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Original Article

The Effect of Online Teaching on the Prevalence of Musculoskeletal Pain in Female Students during the Covid-19 Pandemic

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ABSTRACT

Background: The Covid-19 pandemic has led to the largest disruption in education systems in human history. The use of online teaching increased daily, finally affecting more than 200 million students worldwide. The aim of the present study was to compare the prevalence of musculoskeletal pain in female students during the Covid-19 pandemic with the pre-pandemic period.

Methods: This cross-sectional study was performed in two stages: before the Covid-19 pandemic (October to December 2019) and during the Covid-19 pandemic (January to February 2020). The Nordic Musculoskeletal Questionnaire (NMQ) was used to determine the musculoskeletal pain points. Data was analyzed using the t-test, McNemar test, and logistic regression in SPSS ver. 22, and a $P<0.05$ was considered as the significance level.

Results: A significant decrease in the hours of physical activity (PA) was observed during the pandemic (3.17±2.17 hours/week) ($P<0.001$) compared to the pre-pandemic period (4.76±4.92 hours/week), and a significant increase in hours of using e-learning aids was seen during the pandemic (45.29±23.24 hours/week) compared to the pre-pandemic period (13.01) ($P<0.001$). The McNemar test revealed a significant difference in musculoskeletal pain in nine areas before and during the Covid-19 pandemic ($P<0.001$). The results of the regression test also showed that increasing the hours of online teaching and decreasing the hours of PA increased the odds ratios of increasing musculoskeletal pain.

Conclusion: Based on the present results, changing the teaching method during the Covid-19 pandemic and reducing physical activity has led to an increase in musculoskeletal pain in students.

Introduction

According to the Global Burden of Disease Study (GBD), musculoskeletal disorders (MSDs) significantly lead to lifelong disability [1]. A total of 53% of adults have experienced musculoskeletal pain (MSP) at least once in their lifetime, and 15% have experienced it at least once a week [2]. MSDs are also one of the most important causes of pain among students [3]. MSP can negatively affect a student's body and mind, and the prevalence of MSP in children has been reported to be 48% [4, 5]. MSP was reported to be more prevalent in the neck (35.8%, 33%, 28.5%, 17.1%), shoulder (37.9%, 36.9%, 30.9%, 26.3%, 17.3%), (waist 19.9%, 17.4%, 13.1%), back (27.4%, 20.8%), the upper back (20.2%), and the knees (26.7%, 22.6%) [6-8]. In addition to the

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wide range of MSP points, its adverse effects can impact all aspects of a person's existence, such as emotional, social and behavioral dimensions, and may even lead to physical symptoms such as headache, stomach pain, or sleep problems [5, 9].

MSP, a consequence of today's machine life, can occur because of long hours spent viewing the screens of devices such as mobile phones, tablets, computers, and televisions; a lack of physical activity and immobility; improper ergonomic conditions at home; overweight; and obesity [10, 11].

A new viral disease called SARS-Cov-2 was reported in 2019. The new coronavirus, which causes Covid-19 disease, originated in Wuhan, China and quickly became a widespread global pandemic due to its rapid spread rate [12]. According to World Health Organization statistics, as of May 22, 2021, there were 165,772,430 cases infected with Covid-19 and 3,437,545 deaths [13]. Covid-19 has affected various aspects of people's lives, such as health, economic, political, social, psychological, environmental, and education systems of people all over the world, including Iran. As mentioned, the education system was also affected by the Covid-19 pandemic [14]. With the onset of the Covid-19 pandemic in many countries of the world (including Iran), schools and higher education centers closed, and students were taught and supervised by their teachers through the "online teach education" process. Online teach refers to the strategy that the instructor and the learner are separated by a physical distance, and students not attending the classroom take part in online courses using devices such as computers, mobile phones, and tablets in the information and communication technology platform [15]. While spending a long time using these devices to learn and do homework, many adopt an inappropriate physical posture, such as prolonged bent neck and back posture, which can cause MSP in various areas of the body, i.e. the neck and back [14, 15].

