**Original Article**

Musculoskeletal Pain and Its Association with the Impact of Ergonomics among University Students Studying Online During the COVID-19 Pandemic: A Cross-Sectional Survey

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ABSTRACT

The lockdown, due to the coronavirus, led to a change in lifestyle and physical activity in students. A greater number of university students stayed at home and had to shift towards telework, which predisposed them to different musculoskeletal disorders due to the lack of proper ergonomics. **Objectives:** To determine the prevalence of musculoskeletal pain and its association with the impact of ergonomics among university students studying online during the COVID-19 pandemic. **Methods:** A cross-sectional study was carried out with a total of 584 eligible university students in Pakistan. A self-administered questionnaire was used, with section A containing demographic data. The Standardized Nordic Questionnaire was used to analyze MSK symptoms. SPSS version 22.0 was used to analyze results. **Results:** During COVID-19 prevalence of musculoskeletal pain was identified in the sample, with majority of female students (64.7%) reporting MSK pain and 25% male. Before covid-19 pandemic, participants suffered musculoskeletal pain in different regions of the body, where the most affected regions were the neck (14.4%), the shoulder (8.6%), and the lower back (5.1%). During covid-19 quarantine, this percentage increased up to 95%, where mostly affected areas were the neck (28.9%), shoulder (30.8%), wrist/hand (6.8%), and lower back (19.5%). **Conclusions:** There was a high prevalence of musculoskeletal pain among university students. A significant association was found between MSK pain and adverse working conditions, such as laptops with monitors too low, chairs without armrests, hard edges on desktop surfaces, and long static postures due to a lack of routine breaks.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a newly observed SARS-CoV-2 factor that causes severe respiratory illness. It was first seen in China at the end of 2019. It was declared a pandemic by the World Health Organization (WHO) on [1]. The first case of coronavirus (COVID-19) in Pakistan appeared on 26th February 2020 in Karachi, and the first lockdown in Pakistan was implemented on 15th March [2]. Similar to other respiratory viruses, SARS-CoV-2 transmission occurs mainly via the respiratory route with high adequacy and infectivity. Although aerosols show a

second important route, droplet spreading is the main identified route [3]. As COVID-19 spreads from person to person via droplets, social distancing, social isolation, and the use of preventive equipment, such as the use of mask is adopted to prevent its spread. The rapid spread of infection is seen more in crowded areas due to personal contact among individuals, high motility and public transportation. Millions of people have faced dramatic changes in their routine habits due to the coronavirus pandemic all over the world. Many countries have implemented lockdown



strategies that majorly contribute to these rapid changes [4]. The World Health Organization suggests ceasing activities that have the capability to cause large crowds in an attempt to stop the spread of COVID-19. Therefore, the traditional education system that assembles many learners in one room requires analysis for execution. One substitute form of studying that can be accomplished during the COVID-19 pandemic is online education [5]. The problems of executing an online education system in developing nations like Pakistan are different from those in developed countries [6]. Education delivered to students via the internet through computers, laptops, smartphones, and mobile devices is a type of online education [7]. The academic performance of learners is influenced by educational settings. The learners cannot learn efficaciously while making use of computers they are not comfortable with. Eye problems, hand and wrist pains, waist, back, and cervical injuries, and headaches are some discomforts faced by students while learning in front of a computer screen for a long period of time. Such ailments occur due to the failure to adjust the learning area according to the anthropometric standards [8]. To prevent the spread of severe acute respiratory illness covid_19, millions of individuals exchange their routine work environment for home, and this causes a global change in work ergonomic patterns [9]. Ergonomics can be described as an applied science dealing with designing or managing things frequently used by individuals with the aim that both the people and things link more effectively and safely [10]. The broad range of disorders that cause swelling and deterioration of nerves, muscles, and tendons is called musculoskeletal disorders. Neck, upper and lower back, shoulders, elbows, wrists, and hands are body regions that experience pain and functional limitation affected by MSDs [11]. MSDs are generally caused by a composite of physical components (including repetition, force, and poor postures) in addition to other workplace environmental or departmental components (including unrestrained work rates or durations, inappropriate breaks, and a range of psychosocial workplace attributes) [12]. Prolonged time consumed ahead of a touch screen, a touch screen computer, or a computer with a keyboard leads to incorrect posture in people by decreasing their amount of physical activity. Mainly in this pandemic era, where stress is enormous, it has become extremely important to boost the amount of physical activity or exercise as a component of physical activity among learners acquiring online education [11].

