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Research Paper

Evaluation of COVID-19 Outcomes on the Musculoskeletal System Using the Extended Nordic Questionnaire

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Conflict of interest

The authors declare no conflict of interest.

ABSTRACT

Background and Objectives: Musculoskeletal pains due to COVID-19 have disrupted the daily activities of infected people. Investigating these complications can give us more information to diagnose and treat patients early. This study aims to investigate the effects of this virus on the incidence of musculoskeletal disorders in students or employees with COVID-19 at Iran University of Medical Sciences (IUMS), using the Extended Nordic Musculoskeletal Questionnaire (ENMQ).

Methods: This cross-sectional questionnaire-based study was conducted in 2021 on 107 people. The study participants were selected by convenience sampling from students and employees at IUMS. The inclusion criteria were testing positive for COVID-19, confirmed by a physician, and at least three weeks passed since the onset of symptoms. The exclusion criteria were having a history of an accident or events influencing the musculoskeletal system and being reluctant to participate in the study. We used a researcher-made questionnaire and ENMQ for data collection. Musculoskeletal disorders before infection and the incidence or worsening of these problems after infection were also recorded using ENMQ. Data were analyzed in SPSS software, version 26, using the Mann-Whitney U test and the Kruskal-Wallis test.

Results: The highest pain frequencies before COVID-19 were in the shoulders, knees, and back, in this order. Also, the highest pain frequencies after COVID-19 were in the back, neck, shoulders, and leg, in this order. According to the study results, most patients had low pain in their back, mild pain in their neck and back, and severe pain in their knees before being infected with COVID-19. After the COVID-19 infection, low pain in the knee and mild and severe pain in the back were observed in most patients. In assessing the "pain impact on the functioning" before COVID-19, the highest effects on daily activities were found in the back, neck, and pelvis, in this order. After the COVID-19 infection, the daily activities related to the back, neck, shoulders, and pelvis were reduced.

Conclusion: Based on this study, the difference in right elbow function by gender, the difference in the intensity of right elbow pain by age, the difference in the intensity of ankle and finger pain, and the difference in the function of ankle and fingers on both sides by age before and after suffering from coronavirus were the significant variables of this research.

Keywords: COVID-19, Musculoskeletal system, Nordic questionnaire

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What is "already known" in this topic:

COVID-19 primarily occurs as a respiratory disease or upper respiratory tract infection. This disease can also show many symptoms outside the lungs, such as digestive problems, kidney and liver damage, chest pain, eye inflammation, neurological and skin complications, or even cause Guillain-Barré syndrome. Findings show that myalgia is one of the common clinical features of COVID-19. Other musculoskeletal manifestations of COVID-19 were rarely described early in the disease, but as the global number of patients increased, reports of musculoskeletal symptoms increased. To date, increasing reports of neurological, muscular and rheumatology complications related to this virus exists.

What this article adds:

The use of the ENMQ in this research due to its comprehensive features in identifying the location of the injury, the type of injury and the impact of musculoskeletal injuries on daily activities, helps a lot in achieving the goals of the study.

1. Introduction

COVID-19 refers to the disease caused by the SARS-CoV-2 virus, and its first case was reported in China in December 2019 [1]. This disease is transmitted through droplets of saliva, eyes, and the nose of humans, and respiratory complications are one of its main symptoms. COVID-19 clinical manifestations vary from no symptoms to acute respiratory distress syndrome (ARDS) and disruptions to the body's internal organs. Since the function of each body organ relies on the respiratory system to work efficiently, any disruption to the respiratory system leads to the dysfunction of other organs in the body [2-4]. The non-specific symptoms of this disease include fatigue, muscle pain, fever, and headache. Most patients recover completely after experiencing these symptoms for one week or two, but severe cases require hospitalization [5]. Additionally, prolonged hospitalization, home quarantines, and social distancing reduce physical activities and muscular volume, resulting in musculoskeletal system dysfunction [6].