Considering the complications of MSDs and their treatment costs, identifying and preventing risk factors for them can be effective in reducing the pain and suffering caused by related problems and reducing the cost of treatment. This goal clearly demonstrates the need for such studies, especially during the Covid-19 pandemic. Little information regarding the effect of the prevalence of Covid-19 on the incidence of MSP in Iranian students is available. The need for up-to-date information on the prevalence and causes of MSP during the Covid-19 pandemic led researchers to conduct this study on the effects of the Covid-19 pandemic on the prevalence of MSP by comparing the above-mentioned disorders in the pre-pandemic period and during the pandemic among female students in Hamadan, Iran.

Methods

This cross-sectional study was conducted in two phases, i.e. before the Covid-19 pandemic (October to December 2019) and during the Covid-19 pandemic (January to February 2020). The Ethics Committee of Hamadan University of Medical Sciences approved the protocol and dates of the current study, following the Helsinki ethical standards (Code of ethics: IR.UMSHA.REC.1397.983). In the first phase, the multi-stage sampling method was used to select the samples. To this end, the city of Hamedan was first divided into four municipal districts and then into two educational districts. A number of primary and first secondary schools were randomly selected from each educational district, and then a number of classes and students were randomly selected from each grade. Sampling was continued randomly until the number of 523 students was reached [2].

First, the research aim and the confidentiality of personal information were explained to the students. Then, a demographic questionnaire was given to them. The Nordic body map was used to determine MSP points [16]. In this map, the human body is divided into parts of the neck, shoulders, elbows, wrists, upper back, lower back (waist), thighs, knees, and ankles. To record information about MS, students were asked to identify any pain or discomfort in their muscles, joints, and skeletal system experienced over the prior month in the map shown above. The students were asked to record the presence of pain or discomfort as well as the formation and occurrence of MSP in NMQ. Information about each student's physical activity, including the number of hours engaging in any type of physical activity, each type of exercise or physical game, and the number of hours using digital devices (personal computer, laptop, cell phone, and tablet) for teaching and learning purposes as well as hours spent playing computer games was recorded. These questionnaires were completed during exercise class. Exclusion criteria included having muscle and joint disease, nervous system disorders, and fractures or dislocations in the prior year. An electronic questionnaire was used in the second phase of the study due to quarantine conditions and restrictions on traffic and social communication. Thus, the above-mentioned questionnaire was designed online and sent to previous samples through social network. After collecting information and excluding incomplete questionnaires, 494 complete questionnaires were obtained and used in statistical analysis. Data analysis was conducted using the t-test, McNemar test, and logistic regression in SPSS ver. 22, and a P value <0.05 was considered as the significance level.

Results

A total of 523 and 494 female students entered the study in the first and second phases of the study, respectively. Demographic information (mean and standard deviation) of the participants is shown in Table 1.

The results of the paired t-test showed a significant difference between the time spent using digital education

Table 1: Demographic information of samples (n=523 people)

Variable	Standard deviation±Mean
Age (years)	10.7±1.81
Height (cm)	132.21±11.77
Weight (kg)	30.73±10.24
Body mass index (kg/m^2)	17.17±3.39

tools and the hours of physical activity before and after the Covid-19 pandemic (P<0.0.001) (Table 2).

Frequency of musculoskeletal disorders before and during the Covid-19 pandemic are shown in Table 3.

Results of the McNemar test revealed a significant difference in MSP levels in nine areas before and during the Covid-19 pandemic (Table 4).

Logistic regression (Tables 5 and 6) was used to evaluate the odds ratio of pain according to the hours spent using digital education tools and time spent in physical activity before and after the Covid-19 pandemic (Tables 5 and 6).

The odds ratio (OR) of neck pain decreased by 30% with each hour of physical activity (P=0.484) and increased by 1.5% per hour of tablet use (P=0.193). Moreover, the OR of shoulder pain decreased by 1.52% per hour of physical activity and increased by 1.036% per hour of tablet use. The OR of elbow pain decreased by 0.01% per hour of physical activity and increased by 1.47%

Table 2: Descriptive information of variables

Variable	Before Covid-19 pandemic	During Covid-19 pandemic	P value
Hours of using digital education tools (hours/week)	14.29±13.01	45.29±23.24	P<0.001*
Physical activity (hours/week)	6.76±4.92	2.17±3.32	P<0.001*

*Paired T-test

Table 3: Frequency of musculoskeletal disorders before and during the Covid-19 pandemic