For all the above-mentioned reasons, it became mandatory to conduct this type of study where the prevalence of musculoskeletal pain before and during quarantine, association with physical activity, and association with

ergonomics among university students could be analyzed. This study aimed to determine the prevalence of musculoskeletal pain and its association with the impact of ergonomics among university students studying online during the COVID-19 pandemic.

METHODS

A cross-sectional survey was conducted on the students of Riphah International University, Faisalabad, from 15 December 2021 to 15 June 2022. 584 participants were recruited through a non-probability convenience sampling technique. The total population included in this study was 20000. Sample size was calculated through the EPI tool, in which the estimated population was 0.5% with an estimated error of 0.04% with 95% of confidence level. 1100 students participated in this study, but only 584 students met the inclusion criteria. A customized questionnaire consisting of different sections was included in the study. Section I contained Demographic information in which the independent variables, such as name, gender, age, residence, institution, semester, and lifestyle, were included. Section II A dealt with the study before the COVID-19 quarantine. Section III A consisted of questions dealing with physical activity before quarantine. Section III B consisted of questions dealing with MSK pain before covid-19 quarantine. Section IV A had different questions about study during covid-19 quarantine. Section II B consisted of questions regarding physical activity during quarantine. Section III B consisted of questions regarding MSK pain during COVID-19 quarantine. Section II C had questions related to Ergonomics. Screen ergonomic questions were also included. Written informed consent was taken. A standardized Nordic questionnaire was also included to analyze the musculoskeletal symptoms. Section III A (MSK pain before COVID-19 quarantine), the questions related to nine different body regions, like neck, shoulder, elbows, wrist/hand, upper back, lower back, hips/thighs, knees, and ankles, were also included to assess pain in these regions. The questions were modified according to the context of the research. In the same way, Section III B was also modified according to the study. Descriptive statistics of quantitative data were presented in the form of a frequency table, percentages, and bar charts. Statistical analysis was done through SPSS version 22.0. Chi-square test was used to determine the comparisons and associations of ergonomics, physical activity, and musculoskeletal pain before and during COVID-19.

RESULTS

Result illustrated that out of 584 participants majority were between 20 and 22 years of age. Mean age was 21.1 ± 1.467 . 73.9% with gender distribution 65.8% female and 34.2%

male, the marital status of 98.5% was unmarried, 68% had a sedentary lifestyle, and 92.6% had a middle socioeconomic status (Table 1).

Table 1: Demographics of Study

Variables	Frequency (%)
Gender	
Female	384 (65.8%)
Male	200 (34.2%)
Hand Dominance	
Right Sided	570 (97.6%)
Left Sided	14 (2.4%)
Age	
18-19	98 (16.7%)
20-22	432 (73.9%)
23-26	54 (9.2%)
Marital Status	
Single	575 (98.5%)
Married	9 (1.5%)
Lifestyle	
Sedentary	429 (68.0%)
Active	155 (32.0%)
Socioeconomic Status	
High Socioeconomic Status	27 (4.6%)
Middle Socioeconomic Status	541 (92.6%)
Low Socioeconomic Status	16 (2.7%)
Department	
Department of Physical Therapy	164 (28.1%)
Department of Speech and Language	23 (3.9%)
Department of Medical Laboratory Technology	192 (32.8%)
Department of Human Nutrition and Dietetics	156 (26.7%)
Department of Biotechnology	22 (3.8%)
Department of Food Sciences and Technology	26 (4.5%)
Enrolled Program	
Doctor of Physical Therapy	164 (28.1%)
BS Speech and Language Pathology	23 (3.9%)
BS Medical Laboratory Technology	192 (32.8%)
BS Human Nutrition and Dietetics	156 (26.7%)
BS Biotechnology	22 (3.8%)
BS Food Science and Technology	26 (4.5%)

During covid-19 quarantine, the most commonly affected areas were the neck (28.9%), shoulder (30.8%), wrist/hand (6.8%), and lower back (19.5%). Results revealed that the majority of female students (75.5%) reported MSK pain, and 31.1% male with odd ratio (OR=1.948), 95% CI (1.305-2.907), and a significant association was found between them ($p=0.001$). Odd ratio of right-hand dominance was (OR=1.810) and 95% CI (0.618-5.296) with no significant ($p=0.272$). (OR=1.191) for marital status 95% CI (0.294-4.818) with p -value=0.806). The majority of students (91%) had a sedentary lifestyle with (OR=0.184) 95% CI (0.104-324) with a significant association of lifestyle and MSK pain ($p=0.000$). Students had high socioeconomic status with

(OR=0.800) 95% CI (0.643-996) and p -value=0.200) and for middle socioeconomic status (OR=0.194) 95% CI (0.109-0.343) with p -value=0.000 (Figure 1).