The coronavirus can spread through the bloodstream or endothelium, causing infection in all tissues having the Angiotensin-Converting Enzyme 2 (ACE2) receptor, such as the heart and brain. An elevated Creatine Kinase (CK) level during COVID-19 infection confirms the muscular involvement in this disease. Thus, the musculoskeletal system can also be affected by the infection [7]. Numerous studies are recently investigating the effects of COVID-19 on the neural and musculoskeletal systems. The presence of musculoskeletal symptoms, especially among middle-aged and elderly patients, indicates that inflammatory reactions have overcome the anti-inflammatory effects of the drugs prescribed [8]. The primary symptoms of musculoskeletal involvement that may appear in COVID-19 patients include arthralgia, myalgia, chronic fatigue, and joint swelling. Most symptoms are due to inflammatory or immunological responses of the body to the coronavirus [8, 9]. These complications can stop the patient from doing daily activities, resulting in poor quality of life [10].

Concerning disruptions to daily activities after musculoskeletal pains caused by COVID-19, investigation of these complications can provide us with more information to diagnose and treat patients early. After the pandemic, many works, including the scientific and research services of universities, were carried out on a virtual platform. In addition to its advantages, this type of education may also cause problems, one of which is the possibility of more involvement of professors, students, and employees of universities with musculoskeletal disorders. Therefore, considering the importance of this part of society and their health, we decided to investigate the effects of COVID-19 on the incidence of musculoskeletal disorders in students or employees at Iran University of Medical Sciences using the extended nordic musculoskeletal questionnaire (ENMQ). The results of this study can be used for properly planning rehabilitation interventions.

2. Materials and Methods

This cross-sectional questionnaire-based study was conducted in 2021 on students and employees of Iran University of Medical Sciences to investigate COVID-19 outcomes on the incidence of musculoskeletal disorders

using ENMQ. This research has been approved by the Ethics Committee of Iran University of Medical Sciences under the ethical code of IR.IUMS.REC.1400.267. Considering the confidence level of 0.05 and the test power of 80%, the sample size was 107. Study participants were selected by the convenience sampling method from students and employees working at Schools of Public Health, Nursing and Midwifery, Medicine, Allied Medical Sciences, Pharmacy, Rehabilitation Sciences, Health Management and Information Sciences, Behavioral Sciences, and Mental Health, Iranian Traditional Medicine, and Advanced Technologies in Medicine. The inclusion criteria were testing positive for COVID-19 as confirmed by the physician, and at least three weeks had passed since the onset of symptoms. The exclusion criteria were having a history of an accident or events influencing the musculoskeletal system and being reluctant to participate further in the study.

In this study, two questionnaires were used for data collection. Given the availability of the list of students and employees infected with COVID-19, and after obtaining their written consent forms, their demographic information, such as age, gender, height, weight, the dominant limb, marital status, education, etc., was recorded in the researcher-made questionnaire. The existence of musculoskeletal disorders before infection and the incidence or worsening of these problems after infection was also recorded using ENMQ. Translation, customization, face validity, and test-retest reliability of the ENMQ Persian version were evaluated by Mokhtarinia et al. [11]. ENMQ investigates "pain frequency", "pain severity", and "pain impact on the functioning" of the axial skeleton, and upper and lower limbs. In ENMQ, the "pain severity" is reported by "low pain", "mild pain", and "severe pain", and the "pain impact on the functioning" is expressed by "very low impact", "moderate impact", and "high impact."The study data were analyzed in SPSS using non-parametric statistical methods at $P \leq 0.05$. The Mann-Whitney U test was used to compare "pain severity" and "pain impact on the functioning" in participants by gender. Moreover, the Kruskal-Wallis test was used to evaluate the relation between COVID-19 and "pain severity" and "pain impact on the functioning" by age and education of participants.

3. Results

In this cross-sectional study, 107 patients who recovered from COVID-19 were evaluated. Of these patients, 51 were females with Mean±SD age of 40.73±11.02 years, and 56 were males with Mean±SD age of 40.29±10.57 years. The minimum age of participants (n=1) was 21, and the maximum age of participants (n=1) was 78. To evaluate the effect of age on the incidence of musculoskeletal complications, participants were divided into three young (20-35 y), middle-aged (35-50 y), and elderly (>50 y) groups. The effect of education level on these complications was also investigated. The demographic information of participants is presented in Table 1.