Variable	During Covid-19 pandemic	Before Covid-19 pandemic
Neck	98 (19.8%)	17 (3.4%)
Shoulders	93 (19.29%)	4 (0.8%)
Elbows	9 (1.9%)	8 (1.6%)
Wrists	12 (2.4%)	9 (1.8%)
Upper back	73 (14.8%)	5 (1.0%)
Lower back	7 (1.4%)	3 (0.6%)
Thighs	21 (4.3%)	6 (1.2%)
Knees	55 (11.1%)	12 (2.4%)
Ankles	10 (2.02%)	3 (0.61%)

Table 4: Frequency of musculoskeletal pain before and during Covid-19 pandemic according to McNemar test

Variable	Before+		Before-		P value
	After+	After-	After+	After-	
Neck	17 (3.4%)	477 (96.6%)	98 (19.8%)	396 (80.2%)	0.000*
Shoulders	4 (0.8%)	490 (99.2%)	93 (19.29%)	401 (80.71%)	0.000*
Elbows	8 (1.6%)	486 (98.4%)	9 (1.9%)	485 (98.1%)	0.000*
Wrists	9 (1.8%)	485 (98.2%)	12 (2.4%)	482 (97.6%)	0.000*
Upper back	5 (0.1%)	489 (99.9%)	73 (14.8%)	421 (85.2%)	0.000*
Lower back	3 (0.6%)	491 (99.4%)	7 (1.4%)	487 (98.6%)	0.000*
Thighs	6 (1.2%)	488 (98.8%)	21 (4.3%)	473 (95.7%)	0.01*
Knees	12(2.4%)	482 (97.6%)	55 (11.1%)	439 (88.9%)	0.000*
Ankles	3(0.61%)	491 (99.39%)	10 (2.02%)	484 (97.98%)	0.000*

P<0.05

Table 5: Logistic regression test results (odds ratios of musculoskeletal pain before the Covid-19 pandemic)

Variable	Independent variable	OR	95%CI	P value
Neck	Physical activity	0.703	(0.413-1.050)	0.484
	Tablet (h)	1.015	(0.97-1.050)	0.193
Shoulders	Physical activity (h)	1.525	(0.867-2.684)	0.143
	Tablet (h)	1.036	(0.98-1.095)	0.207
Elbows	Physical activity (h)	0.993	(0.983-2.217)	0.060
	Tablet (h)	1.476	(0.961-1.026)	0.665
Wrists	Physical activity (h)	0.746	(0.413-1.348)	0.332
	Tablet (h)	0.971	(0.913-0.413)	0.344
Upper back	Physical activity (h)	0.333	(0.097-1.143)	0.080
	Tablet (h)	0.999	(0.917-1.069)	0.793
Lower back	Physical activity (h)	0.802	(0.433-1.485)	0.482
	Tablet (h)	1.01	(0.968-1.073)	0.476
Thighs	Physical activity (h)	0.989	(0.945-1.340)	0.120
	Tablet (h)	1.622	(0.882-2.983)	0.620
Knees	Physical activity (h)	0.988	(0.953-1.025)	0.533
	Tablet (h)	1.770	(1.052-2.980)	0.031*
Ankles	Physical activity (h)	0.949	(0.875-1.030)	0.210
	Tablet (h)	1.052	(0.986-1.123)	0.124

* Unit of measurement = hour.

Table 6: Results of logistic regression test (odds ratio of musculoskeletal pain during Covid-19 pandemic

Variable	Independent variable	OR	95%CI	P value
Neck	Physical activity (h)	0.986	(0.97-0.99)	0.024*
	Tablet (h)*	1.24	(1.06-1.45)	0.007*
Shoulders	Physical activity (h)	0.959	(0.943-0.976)	0.000*
	Tablet (h)	1.039	(0.903-1.195)	0.593
Elbows	Physical activity (h)	0.944	(0.616-1.447)	0.792
	Tablet (h)	0.860	(0.781-0.948)	0.002*
Wrists	Physical activity (h)	0.517	(0.295-0.907)	0.021*
	Tablet (h)	1.016	(0.990-1.043)	0.242
Upper back	Physical activity (h)	0.898	(0.758-1.063)	0.210
	Tablet (h)	1.018	(1.00-1.032)	0.009*
Lower back	Physical activity (h)	0.916	(0.707-1.186)	0.505
	Tablet (h)	1.006	(0.997-1.016)	0.199
Thighs	Physical activity (h)	0.905	(0.676-1.210)	0.499
	Tablet (h)	1.068	(1.033-1.103)	0.000*
Knees	Physical activity (h)	1.016	(0.902-1.145)	0.788
	Tablet (h)	1.003	(0.991-1.016)	0.642
Ankles	Physical activity (h)	1.037	(0.583-1.843)	0.902
	Tablet (h)	1.017	(0.979-1.055)	0.386