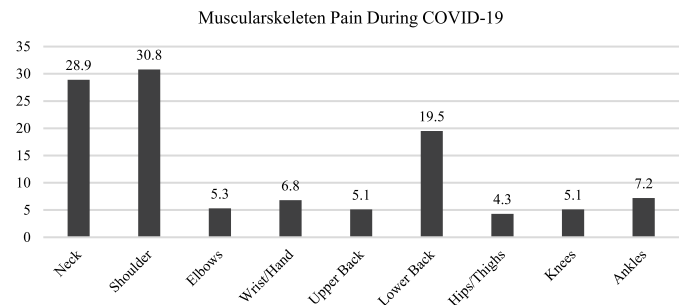


Figure 1: Musculoskeletal Pain During COVID-19

Association of demographics with MSK Pain during COVID-19 demonstrated that the majority of female students (64.7%) reported MSK pain, and 25% male, with OR=852, 95% CI (0.577-1.253), with no significant p -value=0.420. Odd ratio of right-hand dominance was OR=0.723 and 95% CI (0.687-0.761) with a significant p -value=0.021. OR=0.738 for marital status, 95% CI (0.182-2.987) with p =0.669. The majority of students (86.8%) had a sedentary lifestyle with OR=0.090, 95% CI (0.058-138), with a significant association of lifestyle with MSK pain ($p=0.000$). Students had high socioeconomic status with OR=0.071, 95% CI (0.009-547) and p -value=0.005, and for middle socioeconomic status (OR=0.096), 95% CI (0.062-0.149) with p -value=0.000 (Table 2).

Table 2: Association Demographic with MSK Pain During COVID-19

Variables	MSK Pain		OR	95% CI	p-value
	No	Yes			
Gender					
Female	50	150	0.852	0.577-1.258	.420
Male	108	276	Ref		
Age					
18-19	34	64	—	—	0.294
20-22	111	321			
23-26	13	54			
Hand Dominance					
Right Sided	158	412	—	0.687-0.761	0.723
Left Sided	0	14	—		
Single	155	420	0.738	0.182-2.987	0.669
Married	3	6	Ref		
Lifestyle					
Sedentary	59	370	0.090	0.058-138	0.000
Active	99	56	Ref		
Socioeconomic Status					
High Socioeconomic Status	8	19	0.071	0.009-0.547	0.005
Middle Socioeconomic Status	147	394	0.096	0.062-0.149	0.000
Low Socioeconomic Status	3	13	Ref	—	—

The relationship between online study-related behaviors during the COVID-19 quarantine and the occurrence of musculoskeletal (MSK) pains was investigated in terms of

the chi-square analysis. Significant statistical differences were found on several variables that refer to screen exposure, the use of gadgets, posture, and break habits. Online learners during the COVID-19 quarantine claimed a significantly greater prevalence of MSK pain. The duration of screen exposure had a significant correlation with MSK pain ($\chi^2 = 130.140$, $p=0.001$). The respondents who had spent 5-6 or even over 6 hours before screens had significantly higher levels of MSK pain than the respondents who had spent less time before screens. The kind of gadget that was mostly used during online classes also made a strong correlation with MSK pain ($\chi^2 = 106.090$, $p=0.001$). The high prevalence of MSK pain was among the participants who used laptops compared to those who used mobile phones. Likewise, the overall time spent on gadgets was found to have a very strong correlation with MSK pain ($\chi^2 = 218.428$, $p<0.001$), and the prevalence of the pain among gadget users also rose gradually with the length of time spent on gadgets over 67 hours per day. Habits during the use of gadgets were also significantly related to MSK pain ($\chi^2 = 24.247$, $p<0.001$). The respondents who reported no breaks reported higher levels of MSK pain than those who made breaks. Moreover, there was a strong relationship between break and MSK pain ($\chi^2 = 401.448$, $p=0.001$) (Table 3).