According to the results of this study, 86 patients (79.2%) recovered within less than 5 weeks. The shortest recovery duration after infection was one week in 14.9% of participants, and the longest recovery duration was two weeks in 22.4% of participants. Musculoskeletal pain was also observed in 37.7% of vaccinated participants (Table 2).

Table 1. Demographic information of the participants

Variables	Groups	Females	Males	No. (%)
Age groups	Young	17	20	37(34.5)
	Middle-aged	26	27	53(49.5)
	Elderly	8	9	17(15.8)
Education	Under diploma	5	9	14(13.1)
	Diploma and Associate Degree	16	13	29(27.1)
	BSc and MSc	23	27	50(46.7)
	PhD and MD	7	7	14(13.1)
Marital status	Single	13	14	27(25.2)
	Married	31	39	70(65.4)
	Divorced	3	2	5(4.6)
	Widowed	4	1	5(4.6)

Table 2. Clinical information of the participants

Variables	Groups	No. (%)
Recovery duration	1 week	16(14.9)
	2 weeks	24(22.4)
	3 weeks	22(20.5)
	4 weeks	23(21.4)
	5 weeks and above	21(19.6)
Vaccination	Yes	81(75.7)
	No	26(24.2)
Vaccine type	Sinopharm	46(42.9)
	AstraZeneca	28(26.1)
	Sputnik V	5(4.6)
	Barekat	2(1.8)
	None	26(24.2)
Post-vaccination musculoskeletal pain	Yes	42(39.2)
	No	39(36.4)
	No vaccinated	26(24.2)

In this study, the highest pain frequencies before COVID-19 were reported in the shoulders, knees, and back, in that order. Similarly, the highest pain frequencies after COVID-19 were reported in the back, neck, shoulders, and leg, in this order. According to this study, most patients had low pain in their back, mild pain in their neck and back, and high pain in their knees before being infected with COVID-19. After the COVID-19 infection, low pain in the knee and mild and severe pain in the back was observed in most patients. In assessing the "pain impact on the functioning" before COVID-19, the highest effects on daily activities were found in the back, neck, and pelvis, in this order. After the COVID-19 infection, the daily activities related to the back, neck, shoulders, and pelvis were reduced.

To better evaluate the effect of COVID-19 on "pain severity" and "pain impact on the functioning", the "after minus before" difference was used. In Table 3, the areas involved are given in terms of the highest and lowest differences in "pain severity" and "pain impact on the functioning."

4. Discussion

Based on the results obtained from ENMQ, before COVID-19, the highest pain frequencies were found in the right shoulder, right knee, and back, in this order. Similarly, the highest pain frequencies after COVID-19 were observed in the back, neck, right shoulder, and left leg, in this order. In assessing "pain severity" and "pain impact on the functioning", a significant difference was only seen in the right elbow. However, in assessing these variables based on age groups and education, the highest statistical differences were found in various areas of the lower limbs.

Musculoskeletal complications in patients who recovered from COVID-19 are not far from expected, given the prolonged immobility and home quarantines [12]. Since the patients studied complained of pain in various body organs before the infection, the difference between "pain severity" and "pain impact on functioning" was used to assess the effects of being infected with COVID-19. According to Sagat et al. study in Riyadh (Saudi Arabia), the prevalence of low back pain (LBP) increased from 38.8% before the quarantine to 43.8% after the quarantine. In addition, the LBP severity was significantly increased. According to their results, the patients had pain in their backs, necks, shoulders, chests, and legs after the quarantine, and a significant relationship was found between the LBP and the duration of sitting [13]. However, in this study, there was no significant difference between the incidence of LBP before and after COVID-19. In addition, there was no significant difference in "pain severity" before and after COVID-19 among females and males. However, only musculoskeletal complications were examined in the present study. In Abdullahi et al. study, the prevalence of neurological and musculoskeletal manifestations was 35% for smell impairment, 33% for taste impairment, 19% for myalgia, 12% for headache, 10% for back pain, 10% for dizziness, 3% for acute cerebrovascu-

