Original Article :

The association between perceived stress and musculoskeletal pain during e-learning among health-profession students

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Abstract

Background and Aims:

Musculoskeletal pain is among students' most common complaints while learning. University students report high-stress levels, which is a risk factor for developing musculoskeletal problems. Shifting from face-to-face learning to e-learning during the COVID-19 pandemic may have increased college students' time spent on computers. This increase may lead to musculoskeletal problems. This study aimed to assess the correlation between musculoskeletal pain, stress, and time spent on e-learning among female university students.

Methods:

Participants were recruited through an online survey examining demographic data, students' attitudes, the 'Nordic Musculoskeletal Questionnaire' and the 'Perceived Stress Scale'. The survey was distributed, through university email lists and social media, to medical college students at Princess Noura bint Abdulrahman University in Saudi Arabia.

Results:

Respondents' musculoskeletal symptoms during the seven days previous to their responses were present at the neck (55%), lower back (48%), shoulders (43%), and upper back (34%). A positive, significant, weak correlation between musculoskeletal symptoms and total time spent on e-learning ($p = 0.27$, $p < 0.01$) and stress ($p = 0.3$, $p < 0.01$). Students with high-stress scores and negative attitudes toward e-learning had more musculoskeletal pain intensity.

Conclusions:

Respondents' high prevalence of musculoskeletal symptoms appears to be affected by the high stress levels associated with health-profession students' time spent on e-learning. Students' negative attitude toward e-learning correlates with both musculoskeletal pain and stress levels.

Keywords:

Musculoskeletal pain, stress, university students, Nordic Musculoskeletal Questionnaire, Perceived Stress Scale.

Introduction

Musculoskeletal disorder (MSK) is a group of inflammatory, degenerative conditions that affect muscles, joints, ligaments, tendons, blood vessels, and peripheral nerves[1]. It is considered a major burden for individuals' lives, health systems, and the social care system [2]. Musculoskeletal pain significantly affects an individual's quality of life, causing sleep disturbances, decreasing work hours and productivity, and reducing participation in recreational activities [3]. Musculoskeletal pain is among students' most common complaints while learning due to academic stress[1]. The prevalence of musculoskeletal pain among university students is estimated at about 88.5% for medical students and 64.9% non-medical students [4]. Osama, Ali, and Malik reported that the most common sites of posture-related musculoskeletal discomfort among students in Pakistan were the neck (75.7%), lower back (62%), upper back (59%), and right and left shoulders (53% and 44%, respectively) [5]. Moreover, Silva et al. reported concluded that 65% of adolescents complain about MSK pain due to their use of electronic devices [6]. These authors also noted that the worst-affected pain area was the thoracolumbar spine (46.9%), followed by the upper extremity (20%), the cervical area (18.5%), and the scapular region (15.5%) [6].

University students are believed to be one of the populations that report high stress levels due to several causes, due to exam load, fears of the future, peer competition, temporal pressures, and relationships with family, friends, and colleagues [1]. Additionally, medical students have higher academic stress compared to non-medical students[7]. Some studies have found that there is a relationship between academic stress and MSK pain [1,8,9]. Tantawy et al, 2017, reported that the neck and back region were the commonly reported site of pain [1]. Additionally, the prevalence of musculoskeletal pain due to academic stress is higher among females [10].

In 2020, the coronavirus disease 2019 (COVID-19) pandemic forced most countries to shut down schools and shift to e-learning as the only mode of education[11]. The use of computers and the internet is the major component of e-learning, which requires massive amounts of time spent using electronic devices. This global transition in education may affect students physically and mentally. Almoayad et al. reported high levels of anxiety among health students due to e-learning during the pandemic [12]. Additionally, using technology for long periods and extended hours is among the consequences of e-learning that may cause musculoskeletal problems [13].

Hakala et al. found that using a computer for more than 14 hours per week correlated with computer-associated musculoskeletal pain among adolescents [14]. Furthermore, increased time spent on computers and e-devices is considered a risk factor for MSK complaints, especially spinal column pain 6.

Several studies have assessed students' attitudes toward e-learning. Linjawi and Alfadda examined e-learning from a readiness perspective, concluding that students demonstrate a high level of online skills, strongly believe in online technologies' importance for learning and personal purposes, and were most ready overall for e-learning adaptation during the fourth year of undergraduate studies compared to their internship year 15. However, no previous study has assessed students' attitudes toward the MSK pain and stress imposed by e-learning.

The rise in online education might continue even after the end of the COVID-19 pandemic. Due to the gap in the literature concerning students' attitudes toward e-learning and its influence on MSK pain, as well as the stress imposed by e-learning and the association between these factors, resolving this gap may prevent extended musculoskeletal disability at an early age and enable appropriate action. Therefore, the current study aimed to determine the association between musculoskeletal pain, stress, and time spent on e-learning among university students. Additionally, we sought to identify students' attitudes toward e-learning and its effect on stress and MSK symptoms.

Methods

Design and sampling

This study is cross-sectional. Its target population is medical health college students at Princess Noura bint Abdulrahman University (PNU). The study used a convenient-sample technique. Based on the total 2,283 medical health college students at PNU during the 2020-2021 academic year, the sample size calculated with a 95% confidence interval was 329 students. All female health-profession students aged 18 years and over who were studying at one of PNU's four medical colleges that semester were included. Additionally, students were excluded if they had been diagnosed with any musculoskeletal neurological condition (e.g., fibromyalgia) or autoimmune neurological conditions (e.g., multiple sclerosis). Students who had experienced musculoskeletal trauma or fracture or musculoskeletal surgery within the previous six months were also excluded.