Table 3: Association of Musculoskeletal Pain with Online Study

Variables	MSK Pain During COVID-19		χ^2 -value	p-value
	No	Yes		
I Studied Online During COVID-19 Quarantine.				
Yes	158	426	—	—
Elaborate on Your Study Hours in Front of the Screen				
4-5 Hours	96	59	130.140	<0.001
5-6 Hours	29	164		
More Than 6 Hours	33	203		
During, COVID-19 Tick the Gadgets You Use Mostly During Online Classes				
Mobile	158	234	106.090	<0.001
Laptop	0	192		
How Many Hours Did You Spend on These Gadgets?				
3-4 Hours	20	0	218.428	<0.001
4-5 Hours	105	70		
5-6 Hours	10	134		
6-7 Hours or More Than 7	23	222		
Is There Any Break Between the Hours That You Spent on These Gadgets?				
No	42	44	24.247	<0.001
Yes	116	382		
Mention the Break Time				
15 Minutes	0	340	401.448	<0.001
More Than 45 Minutes	96	0		
None	62	86		
What Did You Do Most of Your Break Time During Online Classes?				
Sat Down (Reading, Talking, Doing Work)	30	415	442.235	<0.001

Stood Around	0	11		
Ran Or Walk Little Bit	105	0		
I Did Not Do Anything	23	0		
In Which Position Do You Take Your Classes During Quarantine?				
Sitting	158	426	—	—
Tick the Learning Position				
Sitting on a Chair	138	216	67.315	<0.001
Lying on the Bed	0	11		
Sitting on the Bed	20	159		
Sitting on the Sofa	0	40		
Sitting Then Which Position You Adapted				
Supported Sitting	135	188	106.535	<0.001
Forward Sitting	0	189		
Slumped Sitting	23	49		
During Online Classes, How Many Hours Did You Spend in a sitting position?				
0.00	0	30	111.929	<0.001
2-3 Hours	23	0		
4-5 Hours	30	125		
5-6 Hours	105	201		
More Than 6 Hours	0	70		

Association of ergonomics with Nordic MSK reported MSK pain in 39.21 % students with no upright position of the head. 44.3% students did not look downwards without bending neck and had MSK pain. 39.21% students did not follow the correct body position as their neck and trunk did not face forward. 39.21% students did not follow the trunk perpendicular to the floor posture. 34% students were those whose shoulders were not relaxed and perpendicular. 27.22% did not have their upper arms close to the body and not extended outward. 22% students didn't have their elbows bent close to the body, not extended outward. 15.41% students did not follow the ergonomics, like there forearm, wrists, and hands being straight and parallel to the floor. 15.92% students did not use a wrist rest. 32.36% participants had thighs that were not horizontal with a 90-to-110-degree angle of the hip. 20.37% students did not bend their knees at 90 degrees and did not have their thighs parallel to the floor. 20.54% students did not have their feet rest firmly on the floor or footrest. 46.57% participants did not use the adjustable chair with back support and armrest. 34.41% students' seat pans did not cushion. 22% students did not follow the chair ergonomics, and their hips were not slightly higher than their knees when seated back in the chair. 10% students admired that there was not a fist distance of space between the front of the chair and the back of the knee when seated back fully. 17.8 % students did not have their viewing screen at eye level. 11% students had no glare on the screen. 5.82% students did not have a comfortable level of brightness, contrast, and font size. 5.82% students did not have their elbow on the same height as the keyboard while typing. 6.67% participants did not have a

mouse/input device at the same level and close to the keyboard. 18.83% participants did not straighten their wrists while using the keyboard. 24.65% students did not use an external mouse, an external keyboard, and an external monitor. 49.31% participants did not use a laptop on their laps. 29.79% participants did not keep their wrists straight while using their mobile. 43.32% students did not try to hold their phone in both hands (Table 4).