Table 3. Areas involved based on the greatest and lowest difference in "pain severity" and "pain impact on the functioning" before and after COVID-19 infection

Area	Gender				Age groups						Education							
	Female		Male		Young (20-35 y)		Middle-aged (35-50 y)		Elderly (> 50 y)		Under diploma		Diploma and Associate Degree		BSc and MSc		PhD and MD	
	Lowest	Greatest	Lowest	Greatest	Lowest	Greatest	Lowest	Greatest	Lowest	Greatest	Lowest	Greatest	Lowest	Greatest	Lowest	Greatest	Lowest	Greatest
Spine	Neck f.	Back p and f.	Back p.	Back p.	Neck f.	Back and Pelvis p and f.	Pelvis f.	Back f.	Back f.	Back p.	Neck and Back f.	Back f.	Back f.	Neck f.	Pelvis f.	Back f.	Neck p and f.	Pelvis p and f.
Upper limbs	Right elbow and forearm f.	Right shoulder p and f.	Right forearm p, left forearm f, right and left wrist p.	Right shoulder p and f, left arm f, right elbow f.	Right and left forearm p, right and left wrist p.	Right and left arm f.	Right forearm p.	Right arm f.	Left forearm f, left wrist p.	Right shoulder p.	Left shoulder f.	Left arm p and f.	Right arm p.	Right shoulder and left arm f.	Left forearm p.	Right shoulder and right arm p.	Right and left forearm p, right and left wrist p.	Right shoulder p.
Lower limbs	Left thigh f.	Left thigh p.	Left knee p.	Right and left Leg f.	Right and left Ankle p and f.	Right and left leg f.	Left knee p.	Right leg p.	Left thigh p and f.	Right ankle p.	Thigh, knee, and ankle p and f.	Right and left leg p and f.	Right and left knee f.	Left leg p, right and left ankle p.	Left and right thigh f, left knee p, and f.	Left and right leg p.	Right and left knee p, right, and left ankle p and f.	left Leg f.

*P: Pain severity, F: Pain impact on the functioning.

lar disease, and 2% for impaired consciousness [4]. Generally, two hypotheses have been proposed to explain the incidence of neurological and musculoskeletal symptoms in COVID-19 patients. The first assumption is that the peripheral nerves are infected with the virus entering the central nervous system through the bloodstream, infected endothelial cells, leukocytes, or retrograde nerve pathways. The second assumption is the systemic hypoxia of the body following pneumonia caused by the virus [14].

The body's inflammatory response to COVID-19 triggers systemic inflammatory reactions that impact many other organs in the body, such as the musculoskeletal system. Studies have shown that COVID-19 infection increases cytokines and signaling molecules, such as interferon-gamma type 1, interleukin-1 beta (IL-1B), interleukin-6 (IL-6), IL-8, IL-18, and tumor necrosis factor α. The excessive increase of inflammatory cytokines and C-reactive protein (CRP) during the disease process is called cytokine storm (CS), a characteristic of COVID-19 patients. This phenomenon reduces the body's adaptive immunity against COVID-19 infection, consequently resulting in tissue collapse and a decrease in muscle protein synthesis [15]. Overproduction of IL-6 during CS can cause myalgia. CS can also cause arthralgia in affected patients. Therefore, there is a direct relationship between myalgia and arthralgia in COVID-19 patients [4, 16]. Studies have shown that, in patients with severe involvement, hypoxia in skeletal muscles can lead to myalgia, excess lactic acid formation, low pH level (muscle cramps), or other related complications. The excessive lactic acid formation can be another reason for myalgia. In addition, under chronic hypoxia conditions, the protein metabolism of skeletal muscles is negatively affected, which also contributes to the exacerbation of primary musculoskeletal symptoms [15]. Changes in laboratory parameters, such as a reduction in the number of lymphocytes and an increase in CRP, D-dimers, IL-6, and cardiac ferritin and troponin, may directly or indirectly affect the prognosis of COVID-19 patients [17]. However, more research is needed to explain the mechanism of musculoskeletal pathophysiology.

