


COMMUNICATION

Increased incidence of musculoskeletal pain in medical students during distance learning necessitated by the COVID-19 pandemic

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Abstract

As a consequence of lockdown during the COVID-19 pandemic, the education system has changed globally. Face to face education has been replaced by distance learning. The aim of the present study was to find the prevalence of musculoskeletal pain and syndromes among medical students during distance learning and to investigate the correlations of musculoskeletal pain with different causal factors. A total of 282 students completed an online questionnaire that measured time spent on digital devices, type of physical activity, time spent sitting, number of walking days/week, ergonomics, and postural habits. Some of these measurements were compared between periods before and during the pandemic. Because of distance learning, time spent on digital devices and total time spent sitting increased significantly from before to during the pandemic ($p < 0.001$); students' daily physical activities and the number of days per week with at least 10 min of walking decreased significantly ($p < 0.001$). Most of the students (75.9%) experienced at least one type of musculoskeletal pain, predominately shoulder and neck pain (65%). There was a very significant positive correlation between musculoskeletal pain and postural habits ($p < 0.0001$). This study suggested that postural habits while sitting have a profoundly negative effect on the musculoskeletal system and are factors in the causation of musculoskeletal pain.

KEYWORDS

COVID-19, distance learning, pain, physical activity, sitting, walking

1 | INTRODUCTION

Since outbreaks of COVID-19 were first reported in Wuhan at the end of December 2019 (Layne et al., 2020), many precautionary interventions have been imposed to keep the infection from spreading further. However, the disease has expanded rapidly over the world (Fan et al., 2020) with a significant increase in the number of cases reported internationally, leading to the WHO declaring COVID-19 a pandemic on March 11, 2020 (Cucinotta & Vanelli, 2020). In light of

these rapid developments, governments around the world attempted to implement strict public health measures to combat the aggressive spread of the disease, such as lockdowns, isolation, quarantine, and containment measures ranging from social-distancing to community-wide quarantine (Koh, 2020; Wilder-Smith & Freedman, 2020).

Musculoskeletal pain (MSP) denotes pain in any part of the musculoskeletal system such as muscles, bones, ligaments, tendons, and nerves. A person can feel this pain in just one area, such as eye tiredness, the jaw, the neck, the back, the elbow, the knee, and the calves;

or the whole body can be affected (Dieppe, 2013). Excessive time spent using electronic devices, which is linked to bad posture, lack of regular physical activity, and increased sedentary time (Dogra & Stathokostas, 2012; Memari et al., 2020), and has been associated with the development of musculoskeletal discomfort. MSP is considered multifactorial, having physical, psychological, and social aspects (Akulwar-Tajane et al., 2021; Al Omar, 2021).

Musculoskeletal syndromes (MSS) are defined as injuries or disorders of the muscles, nerves, tendons, joints, cartilage, and intervertebral discs. Examples include text neck syndrome, text finger syndrome, carpal tunnel syndrome, computer vision syndrome, and cubital tunnel syndrome (Kulin & Reaston, 2011). In students, many risk factors provoke MSP and MSS. These include little or no physical activity, excessive time spent in sitting posture, ergonomics, and bad postural habits. Level of physical activity, time spent in sitting posture, and good posture, have been variously researched. A cross-sectional study in Kuwait to investigate the influence of the pandemic on physical activity showed that around one-third of respondents (33.1%) reported doing less than 30 min of physical activity or exercise each week (Salman et al., 2021). According to a cross-sectional study in India to examine the effect of lockdown on posture in physiotherapy students, most students had inefficient posture patterns and poor postural habits. Low back pain was the most common result of improper postural pattern, followed by neck pain, upper back pain, and shoulder pain (Akulwar-Tajane et al., 2021).

Ergonomics is the discipline of matching the capabilities of the working or studying population to the conditions of the job or study environment. Its aim is to alleviate stress while preventing injuries and diseases caused by misuse of muscles, poor posture, and repetitive jobs. According to the Health and Safety Executive (HSE) in the United Kingdom, 4.1 million working days were missed in 2001/02 owing to MSS mostly affecting the upper limbs or neck, which were caused or exacerbated by labor (Buckle, 2005).