Table 4: Association Ergonomics with Nordic MSK

Variables	MSK Pain			OR	95% CI	p-value
	No	Yes				
Body Position						
Is your head upright?	No	13	229	0.077	0.042-0.140	0.000
	Yes	145	197	Ref		
Are your eyes looking slightly downward without bending your neck?	No	9	259	0.039	0.019-0.078	0.000
	Yes	149	167	Ref		
Are your neck and trunk facing forward /upright?	No	15	229	0.090	0.051-0.159	0.000
	Yes	143	197	Ref		
Is your trunk about to be perpendicular to the floor?	No	9	229	0.052	0.026-0.105	0.000
	Yes	149	197	Ref		
Is your shoulder relaxed and perpendicular to the floor?	No	9	199	0.069	0.034-0.139	0.000
	Yes	149	227	Ref		
Are your upper arms close to the body, not extended outward?	No	10	159	0.113	0.058-0.222	0.000
	Yes	148	267	Ref		
Is your elbow bent close to the body, not extended outward?	No	8	129	0.123	0.059-0.258	0.000
	Yes	150	297	Ref		
Are your forearms, wrists, and hands straight and parallel to the floor?	No	12	90	0.294	0.156-0.554	0.000
	Yes	146	336	Ref		
Is there a wrist rest?	No	15	93	0.376	0.210-0.670	0.001
	Yes	143	333	Ref		
Are your thighs horizontal with a 90-to-110-degree angle of the hip?	No	9	189	0.076	0.038-0.152	0.000
	Yes	149	237	Ref		
Is your knee bent 90 degrees and your thighs parallel to the floor?	No	9	119	0.156	0.077-0.135	0.000
	Yes	149	307	Ref		
Are your feet resting firmly on the floor or footrest?	No	9	120	0.154	0.076-0.312	0.000
	Yes	149	306	Ref		
Chair Ergonomics						
Are you using the adjustable chair with back support and armrests?	No	9	272	.034	0.017-0.069	0.000
	Yes	149	154	Ref		
Is the curve of the lower back supported in the chair?	No	13	159	.151	0.083-0.274	0.000
	Yes	145	267	Ref		
Is the seat pan cushioned?	No	6	201	.044	0.019-0.102	0.000
	Yes	152	225	Ref		
Are the hips slightly higher than the knees when seated back in the chair?	No	10	129	0.156	0.079-0.305	0.000
	Yes	148	297	Ref		
Is there a first distance of space between the front of the chair and the back of the knee when seated back fully?	No	13	59	0.558	0.297-1.048	0.066
	Yes	145	367	Ref		
Desk Usage						
Are you using the desk?	No	105	169	3.01	2.054-4.419	.000
	Yes	53	257	Ref		

Screen Ergonomics						
Is the curve of the lower back supported in the chair?	No	9	104	0.187	0.092-0.380	.000
	Yes	149	322	Ref		
Is there a glare on the screen?	No	12	64	0.465	0.244-0.887	0.018
	Yes	146	362	Ref		
Is it adjustable to a comfortable level of brightness, contrast, and font size?	No	96	34	17.85	11.1-28.6	0.000
	Yes	62	392	Ref		
Screen Ergonomics						
While typing, the elbow should be at the same height as the keyboard.	No	22	34	1.767	0.992-3.149	0.051
	Yes	136	392	Ref		
Is the mouse/input device at the same level and close to the keyboard?	No	9	39	0.599	0.283-1.268	0.176
	Yes	149	387	Ref		
Are your wrists straight while keyboarding or using the mouse (not angled or drooping)?	No	6	110	0.113	0.049-0.264	0.000
	Yes	152	316	Ref		
Do you use an external mouse, an external keyboard, and an external monitor?	No	96	144	3.03	2.079-4.422	0.000
	Yes	62	282	Ref		
Do you use a laptop on your lap?	No	96	288	0.742	0.508-1.083	0.121
	Yes	62	138	Ref		
Are you typing at high speed?	No	139	343	1.77	1.036-3.026	0.035
	Yes	19	83	Ref		
Do you keep your wrist straight while using your mobile?	No	21	174	.222	0.135-0.365	0.000
	Yes	137	252	Ref		
Do you try to hold your phone in both hands?	No	106	253	1.394	0.949-2.047	0.089
	Yes	52	173	Ref		
Do you text at high speed?	No	129	343	1.076	0.674-1.720	0.758
	Yes	29	83	Ref		