In the case of long-term infection with COVID-19, males are more inclined to mortality, while females become more prone to infection complications [18]. In Muge et al. study, post-COVID-19 musculoskeletal pain was much more prevalent in females than in males. They attributed this finding to the higher level of health anxiety and the lower pain threshold in females than males. Also, it was observed that anxiety has a direct relationship with musculoskeletal symptoms in both genders [19]. In the present study, despite no significant correlation in the post-COVID-19 of pain severity, females had more pain in their lower limbs than males. In contrast, the pain severity in lower limbs was nearly equal in both genders. Celenay et al. found that people who stayed at home during the COVID-19 pandemic had more musculoskeletal complaints, especially in the spine than those who continued to work. They attributed this finding to prolonged sitting and reduced physical activities. Although they did not mention the pain distribution by gender, in the present study, the post-COVID-19 neck pain was significantly higher in females than in males [20].

Fallon et al. investigated the effects of home quarantines in the United Kingdom on individuals with chronic pain relative to a healthy control group [21]. According to their results, people with chronic pain reported greater pain intensity compared to their estimation of typical pre-lockdown pain levels. Additionally, they were more adversely impacted by lockdown conditions and showed greater self-perceived increases in anxiety, depression, loneliness, and reduced levels of physical exercise compared to pain-free individuals. They concluded that reduced physical activities result in muscular atrophy, increased pain, and increased fear of doing activities [21].

In Bai et al. study on 377 patients in a Hospital in Milan, female gender, older age, and active smoking were the risk factors of developing "long COVID" syndrome. This syndrome was observed in 69% of patients, and the most common symptoms were fatigue, shortness of breath during activity, musculoskeletal pain, and brain fog [22]. In the present study, 22 patients (20.56%) had long COVID syndrome. However, other patients who recovered from COVID-19 for between one to four weeks were not followed up.

Due to the restrictions caused by repeated quarantines and the fear of revealing the infection of COVID-19 at the beginning of the pandemic, which led to non-cooperation, it was impossible to survey a larger number of students and employees of Iran University of Medical Sciences. Thus, now that the pandemic does not lead to a rise in individual and social fear and anxiety, it is recommended to conduct additional research with bigger groups and a long-term follow-up period.

5. Conclusion

In general, the results of the present study showed that among the employees and people studying at Iran University of Medical Sciences who were infected

with COVID-19, there was an increase in musculoskeletal disorders compared to before the infection, and these disorders were more evident, especially in the lower back area. Based on the study findings, the difference in right elbow function by gender, the difference in the intensity of right elbow pain by age, the difference in the intensity of ankle and finger pain, and the difference in the function of ankle and fingers on both sides by age before and after suffering from coronavirus were all significant ($P<0.05$).

Since the global pandemic caused by COVID-19 continues to leave its effects, special attention should be paid to the effects of this viral infection on the performance of the musculoskeletal system. Infection with this virus can cause musculoskeletal symptoms, such as arthralgia, myalgia, neuropathy, and myopathy. Importantly, current treatments in the management of COVID-19 patients, such as the use of corticosteroids, can also cause musculoskeletal effects that clinicians should be aware of it. Finally, understanding the need for effective rehabilitation to help patients return to pre-infection mobility and function is critical.

Ethical Considerations

Compliance with ethical guidelines

The Ethics Committee of the Iran University of Medical Sciences approved this study (Code:IR.iums.rec.1400.267). All participants signed informed consent to participate in this study.

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The paper was extracted from the MSc. thesis of the first author at the Department of Physiotherapy, Faculty of Rehabilitation Science, Iran University of Medical Science.

Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declare no conflicts of interest.