Several studies have examined the relationship between increased time spent on electronic devices and some MSP and MSS. Nowadays, the percentage of working people using computers as a part of daily activity is 75% (Logaraj et al., 2013). It is thought that this percentage increased during the lockdown. The symptoms comprising computer vision syndrome are many. The most common ones are eye fatigue, headaches, light or glare sensitivity, neck pain, shoulder pain, and backaches (Korkmaz et al., 2011). According to a study evaluating eye symptoms in computer vision syndrome during the COVID-19 lockdown in Spain, these symptoms were more frequently reported by participants spending more time on electronic devices and less time outdoors (Galindo-Romero et al., 2021). Eye symptoms and musculoskeletal discomfort associated with computer vision syndrome could reduce productivity in 40% of users (Gangamma & Poonam, 2010). In addition, long-time exposure to electronic devices caused many MSS such as neck stiffness and pain in the head, back, and shoulders (Anshel, 2005). Another study showed that 46% of people working from home using a laptop or mobile phone during the quarantine period had text neck syndrome (Taneja, 2021). All these factors together can be considered risk factors for the development of MSP and MSS.

Other reports have examined and emphasized the negative effects of COVID-19 pandemic lockdowns on mental and psychological status and dietary behavior (Ayanniyi et al., 2011; Ingram et al., 2020; Karageorghis et al., 2021; Violant-Holz et al., 2020). There have been many studies of the effects of COVID-19 pandemic lockdowns on general physical activity or social and psychological status, or even dietary behaviors. The present study is the first to investigate the effects of the lockdown on medical students' physical health by measuring many risk factors. The objectives were to find the prevalence of musculoskeletal pain and musculoskeletal disorders among medical students during distance learning, and to study the correlation between musculoskeletal pain and causative factors (time spent on digital devices, type of physical activity, time spent in setting, number of walking days/week, ergonomics, and postural habits) during distance learning.

2 | MATERIALS AND METHODS

2.1 | Design and participants

A total of 282 students participated in this cross-sectional study, which was conducted over 90 days (July to September 2021) during online teaching. The study targeted undergraduate medical students between 18 and 22 years old in basic medical science levels (first-third years) at Al-Balqa Applied University (BAU), a government-supported university in Jordan. Students with no history of MSP were included, but students who had any type of MSS were also allowed to participate.

Students were invited to participate in an online survey, the questionnaire being distributed in Google form via social media and official channels of BAU on Microsoft Teams. Participation was voluntary, but completing the survey was considered as consent to participate in the study. The study was approved by the local ethics committee, Al-Balqa Applied University.

2.2 | Questionnaire

The questionnaire was adopted from the short form of the International Physical Activity Questionnaire (IPAQ-SF) and is in the English language. It is semi-structured with a combination of short-answer and multiple-choice questions. A brief description of the study and its objectives were given in Section 1. Section 2 included demographic, anthropometric, and some health status data (Table 1). Sections 3 and 4 measured many variables before and during the pandemic: Section 3 included time spent actively on digital devices (Table 2), while Section 4 included the type of physical activity, total time per day spent sitting, and walking days/week (Table 3). This study focused on qualitative measures; therefore, the questionnaire comprised types of physical activities but did not focus on the frequency and duration thereof. Physical activities were categorized into vigorous physical activity (such as lifting heavy objects, cycling, or running), moderate physical activity (such as carrying light weights or riding a stationary

bike at a regular pace), and low physical activity (such as free body exercises with or without the use of tools, for example, elastic bands or dumbbells, in addition to separate exercises and treadmills). Section 5 comprised ergonomic measures including chairs with back and arm supports and digital device holders (Table 4). Section 6 focused on sitting postural habits during lectures, self-studying, or even leisure activities and rest (Table 5). Sections 7 and 8 comprised different types of MSP (according to body region) that students experienced for the first time during the pandemic (Table 6). The final two

sections recorded whether any participating student had previously been diagnosed with a prevalent MSS and whether the symptoms were the same or aggravated during the pandemic (Table 7).

