pain, while 0 indicates no pain. Following the World Health Organization's pain intensity scale, pain scores below three were categorized as mild, between 3 and 6 as mild to moderate, and above six as severe.[15]

The Douleur Neuropathique 4 Questions (DN4)

The Douleur Neuropathique 4 Questions (DN4) is a screening test recommended by the International Association for the Study of Pain (IASP) for evaluating neuropathic and non-neuropathic pain. A review of the DN4 has shown a sensitivity of 83% and a specificity of 90%.[16] The initial seven questions in the DN4 are related to symptom assessment, covering sensations like burning, painful coldness, electric shock sensation, tingling, pins and needles sensation, numbness, and itching. In our study, we used these questions to assess neuropathic pain in healthcare workers who had recovered from COVID-19.

The Oswestry Low Back Pain Disability Questionnaire

The Oswestry Low Back Pain Disability Questionnaire was originally developed by Fairbank et al.[17] in 1980 to measure disability levels in individuals with lower back pain. It was later revised by Fritz and colleagues in 2001. This questionnaire assesses personal care, pain intensity, lifting, sitting, walking, standing, sleeping, pain change, social life, travel activities, and daily life activities. The minimum score that can be obtained from this scale is 0, and the maximum score is 50. The Oswestry score is calculated using the formula: (individual's score/possible maximum score) X 100. The interpreted percentage values are as follows:

- 0% to 20%: Lower back pain is not a significant problem in the individual's life.
- 20% to 40%: Lower back pain mildly restricts the individual's daily life.
- 40% to 60%: Lower back pain severely limits the individual's daily life.
- 60% to 80%: The individual's daily life is entirely restricted due to lower back pain.
- 80% to 100%: The individual is considered bedridden due to lower back pain. In this study, the Oswestry Score was calculated only for healthcare workers with lower back pain.

Data Collection

The data collection process received approval from the Ministry of Health, complying with pandemic control measures (Approval Number: 2021-05-31T11_17_18).

Data were collected using telemedicine methods and were obtained between July 10, 2021, and December 10, 2021. The following variables were documented for each participant: age, gender, occupation, date of COVID-19 diagnosis, date of pain onset, pain locations, pain intensity, duration of pain, character of pain, and the presence of neuropathic pain characteristics.

Statistical Analysis

The data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25. To assess the normality of data distribution, the Kolmogorov-Smirnov test was applied. Descriptive statistics were utilized to provide a summary of the data, with continuous variables presented as mean±standard deviation and, where appropriate, as median (minimum-maximum). Categorical data were expressed in terms of counts and percentages. Group comparisons for parametric variables were carried out through the independent student's T test and one-way ANOVA analysis. A significance level of $p<0.05$ was considered to indicate statistical significance in the results.

RESULTS

The study included a total of 101 participants, with an average age of 37.72±1.22 years. Among these participants, 78 individuals (77.2%) were female, while 23 individuals (22.8%) were male. It's noteworthy that out of the individuals who had previously recovered from COVID-19, 8 of them (7.9%) had to be hospitalized. The mean age of those patients who experienced severe pain requiring hospitalization was 48.62±3.73 years. For more comprehensive demographic and clinical information, please refer to **Table 1**.

Table 1. The demographic and clinical characteristics of the patients

Age (mean±SD) (min-max)	37.72±10.28 (20-58)		
F/M (n, %)	78 (77.2)/23 (22.8)		
Occupation (n, %):			
Physician	32 (31.7)		
Nurse	34 (33.7)		
Healthcare personal	35 (34.7)		
Hospitalization (n, %)	8 (7.9)		
Pain (n, %)	84 (83.2)		
Duration of pain (n, %):			
Less than 4 weeks	55 (64.6)		
4-12 weeks	20 (24.4)		
More than 12 weeks	9 (11)		
Pain regions and severity	**n**	**mVAS**	**VAS >7 (n, %)**
Headache	80	4.9	35 (34.6)
Lower back	78	4.69	35 (34.6)
Back	76	4.84	29 (28.7)
Legs	73	4.35	24 (23.7)
Arms	70	3.58	16 (15.8)
Neck	69	2.92	9 (8.9)
Shoulder	69	3.18	17 (16.8)
Chest	68	2.73	15 (14.8)
Knee	67	3.37	15 (14.8)
Elbow	66	3.07	14 (13.8)
Hip	64	3.50	14 (13.8)
Ankle	64	2.89	17 (16.8)