*Unit of measurement = hour

per hour of tablet use. The OR of wrist pain decreased by 26% per hour of physical activity and increased by 0.97% per hour of tablet use. The OR of upper back pain decreased by 67% per hour of physical activity and increased by 0.99% per hour of tablet use. The OR of lower back pain decreased by 20% per hour of physical activity and increased by 1.01% per hour of tablet use. The OR of thigh pain decreased by 0.02% per hour of physical activity and increased by 1.622% per hour of tablet use. The OR of ankle pain decreased by 06% per hour of physical activity and increased by 52% per hour of tablet use.

The odds ratio (OR) of neck pain decreased by 0.2% with each hour of physical activity (P=0.024) and increased by 1.24% per hour of tablet use (P=0.193). Moreover, the OR of shoulder pain decreased by 0.041% per hour of physical activity and increased by 0.39% per hour of tablet use.

The OR of elbow pain decreased by 0.056% per hour of physical activity and increased by 1.47% per hour of tablet use. The OR of wrist pain decreased by 0.483% per hour of physical activity and increased by 1.016% per hour of tablet use. The OR of upper back pain decreased by 0.102% per hour of physical activity and increased by 0.018% per hour of tablet use. The OR of lower back pain decreased by 0.84% per hour of physical activity and increased by 1.006% per hour of tablet use. The OR of thigh pain decreased by 0.095% per hour of physical activity and increased by 1.068% per hour of tablet use. The OR of knee pain decreased by 1.016% per hour of physical activity and increased by 1.003% per hour of tablet use. The OR of ankle pain decreased by 1.037% per hour of physical activity and increased by 1.017% per hour of tablet use.

Discussion

According to the results of the present study, the prevalence of MSP before and during the Covid-19 pandemic period was 3.4% and 19.29% in the neck, 0.8% and 19.8% in shoulders, 1.6% and 1.9% in elbows, 1.8% and 2.4% in wrists, 0.1% and 14.8% in the back region, 0.6% and 1.4% in lower back, 1.2% and 4.3% in thighs, 2.4% and 11.1% in knees, and 0.6% and 2.02% in ankles, respectively. According to the results, the prevalence of pain in all nine points was significantly higher during the pandemic (Table 3) than in the pre-pandemic period (Table 4). The most to least prevalence of pain during the pandemic was related to the neck, shoulders, back, knees, thighs, wrists, ankles, elbows, and back, respectively. The present study showed a significant increase in hours spent using digital education tools during the pandemic (24 hours per week) (p=0.001) compared to the pre-pandemic period (p=13.01) (Table 2), and this variable could predict the prevalence of knee pain in the pre-pandemic period and the prevalence of pain in the neck, back, elbows, and thighs during the pandemic period.

Although a high prevalence of MSP, especially in the neck, shoulders, and back of students, was reported before the Covid-19 pandemic [8, 13, 16, 17], it seems that changes in teaching and learning methods during the pandemic in using digital teaching devices such as tablets and mobile phones is one of the important reasons for the increase in MSP among students [11]. One of the studies that were consistent with the present one regarding the increased prevalence of MSP during the Covid-19 pandemic was conducted by Patel and Shet. They reported an increase in the prevalence of MSP (51%) in Indian students during the pandemic compared to the pre-pandemic period and found the highest rates of MSP in the neck, back, and shoulders, respectively. They also reported longer hours spent using electronic devices during the pandemic compared to pre-pandemic, and this issue was directly associated with the increased prevalence of MSP [14]. Amero et al. also reported a higher prevalence of MSP in the head, neck, and back of students during the Covid-19 pandemic compared to the pre-pandemic period, which in turn increased the hours spent using computers, laptops, and cell phones [18]. Other studies have reported the prevalence of back,

neck, and shoulder pain in students following the use of laptops as well as the prevalence of shoulder and neck pain following the use of mobile phones for educational purposes [18, 19].