2.3 | Calculation of sample size

Minimal sample size was estimated before the study using an online sample size calculator (<https://www.calculator.net/sample-size>). A population of 1000 students with academic levels of first to third year at BAU was determined based on a 50% population proportion, a 5% margin of error, and a 95% confidence level. Using this calculator, a minimum sample size of 278 students was representative enough for this study.

2.4 | Statistical analysis

SPSS version 22 (SPSS Inc.) was used for data analysis. McNemar's test was used to compare certain variables between two intervals before and during the pandemic, while a chi-square test was used to

TABLE 1 Demographic data

	n (%)
Participants	282
Female	174 (61.7)
Male	108 (38.3)
Academic year	
1st	134 (47.5)
2nd	122 (43.3)
3rd	26 (9.2)
BMI level	
Underweight	34 (12.1)
Healthy weight	223 (79.1)
Overweight	7 (2.5)
Obese	18 (6.4)
Type of electronic device usage	
Mobile only	32 (11.4)
Laptop only	10 (3.6)
Tablet only	3 (1.1)
More than one device	237 (83.9)

TABLE 2 Comparing the number of hours students were spending by using digital devices daily

Time spent on digital devices (h)	Before the pandemic	During the pandemic	p value
	n (%)	n (%)	
<6	229 (81.2)	49 (17.4)	<0.001
>6	53 (18.8)	233 (82.6)	

TABLE 3 Comparing the physical activity students were doing daily, the total time students were spending sitting position daily, number of walking days per week for at least 10 minutes continuously

	Before the pandemic	During the pandemic	p value
	n (%)	n (%)	
Physical activity			
Low physical activity	132 (46.8)	212 (75.2%)	<0.001
Moderate, Vigorous physical activity	150 (53.2)	70 (24.8%)	
Time spent in sitting position (h/day)			
<8	202 (71.6%)	89 (31.6)	<0.001
>8	80 (28.4)	193 (68.4)	
Number of walking days per week			
0-3	46 (16.3)	156 (55.3)	<0.001
4-7	236 (83.7)	126 (44.7)	

TABLE 4 Ergonomic measures adopted during use of digital devices

Ergonomics measure use	Yes	No
	n (%)	n (%)
Chair with arm rest	160 (56.7)	122 (43.3)
Chair with back rest	249 (88.3)	33 (11.7)
Mobile/tablet holder	189 (67)	93 (33)
Device monitor position within eye level	184 (65.2)	98 (34.8)

investigate correlations between factors influencing MSP. *p* values less than 0.05 were considered statistically significant.

TABLE 5 Postural habits in sitting position

	Yes <i>n</i> (%)	No <i>n</i> (%)
Back		
Well supported ^a	90 (31.9)	192 (68.1)
Anterior/posterior postural tilt ^b	126 (65.6)	
Medial/lateral postural tilt ^b	66 (34.4)	
Buttocks and hips		
Well supported	77 (27.3)	205 (72.7)
Anterior postural tilt	148 (72.2)	
lateral postural tilt	57 (27.8)	
Legs		
Crossed	169 (59.9)	113 (40.1)
Feet		
Supported	139 (49.3)	143 (50.7)
Unsupported	143 (50.7)	139 (49.3)

^aWell supported back means supporting the back by a backrest and maintaining the natural curve of the back.

^bTilted back means sloping the back anteriorly, posteriorly, medially, and laterally away from a backrest.