SD: Standard deviation, Min: Minimum, Max: Maximum, F: Female M: Male, mVAS: Median Visual Analog Scale

Regarding regions with the highest pain intensity (VAS 7≤), it was observed that the most common areas were the head 35 (34.6%) and the lower back 35(34.6%) out of 101 participants.

Out of the 47 participants (46.53%) aged 40 and above, 39 (83.0%) reported experiencing pain. Similarly, among the 54 participants (53.47%) aged below 40, 45 (83.3%) had pain. A statistical comparison of pain prevalence between individuals aged below 40 and those aged 40 and above revealed no significant difference ($p=0.963$).

Among the healthcare workers included in the assessment, 32 physicians were evaluated using the Oswestry scores. Of these physicians, 17 (53.1%) reported no significant back issues, 14 (43.8%) experienced mild limitations in their daily life activities, and only one person (3.1%) had severe restrictions in their daily life activities due to back problems. Out of the 34 nurses assessed, 5 of them (14.7%) did not report significant back issues, 16 individuals (47.1%) experienced mild limitations in their daily life activities, and eight nurses (23.5%) had severe restrictions in their daily life activities due to back problems. Additionally, five individuals (14.7%) were completely restricted in their daily life activities due to back problems. Out of the 35 healthcare personnel assessed, individuals (34.3%) had no significant back issues,12 individuals (34.3%) reported mild limitations in their daily life activities, 10 individuals (28.6%) experienced advanced restrictions in their daily life activities, one person (2.9%) was completely restricted in their daily life activities due to back problems.

When comparing Oswestry Scores among professional groups, a statistically significant difference was observed between the groups with a 95% confidence interval (F=9.858, p <0.001). In subgroup analyses, no statistically significant difference was found between nurses and other healthcare personnel (p=0.082), whereas a significant difference was noted between physicians and nurses (p<0.001) as well as between physicians and other healthcare personnel (p=0.008) Table 2.

Table 2. Oswestry low back pain disability questionnaire

	Not a significant problem	Mildly restricts	Severely limits	Entirely restricted	
All (n, %)	34 (33.6)	42 (41.5)	19 (18.8)	6 (5.9)	
Physician (n, %)	17 (53.1)	14 (43.8)	1 (3.1)	-	F=9.858, p<0.001*
Nurse (n, %)	5 (14.7)	16 (47.1)	8 (23.5)	5 (14.7)	
Healthcare personal (n, %)	12 (34.3)	12 (34.3)	10 (28.6)	1 (2.9)	

*ANOVA one way

When the Oswestry Low Back Pain Disability Questionnaire scores of individuals aged below 40 and those aged 40 and above were compared, there was no statistically significant difference found between the two groups within a 95% confidence interval (p=0.717)

When analyzing healthcare workers who experienced neuropathic symptoms following their COVID-19 infection, the three most common symptoms were tingling, numbness, and pins and needles sensation. The percentages of other neuropathic symptoms are detailed in Table 3.

Table 3. Douleur neuropathique 4 questions n (%)

Pins and needles	42 (41.2)
Numbness	35 (34.7)
Tingling	30 (29.7)
Painful cold	28 (27.7)
Burning	25 (24.2)
Electric shock	15 (14.9)
Itching	8 (7.9)

No statistically significant differences were found in any of the neuropathic symptoms when comparing individuals aged below 40 with those aged 40 and above (p>0.05).