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مقاله پژوهشی

بررسی عوارض کووید-۱۹ بر روی سیستم اسکلتی-عضلانی با استفاده از پرسشنامه توسعه یافته نوردیک

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چکیده

مقدمه با توجه به بروز اختلال در فعالیت‌های روزانه به‌دلیل بروز دردهای اسکلتی-عضلانی متعاقب ابتلا به کووید۱۹-، بررسی این عوارض می‌تواند اطلاعات بیشتری را به منظور تشخیص و درمان زود هنگام بیماران در اختیار ما بگذارد. بنابراین، هدف از این مطالعه بررسی تاثیر این ویروس بر میزان بروز اختلالات اسکلتی-عضلانی افراد مشغول به تحصیل یا کار در مبتلایان به کرونا در دانشگاه علوم پزشکی ایران با استفاده از پرسشنامه توسعه یافته نوردیک بود

مواد و روش‌ها این مطالعه پرسشنامه‌ای مقطعی در سال ۱۴۰۰ بر روی ۱۰۷ داوطلب انجام گرفت. نمونه‌گیری به روش ساده (در دسترس) از میان کارکنان و دانشجویان دانشگاه علوم پزشکی ایران صورت گرفت. معیارهای ورود عبارت بودند از: تاییدیه ابتلا به کووید-۱۹ توسط پزشک و گذشت حداقل سه هفته از شروع علائم کووید-۱۹. معیارهای خروج از مطالعه عبارت بودند از: داشتن سابقه حادثه یا تصادف اثرگذار بر روی سیستم اسکلتی عضلانی و عدم تمایل شرکت کننده برای ادامه همکاری. در این مطالعه از دو پرسشنامه محقق ساخته و پرسشنامه توسعه یافته نوردیک جهت جمع‌آوری داده‌ها استفاده شد. وجود اختلالات اسکلتی عضلانی قبل از ابتلا به کووید-۱۹ و بروز یا تشدید این اختلالات بعد از ابتلا نیز با استفاده از پرسشنامه توسعه یافته نوردیک ثبت گردید. داده‌ها در نرم افزار SPSS و با استفاده از آزمون های من – ویتنی و کروسکال والیس مورد تجزیه و تحلیل قرار گرفتند.

یافته‌ها بیشترین توزیع فراوانی درد قبل از ابتلا به کووید-۱۹ به ترتیب در نواحی شانه، زانو، کمر و پس از ابتلا به کرونا به ترتیب در نواحی کمر، گردن، شانه و ساق پا وجود داشت. بر اساس نتایج بدست آمده از این تحقیق، بیشتر افراد قبل از ابتلا به کووید-۱۹، درد با شدت کم در ناحیه کمر، درد با شدت متوسط در نواحی گردن و کمر و درد با شدت زیاد در ناحیه زانو داشتند. بعد از ابتلا در بیشتر افراد، درد با شدت کم در ناحیه زانو و درد با شدت متوسط و شدید در ناحیه کمر مشاهده شد. در بررسی "تاثیر درد بر روی عملکرد" قبل از ابتلا به کووید-۱۹، به ترتیب در نواحی کمر، گردن و لگن بیشترین تاثیر بر فعالیت‌های روزانه دیده شد. پس از ابتلا نیز به ترتیب در نواحی کمر، گردن، شانه و لگن کاهش عملکرد در فعالیت‌های روزانه مشاهده شد

نتیجه‌گیری بر اساس نتایج به‌دست آمده، تفاوت عملکرد آرنج راست بر حسب جنس، تفاوت شدت درد آرنج راست بر حسب سن، تفاوت شدت درد مچ پا و انگشتان راست و چپ بر حسب سن و تفاوت عملکرد مچ پا و انگشتان راست و چپ بر حسب سن، قبل و پس از ابتلا به ویروس کرونا، از جمله متغیرهای معنادار این مطالعه بودند (P<۰/۰۵).

کلیدواژه‌ها:
کووید-۱۹، سیستم اسکلتی-عضلانی، پرسشنامه نوردیک

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