DISCUSSION

This descriptive study aimed to determine the prevalence of musculoskeletal pain and its association with the impact of ergonomics among university students studying online during covid-19 pandemic. Results of the study demonstrated marked increases in the prevalence of musculoskeletal pain among university students, together with changes in the physical activity level of students before and during quarantine. The association of these variables was also found with ergonomics, followed by students during quarantine. Results of a previous study conducted on students contradict our results, as they reported a slight reduction in musculoskeletal pain during quarantine [13, 14]. The phenomenon of a significant increase in musculoskeletal pain during quarantine was associated with the sedentary lifestyle of students, the socioeconomic status of students, and a long period of quarantine. The highly prevalent areas of musculoskeletal pain observed suggested that females most commonly experienced pain before quarantine and during quarantine. No significant association was found between musculoskeletal pain and gender ($p>0.05$), with both

genders having an equal chance of getting musculoskeletal pain during quarantine. The highly prevalent areas of musculoskeletal pain were observed in previous researches which deduced that the chances of women suffering more significantly from musculoskeletal pain increase by spending more time in a sitting position as compared to men [15-17]. This study suggests that a high percentage of participants with a sedentary lifestyle and middle socioeconomic status experienced musculoskeletal pain during covid-19 pandemic. Strong evidence is present in previous studies that report that musculoskeletal pain is strongly associated with a sedentary lifestyle [18]. A study conducted on sedentary office workers reported that the majority of workers reported pain in the shoulder and neck region as a result of their sedentary behavior [19]. The neck, shoulder, and lower back were the major areas affected during quarantine. Previous researches report that more stress is imposed on the neck, shoulders, and lower back while in a sitting position due to lack of proper chair usage, poor body postures, and improper ergonomics [13]. During Covid-19 quarantine, the percentage of musculoskeletal pain in the cervical, shoulder, wrist/hand, and lower back regions increases. Positive association has been found between physical activity and musculoskeletal pain ($p < 0.05$), as the majority of participants who performed strength and aerobic exercises experienced no pain before quarantine. During covid-19 quarantine inverse relationship was observed between musculoskeletal pain and physical activity, as with decreasing levels of physical activity, there was an increased prevalence of musculoskeletal pain. Results were supported by previous studies, which also depicted that the chances of getting musculoskeletal problems increase by spending more time sitting in front of screens of gadgets [20]. During covid-19 quarantine majority of participants who suffered from neck and shoulder pain did not follow proper body mechanics, as their heads were not upright, their eyes were not looking slightly downward, their trunk was not perpendicular to the floor, and their shoulders were not relaxed and perpendicular to the floor while using different gadgets during online classes. A positive association was found between improper body mechanics and musculoskeletal pain ($p < 0.05$). Evidence is present from previous studies which also report that the usage of laptops, computers and mobile phones causes poor wrist positions while typing on keyboard or touching the screens of mobile phones, arms were not supported that increased the stress on upper back and flexion at neck in attempt to look down at the screen that increased stress on neck causing neck pain [21, 22]. The majority of the participants did not use an external mouse, external keyboard, or external monitor, and the top

of the viewing screen was not at eye level, which increased the prevalence of neck, shoulder, arm, and back pain. The findings were concurrent with previous studies, which also suggested that awkward postures of neck, arms, and back caused discomfort, which could be corrected by using external monitors with the top of the screen at eye level, an external mouse, and an external keyboard. The majority of participants who suffered from shoulder and back pain during covid-19 quarantine did not use an adjustable chair with armrests, and back was not well supported in the chair. Positive association was found between musculoskeletal pain and a chair without armrests ($p < 0.05$). Previous studies suggested that there are increased chances of musculoskeletal pain in the neck and head, shoulders, lower back, hips, and legs due to seating positions without back support. More flexion in neck and back pain is triggered by glare on the screens, that caused several body postures [13, 14].

CONCLUSIONS

This study concluded that there was a high prevalence of musculoskeletal pain among university students. The majority of participants suffered from musculoskeletal pain due to a lack of appropriate ergonomics, and many students developed neck pain, shoulder pain, wrist/hand pain, and lower back. During covid-19 quarantine significant association was found between musculoskeletal pain and physical activity, as the majority of participants who performed strength and aerobic exercises experienced no pain before quarantine. Positive association was also found between MSK pain and improper body mechanics.

Authors Contribution

Conceptualization: HY

Methodology: HY, NS

Formal analysis: NS, SH

Writing and Drafting: NS, SH, AUK, MK

Review and Editing: HY, NS, SH, AUK, MK

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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