DISCUSSION

Many studies show that pain in healthcare workers during the pandemic is higher than in the general population.[18] One study demonstrated a fourfold higher infection rate among healthcare workers compared to non-healthcare workers.[19]

In the literature, studies indicating an increase in the incidence of early pain after COVID-19 have frequently observed.[20-22] In studies, the most common pain areas/types are generally listed as headache, lower back, and back pain. A study conducted in Ireland on healthcare workers who had recovered from COVID-19 identified headache as one of the most common presenting symptoms among cases.[23] Another study on healthcare workers, which is in line with our study, found that headache was one of the most common symptoms, with a prevalence of 29.6%.[24] A study by Alomar et al.[25] supporting our findings identified lower back pain as the most common complaint among healthcare workers affected by COVID-19. In a retrospective study conducted by Lim et al.[26] on 609 COVID-19-infected healthcare workers, common pains were observed as musculoskeletal pain 19.2%, headache 14.8%. In a research article by Madani et al.,[27] they found a 22.9% rate of headaches in healthcare workers infected with COVID-19.

In our study, healthcare workers affected by COVID-19 were found to experience headaches, lower back pain, and back pain most frequently. This could be attributed to healthcare professionals performing various tasks, such as staying in the same position for long periods, working in shifts, and lifting and carrying patients, which may have contributed to a higher prevalence of lower back pain even before the COVID-19 pandemic.

In a study conducted on healthcare workers during the pandemic, 43 (27.2%) of 158 healthcare workers had a VAS of 7 and above (severe).[28] In our study, we observed that the regions with a VAS of 7 and above were the head and lower back, 35 (34.6%).

Studies conducted in the literature on COVID-19 cases have identified that 13.8% of cases required hospitalization due to severe disease activity, and 6.1% had critical illness requiring intensive care.[29] Our study is in line with the literature, as a small number of 8 patients (7.9%) required hospitalization in the COVID ward. Another study in the literature, which supports our findings, reported a hospitalization rate of 3.7% among healthcare workers under 40 years of age, while the hospitalization rate was 16.2% among healthcare workers aged 40-60.[30]

In our study, the most common neuropathic symptoms were pins and needles and numbness. In particular, physicians had lower disability scores compared to other healthcare professionals, and this difference was statistically significant among healthcare professionals in the Oswestry Low Back Pain Disability Questionnaire. In a study evaluating neuropathic pain using DN4 in patients who had recovered from COVID-19, symptoms such as numbness (42.2%), electric shock (37.8%), burning (33.3%), tingling (15.6%), and needle-like sensations were identified.[31] Our study aligns with the literature as it found a high prevalence of symptoms like numbness, along with a significant presence of needle-like sensations and tingling among healthcare workers.

One of the strengths of our study is that it is the first study to examine the character, regional prevalence, and distribution in the musculoskeletal system of pain in healthcare workers during the pandemic. Additionally, to the best of our knowledge, our study is the first to use the Oswestry Low Back Pain Disability Questionnaire on healthcare workers who have recovered from COVID-19.

Limitations

There are some limitations of our study, such as the small sample size, the inability to evaluate the examination part of DN4 in this study conducted through telemedicine, the fact that the majority of the participants were women, and the study had a cross-sectional design without specific pain assessments, the source of pain and its relationship with COVID were not determined.