TABLE 6 The prevalence of musculoskeletal pain

Have any type of musculoskeletal pain	Yes <i>n</i> (%)	No <i>n</i> (%)
	214 (75.9)	68 (24.1)
Eye tiredness	132 (61.7)	
Jaw pain	61 (28.5)	
Neck and shoulder pain	139 (65)	
Elbow pain	54 (25.2)	
Wrist and hand pain	76 (35.5)	
Back pain	133 (62.1)	
Leg and calf pain	75 (35)	

TABLE 7 The prevalence of musculoskeletal syndromes

Have any type of musculoskeletal syndrome	Yes <i>n</i> (%)	No <i>n</i> (%)	-
	20 (7)	262 (93)	
Symptoms of musculoskeletal syndrome	Worsen <i>n</i> (%)	Eliminated <i>n</i> (%)	The same <i>n</i> (%)
Text neck syndrome	3 (15)	0	3 (15)
Text finger syndrome	3 (15)	0	3 (15)
Carpal tunnel syndrome	0	0	0
Computer vision syndrome	6 (30)	0	2 (10)
Cubital tunnel syndrome	0	0	0

3 | RESULTS

3.1 | Demographic data

A total of 282 students participated in the study (Table 1), 174 (61.7%) females and 108 (38.3%) males, a male to female ratio of 1:1.6. Most of the students were from the first and second years (47.5% and 43.3%, respectively); 91.1% were non-smokers, and most (83.9%) used more than one electronic device during their study and leisure times. Their BMIs were categorized into four groups: underweight (BMI < 18.5), healthy weight (BMI 18.5–24.9), overweight (BMI 25–29.9), and obese (BMI > 30). As shown in Table 1, 79.1% of students were classed as healthy weight.

3.2 | Total time spent on electronic devices before and during the pandemic

Before the pandemic, 81.2% of students spent less than 6 h daily on their electronic devices. During the pandemic, 82.6% spent more than 6 h daily. This difference was statistically significant ($p < 0.001$) (Table 2). This expansion in hours on electronic devices was a result of moving toward distance learning. Subsequently, a minimum of 4 h/day was increased to attending lectures and additional hours were spent in self-studying, as most students depended on electronic duplicates of the study material. In addition, during the lockdown, there was no relaxation other than investing energy staring at the TV or enjoying good times via web-based media.

3.3 | Students' daily physical activities, total time spent sitting, and the number of days per week with at least 10 min walking, before and during the pandemic

There was a statistically significant difference in the type of physical activity students practiced between before and during the pandemic ($p < 0.001$). During the pandemic, the number of students who practiced vigorous and moderate physical activities decreased from 150 to 70, whereas students who practiced low physical activities increased from 132 to 212 (Table 3). This increase could be attributed to gym

closures on specific days and apprehension of reclosure later when subjects began to practice low physical activities at home; or to remarkable housework accomplished by these subjects.

Prior to the pandemic, 202 out of the 282 students spent less than 8 h per day sitting; during the pandemic, most of them (193) spent more than 8 h per day, a statistically significant difference ($p < 0.001$). Before the pandemic, 236 of the 282 students walked more than 4 days per week for at least 10 min continuously. However, during the pandemic, the number of students walking more than 4 days per week declined to 126, and 12 did not engage in any walking activity. This difference is statistically significant ($p < 0.001$) (Table 3).

3.4 | Ergonomic measures adopted during the use of digital devices before and during the pandemic

Most students (88.3%) used chairs with backrests, but only 56.7% used chairs with armrests. In addition, similar proportions of students used mobile or tablet holders where the monitors of their digital devices were at eye-level; the percentages were 67.3% and 65.1%, respectively (Table 4).

3.5 | Postural habits assumed while sitting

Most students had poorly supported backs while sitting, and poorly supported buttocks and hips (68.1% and 72.7%, respectively). The most commonly observed poor postural patterns among the students were anterior/posterior tilting of the back (65.6%), anterior tilting of the pelvis (72.2%), lateral/medial tilting of the back (34.4%), lateral tilting of the pelvis (27.8%), crossed legs (59.9%), and unsupported feet (50.7%) (Table 5).