Improper postural habits when using electronic teaching devices explain the increased prevalence of MSP, especially in the neck and shoulders [8, 20].

Pressure applied to intervertebral joints during neck flexion causes musculoskeletal pain [21]. Fars et al. studied risk factors for neck pain in students, and 100% of them reported neck and back flexion when using a mobile phone or tablet [22]. It should also be noted that a sitting position may lead to a greater change in the head-neck angle than a standing position when using a mobile phone [23]. Arins et al. found a positive relationship between neck flexion and pain in this area. Neck pain increases significantly particularly in people who bend their necks at least 20 degrees while studying and maintain this posture for more than 70% of their study time [24]. By considering inappropriate postural habits, such as neck and back flexion, as well as long-term use of digital education tools, we will achieve a better interpretation of the study results. Considering that the hours spent using mass media have increased during the Covid-19 pandemic [25], which has also been confirmed in the present study, and the direct relationship between the number of hours spent using digital education tools with musculoskeletal pain, the cause of the increased MSP in students can be better interpreted. Prolonged use of a mobile phone causes constant mechanical stress on muscles, tendons, ligaments, and intervertebral joints, especially the neck, shoulders, and lower back, which in turn can lead to MSP and postural abnormalities. The present study also found an increased incidence of MSP in wrists and fingers [8, 26-30].

The present study demonstrated a significant decrease in hours of physical activity during the pandemic (2.17±3.32 hours/week) ($P<0.001$) compared to the pre-pandemic period (6.76±4.92 hours/week) (Table 2). Hours of physical activity during the pandemic period could predict the prevalence of pain in the neck, shoulders, and wrists.

The World Health Organization (WHO) recommends an average of 60 minutes per day of moderate-to-vigorous intensity physical activity for three days a week in people aged 6 to 17 years to increase muscle and bone strength [31]. Regular physical activity is important to keeping the body in good physical condition, maintaining the correct level of physical fitness factors such as endurance, muscle strength, and flexibility, and preventing joint dryness, which thus prevents the development of musculoskeletal pain [32]. Quarantining has given rise to changes in time spent in and type of physical activity during the pandemic, and some studies have reported a decrease in the level of physical activity during quarantine [8]. Homami et al. investigated physical activity during the Covid-19 pandemic and stated that the use of some home physical activities such as aerobic exercise using an ergometer and treadmill, body weight training, dancing and active video gaming can be helpful in counteracting the harmful physical and mental effects of quarantining on children and adults [33]. Other studies have highlighted the importance of regular daily physical activity at home during quarantine in order to ensure health, maintain the body's immune system, and combat the physical and mental effects of this period [34]. Consistent with the present study, Ghasemi et al. reported an increase in the prevalence of neck, shoulder, back, and lower back pain among university professors during the Covid-19 quarantine and a decrease in hours of physical activity at the workplace, during leisure time, and while exercising. A negative correlation was found between neck, wrist, and knee pain and level of physical activity among the professors [8, 35]. Similar to the present study, Silva et al. found that hours spent using digital tools and physical activity could predict pain in the neck, middle back, back, shoulders, knees, ankles, and wrists [7].

The current study found that physical activity reduces the risk of MSP in the neck and shoulders and plays a supportive and preventive role against MSP, which is consistent with a study by Shaun et al. that showed one hour of physical activity could effectively prevent neck, shoulder, and back pain in Chinese students [8].

Adopting a posture that causes static loading in the upper body is positively associated with neck and shoulder pain, but engaging in physical activities that yield dynamic loading in the upper body is negatively related to pain in these areas. Increasing the strength and improving the metabolism of the mentioned muscles, which occurs after engaging in physical activities, reduces MSP in the neck and shoulders, which is consistent with the results of a seven-year study by Sivola et al. [36], who found that dynamic loading in the upper body during exercise would reduce the prevalence of neck and shoulder pain in the coming years.

Conclusion

Considering that MSP and MSDs can affect the health of students and cause more serious physical, psychological, and even economic complications in the future, taking measures to engage in regular physical activity and manage the time spent using digital education tools, such as dividing teaching and learning time during the day and week, can be effective in reducing the incidence of MSP and MSDs.

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