CONCLUSION

After the pandemic, many neurological and musculoskeletal system problems have arisen among healthcare personnel that cannot be definitively attributed to the secondary effects of COVID-19. Particularly, this study that examines the location and character of pain in the musculoskeletal system in healthcare workers can support fundamental strategies in protecting healthcare workers and the continuity of healthcare system delivery. Developing necessary prevention strategies is crucial to prepare healthcare workers for managing future outbreaks. Further research with larger sample sizes and comprehensive assessments is needed to better understand the long-term effects of COVID-19 on musculoskeletal pain in healthcare workers and to develop effective management strategies.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Dr. Abdurrahman Yurtaslan Ankara Oncology Health Application and Research Center Clinical Researches Ethics Committee (Date: 08.07.2021, Decision No: 2021-07/1285).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Mullen L, Richardson C, Gardner A, Jones T, Tolley C. 458 Medicines management of long-term conditions during the COVID-19 pandemic: a narrative systematic review. *Int J Pharm Pract*. 2023;31(Supplement_1): i14-i15. doi:10.1093/ijpp/riad021.016
2. Grad R, Ebell MH. Top 20 research studies of 2023 for primary care physicians. *Am Fam Physician*. 2024;110(1):65-73.
3. World Health Organization. COVID-19 weekly epidemiological update, edition 134, 16 March 2023.
4. Swank Z, Senussi Y, Manickas-Hill Z, et al. Persistent circulating severe acute respiratory syndrome Coronavirus 2 spike is associated with post-acute Coronavirus disease 2019 sequelae. *Clin Infect Dis*. 2023; 76(3):e487-e490. doi:10.1093/cid/ciac722
5. Mageriu V, Zurac S, Bastian A, Staniceanu F, Manole E. Histological findings in skeletal muscle of SARS-CoV2 infected patient. *J Immunoassay Immunochem*. 2020;41(6):1000-1009. doi:10.1080/15321819. 2020.1863819
6. Buonsenso D, Martino L, Morello R, Mariani F, Fearnley K, Valentini P. Viral persistence in children infected with SARS-CoV-2: current evidence and future research strategies. *Lancet Microbe*. 2023;4(9): e745-e756. doi:10.1016/s2666-5247(23)00115-5
7. Murat S, Dogruoz Karatekin B, Icagasioglu A, Ulasoglu C, İçten S, Incealtin O. Clinical presentations of pain in patients with COVID-19 infection. *Irish J Med Sci (1971)*. 2021;190(3):913-917. doi:10.1007/s11845-020-02433-x
8. Su S, Cui H, Wang T, Shen X, Ma C. Pain: a potential new label of COVID-19. *Brain Behav Immun*. 2020;87:159-160. doi:10.1016/j.bbi. 2020. 05.025
9. Attal N, Martinez V, Bouhassira D. Potential for increased prevalence of neuropathic pain after the COVID-19 pandemic. *Pain Rep*. 2021;6(1): e884. doi:10.1097/PR9.0000000000000884
10. Moldofsky H, Patcai J. Chronic widespread musculoskeletal pain, fatigue, depression and disordered sleep in chronic post-SARS syndrome; a case-controlled study. *BMC Neurology*. 2011;11(1):37. doi: 10.1186/1471-2377-11-37
11. Stainsby B, Howitt S, Porr J. Neuromusculoskeletal disorders following SARS: a case series. *J Can Chiropr Assoc*. Mar 2011;55(1):32-39.
12. Bozdağ F, Ergün N. Psychological resilience of healthcare professionals during COVID-19 pandemic. *Psychol Rep*. 2021;124(6):2567-2586. doi:10.1177/0033294120965477
13. World Health Organization clinical management of COVID-19: interim guidance 27 may 2020. World Health Organization. 2020.
14. Fadhil M, Singh R, Havas T, Jacobson I. Systematic review of head and neck lymphedema assessment. *Head Neck*. 2022;44(10):2301-2315. doi: 10.1002/hed.27136