3.6 | Types of musculoskeletal pain and musculoskeletal syndrome newly experienced during the pandemic

At least one type of MSP was experienced by 75.9% of the participating students. Shoulder and neck pain predominated (65%), followed by similar proportions of back pain (62.1%) and eye tiredness (61.7%) (Table 6). Table 7 shows that only 20 students (7%) reported experiencing one type of MSS, the most prevalent being computer vision syndrome in eight students. During the pandemic the symptoms were unchanged in two students, but worsened in the other six. Six students had text neck syndrome in addition to six with text finger syndrome. The symptoms worsened in three students and were the same in the other three for both those syndromes.

3.7 | Associations between musculoskeletal pain and all parameters

Sex, academic year, and BMI were not significantly associated with MSP (Table 8). There was no significant association between MSP and

TABLE 8 Association between musculoskeletal pain and sex, academic year, and BMI level

	MSP (n = 214) n (%)	No MSP (n = 68) n (%)	Sig
Sex			
Female	138 (64.5)	36 (52.9)	0.088
Male	76 (35.5)	32 (47.1)	
Academic year			
1st year	99 (46.3)	35 (51.4)	0.696
2nd year	94 (43.9)	28 (41.2)	
3rd year	21 (9.8)	5 (7.4)	
BMI level			
Underweight	25 (11.7)	9 (13.2)	0.622
Healthy weight	172 (80.4)	51 (23.8)	
Overweight	4 (1.9)	3 (4.4)	
Obese	13 (6.1)	5 (7.4)	

time spent on digital devices, type of physical activity, number of walking days, time spent sitting, and ergonomics (Table 9). On the other hand, Table 9 shows that postural habits were significantly associated with MSP ($p < 0.0001$).

4 | DISCUSSION

Undergraduate medical students studied by distance learning for five semesters from the fall semester of 2020 to the summer semester of 2021. One inevitable consequence of the introduction and long-term continuation of distance learning was an increase in the daily hours students spent in front of a laptop or desktop computer in order to attend lectures, study, or do homework, in addition to personal use. Excessive use of technology, particularly smartphone usage, has been linked to a variety of chronic problems among young people (Katz et al., 2000). According to our study, the total hours that students spent on digital devices increased significantly during the pandemic because of distance learning, 82.6% spending more than 6 h. The total time students spent sitting also increased significantly, more than half (68.4%) spending more than 8 h. Following our outcome, a preliminary study showed that most of the students who participated in the study (77.6%) spent more than 4 h actively on their digital devices during the pandemic, and more than half (50.2%) spent four to 8 h daily in a sitting position (Dunton et al., 2020). Sitting for extended periods entails several risk factors for postural disturbances (Gerr et al., 2002; Stockwell et al., 2021). Furthermore, our study showed that more students (75.2%) engaged in low physical activity during the pandemic than before the pandemic, when more than half (53.2%) engaged in vigorous and moderate activities, indicating a significant change. Furthermore, this study showed a significant decrease during the pandemic in the number of days per week students walked for at least 10 min continuously. Before the pandemic, 83.7% of students walked for 4–7 days/week. During the pandemic, this percentage decreased to 44.7%.

	MSP (n = 214) n (%)	No MSP (n = 68) n (%)	Sig
Time spent on digital devices (h)			
<6	39 (18.2)	10 (14.7)	0.505
>6	175 (81.8)	58 (85.3)	
Type of physical activity			
Low physical activity	165 (77.1)	47 (69.1)	0.184
Vigorous and moderate physical activity	49 (22.9)	21 (30.9)	
Number of walking days per week			
0-3	122 (57)	66 (53.2)	0.311
4-7	92 (43)	58 (46.8)	
Time spent on sitting (h/day)			
<8	66 (30.8)	23 (34.7)	0.645
>8	148 (69.2)	81 (65.3)	
Ergonomics			
Chair with arm rest	123 (57.5)	37 (54.4)	0.240
Chair with back rest	193 (90.2)	56 (82.4)	
Mobile/tablet holder	70 (32.7)	23 (33.8)	
Device monitor position within eye level	66 (30.8)	32 (47.1)	
Postural habits			
Well supported back	55 (25.7)	35 (51.5)	<0.0001
Anterior/posterior postural tilt of back	118 (55.1)	8 (11.8)	
Medial/lateral postural tilt of back	41 (19.2)	25 (11.7)	
Well supported buttocks and hips	57 (26.6)	20 (9.3)	
Anterior postural tilt of buttocks and hips	137 (64)	12 (17.6)	
lateral postural tilt of buttocks and hips	21 (9.8)	36 (52.9)	
Crossed legs	136 (63.6)	33 (15.4)	
Supported feet	101 (47.2)	37 (17.3)	
Unsupported feet	112 (52.3)	31 (14.5)	