15. Bouhassira D, Attal N, Alchaar H, et al. Comparison of pain syndromes associated with nervous or somatic lesions and development of a new neuropathic pain diagnostic questionnaire (DN4). *Pain*. 2005;114(1-2): 29-36. doi:10.1016/j.pain.2004.12.010
16. Macdonald N. Canada and the WHO cancer pain relief program. *J Palliat Care*. 1986;1(2):31.
17. Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry low back pain disability questionnaire. *Physiotherapy*. 1980;66(8):271-273.
18. Buscemi V, Chang WJ, Liston MB, McAuley JH, Schabrun SM. The role of perceived stress and life stressors in the development of chronic musculoskeletal pain disorders: a systematic review. *J Pain*. 2019;20(10): 1127-1139. doi:10.1016/j.jpain.2019.02.008
19. Wei JT, Liu ZD, Fan ZW, Zhao L, Cao WC. Epidemiology of and risk factors for COVID-19 infection among health care workers: a multi-centre comparative study. *Int J Environ Res Public Health*. 2020;17(19): 7149. doi:10.3390/ijerph17197149
20. Ciaffi J, Vanni E, Mancarella L, et al. Post-acute COVID-19 joint pain and new onset of rheumatic musculoskeletal diseases: a systematic review. *Diagnostics*. 2023;13(11):1850. doi:10.3390/diagnostics13111850
21. El-Tallawy SN, Perglozzi JV, Ahmed RS, et al. Pain management in the post-COVID era-an update: a narrative review. *Pain Therapy*. 2023; 12(2):423-448. doi:10.1007/s40122-023-00486-1
22. Fernández-De-Las-Peñas C, Navarro-Santana M, Plaza-Manzano G, Palacios-Ceña D, Arendt-Nielsen L. Time course prevalence of post-COVID pain symptoms of musculoskeletal origin in patients who had survived severe acute respiratory syndrome Coronavirus 2 infection: a systematic review and meta-analysis. *Pain*. 2022;163(7):1220-1231. doi: 10.1097/j.pain.0000000000002496
23. O'Sullivan G, Jacob S, Barrett PM, Gallagher J. COVID-19 presentation among symptomatic healthcare workers in Ireland. *Occupat Med*. 2021; 71(2):95-98. doi:10.1093/occmed/kqab012
24. Lan F-Y, Filler R, Mathew S, et al. COVID-19 symptoms predictive of healthcare workers' SARS-CoV-2 PCR results. *PLoS One*. 2020;15(6): e0235460. doi:10.1371/journal.pone.0235460
25. AlOmar RS. Levels of physical activity and prevalence of musculoskeletal disorders among physicians in Saudi Arabia post COVID-19 lockdown: an epidemiological cross-sectional analysis. *J Prim Care Community Health*. 2021;12:21501327211040359. doi:10.1177/ 21501327211040359
26. Lim SH, Lim YC, Zaki RA, et al. Prevalence and predictors of post-acute COVID syndrome among infected healthcare workers at University Malaya Medical Centre. *PLoS One*. 2024;19(4):e0298376. doi:10.1371/ journal.pone.0298376
27. Madani TA, Al-Abdullah NA, Binmahfooz SM, et al. COVID-19 infections among health care workers at a university hospital in Jeddah, Saudi Arabia. *Am J Infect Control*. 2024;52(11):1258-1262. doi:10.1016/j. ajic.2024.06.022
28. Arca M, Dönmezdil S, Durmaz ED. The effect of the COVID-19 pandemic on anxiety, depression, and musculoskeletal system complaints in healthcare workers. *Work*. 2021;69(1):47-54. doi:10.3233/ wor-205014
29. Ateş R, Yakut H. Investigation of musculoskeletal disorders, physical activity level, sleep quality, and fatigue in health professionals with and without a history of COVID-19. *Work*. 2023;74(4):1277-1287. doi:10. 3233/wor-220283
30. Buonafine CP, Paiatto BNM, Leal FB, et al. High prevalence of SARS-CoV-2 infection among symptomatic healthcare workers in a large university tertiary hospital in São Paulo, Brazil. *BMC Infect Dis*. 2020; 20(1):917. doi:10.1186/s12879-020-05662-8
31. Magdy R, Eid RA, Fathy W, et al. Characteristics and risk factors of persistent neuropathic pain in recovered COVID-19 patients. *Pain Med*. 2022;23(4):774-781. doi:10.1093/pm/pnab341