TABLE 9 Association between musculoskeletal pain and time spent on digital devices, physical activity, number of walking days per week, time spent sitting, ergonomics, and posture

The findings of this study parallel those of a systematic review of 64 articles, which showed that during individual lockdowns, several populations, including children and patients with a variety of medical issues, experienced a decrease in physical activity and an increase in sedentary behavior (Paul et al., 2013). Despite our results, there was no significant association between MSP and the time spent on digital devices, type of physical activity, number of walking days, or time spent sitting. Dogra and Stathokostas and Memari et al. found that excessive use of electronic devices is associated with poor posture, lack of regular physical activity, and increased sedentary time, linked to the development of musculoskeletal discomforts (Dogra & Stathokostas, 2012; Memari et al., 2020).

Our data revealed that three-quarters of the students (75.9%) experienced MSP for the first time during distance learning, primarily in the shoulders and neck (65%), followed by similar proportions of back pain (62.1%) and eye tiredness (61.7%). Approximately two-thirds of participants in the study by Isha et al. reported new musculoskeletal pain in numerous body locations during the lockdown

(66.6%), mostly and nearly-evenly distributed in the lumbar spine (33.3%) and cervical spine (32%) (Akulwar-Tajane et al., 2021).

The results of the current study revealed that a high percentage of medical students (88.3%) used chairs with back support but fewer used chairs with arm support (56.7%) or digital device holders, and the monitors of digital devices were at eye level. They preferred a comfortable position to good ergonomics while studying.

Because digital devices are mobile and portable, students can sit and study in any location. Although most students in the present study reported that they sat on a chair while studying, some sat on a couch, bed, or even the floor, with or without using a table. We found that most of the students were not aware of how they were sitting, or of the adverse effects of these bad postural habits; 68.1% did not have well-supported backs during sitting while they were performing anterior/posterior back tilt and medial/lateral back tilt. In addition, 72.7% had poorly supported buttocks and hips during sitting while performing anterior buttock tilt and lateral buttock tilt. In addition to the aforementioned bad postural habits, 59.9% of students sat with crossed legs, and 50.7% with unsupported feet.

Another important finding this study was the very significant positive correlation between MSP and postural habits ($p < 0.0001$), suggesting that poor posture in sitting has a profoundly negative effect on the musculoskeletal system and is a causative factor of MSP. Poor postural habits make changes in muscle tone distribution, loss of body alignment symmetry, and the development of bad postural patterns more likely. Muscle imbalance or a disturbance of muscle tension equilibrium is caused by the frequency of static or dynamic loading in these regularly repeated patterns of body alignment. Out-of-balance muscles correct themselves in regular patterns, resulting in diverse postural patterns and discomfort varying in intensity and location (Noll et al., 2012). The need to encourage proper posture awareness among university students should not be neglected. In addition to schools, instructional and educational programs for promoting healthy postural behaviors have been implemented in the workplace and other community settings (Borges et al., 2011; Harman et al., 2005; Kim et al., 2015; Noll et al., 2014; Shariat et al., 2017; Tobo et al., 2010). These programs have been shown to help people become more conscious of their posture and change their habits.

In conclusion, our findings suggest for the first time that because of the lockdown, a prolonged period of emergency distance learning induced musculoskeletal discomfort in the form of pains in different body regions among medical students. Sitting postural habits have a significant effect on musculoskeletal discomfort.

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