Questionnaire

A Microsoft Forms survey was used for this study's questionnaire, to which a link

was sent via university email lists and social media, targeting PNU medical health students who were eligible for participation. All participants confirmed their consent and voluntary participation online prior to completing the questionnaire. This research project was conducted after obtaining ethical approval from the institutional review board at PNU (IRB log number 21-0138).

The questionnaire contained four sections: demographic information, the 'Nordic Musculoskeletal Questionnaire' (NMQ), the 'Perceived Stress Scale' (PSS-10), and students' attitudes toward e-learning. In total, the questionnaire comprised 42 questions in the English language that took respondents 10–15 minutes to answer.

Demographic characteristics

Questions related to respondents' age, specialty, academic level, and grade point average (GPA) were used to rule participants out based on the exclusion criteria. Additionally, information related to e-learning was obtained via questions related to respondents' average hours spent daily on virtual classes, studying or completing assignments, and taking clinical or practical classes, as well as the types of devices they used and their preferred body position (sitting on a desk, laying on a sofa, or moving around) during virtual classes, studying, or completing assignments.

The 'Nordic Musculoskeletal Questionnaire' (NMQ)

The NMQ is a standardized questionnaire used to detect musculoskeletal pain and symptoms according to nine body parts: the neck, shoulders, elbows, wrists and hands, upper back, lower back, hips and thighs, knees, and ankles and feet [16]. Its four questions focus on the most-experienced symptoms, their presence over the previous 12 months and the previous seven days, whether respondents have consulted a physician, and whether the symptoms affect respondents' daily life for each body region [16]. Respondents must answer the questions with 'yes' or 'no'. The mean score for each body region for each participant is calculated to identify severity levels (0.25, 0.50, 0.75, or 1), which higher scores indicate more severity [16].

The NMQ was selected for the current study to assess the prevalence of musculoskeletal pain and symptoms among students during e-learning. The NMQ has a construct validity score of 0.8 to 1 and a test-retest reliability of 0.77 to 1 [16]. This tool has been use-tested with various occupations, such as bus and shunter drivers [17], dentists [18], nurses [9], forestry workers [19], and students [20].

The 'Perceived Stress Scale' (PSS)

The PSS was used to assess stress levels among students during e-learning. The PSS is a self-reported, 10-item Likert scale. It measures the degree to which an individual perceives life aspects as unpredictable, uncontrollable, or overloading within the last month 21. The scale's scores range from 0 to 4 (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often). The PPS score for all questions must be calculated using 0 = 0, 1 = 1, 2 = 2, 3 = 3, and 4 = 4, except for questions 4, 5, 7, and 8, whose scores are reversed (0 = 4, 1 = 3, 2 = 2, 3 = 1, 4 = 0). PSS scores range from 0 to 40. Higher scores indicate higher perceived stress. Scores between 0 and 13 indicate less stress, and scores between 14 and 26 indicate moderate stress, while scores between 27 and 40 indicate high stress. Roberti, Harrington, and Storch reported a reliability of $\alpha = 0.89$ and a convergent validity of 0.73 for this scale [22]. This tool has been used with students [21], the parents of chronically ill children, substance abusers, healthy undergraduate students, and HIV-positive patients [23], and full-time teachers [24].

Attitudes toward e-learning and musculoskeletal pain

Seven questions were developed by the authors to assess students' attitudes toward e-learning. Participants chose to which extent they agreed with the statements using a Likert scale (5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree). Total scores for the seven questions indicated positive, neutral, or negative attitudes. Scores between 7 and 14 indicated a positive attitude, scores of 15–24 indicated a neutral attitude, and scores of 25–35 indicated a negative attitude. Face validity of this section was obtained from four experts, and the internal consistency was $\alpha = 0.79$.

Data analysis

Statistical analysis was conducted using SPSS software (version 27.0). Descriptive data were presented as percentages using Excel or mean ± SD with a cut-off point for significance of $p < 0.05$. For analysis, a test was selected according to the results of a normality test. Correlations using Spearman's correlation coefficient were assessed between NMQ scores, PSS scores, students' attitudes, time spent on virtual classes and studying, and NMQ body regions. A Kruskal-Wallis test was used to compare NMQ scores between the PSS categories and students' attitudes categories. A comparison of PSS values across the students-attitude categories was assessed using a Kruskal-Wallis test. An internal consistency test was conducted for the PSS and students' attitudes to as-

sess the items' reliability.

Results

Participants

In total, 125 respondents completed the study's questionnaire within the required time period. All respondents were female students at PNU. Their mean age was 21± (1.4) years old. Of the total, 117 were eligible for participation, and eight participants were excluded due to their matching our exclusion criteria. While 57% of participants were students at the health and rehabilitation college, the other 43% represented other health majors, such as nursing, medicine, dentistry, and pharmacy. Participants' GPAs were high, with most students (63%) having excellent grades and the remainder of students having very good (35%) and good (3%) grades (Table 1).

Table 1: Demographic data with subdivision and percentage.

Demographic data	Subdivisions	N (%)
Collages	Medicine	9 (8%)
	Dentistry	9 (8%)
	Nursing	16 (14%)
	Pharmacy	16 (14%)
	Health and Rehabilitation	67 (57%)
Level of study	Level 3 - 4	28 (24%)
	Level 5 - 6	31 (26%)
	Level 7 - 8	32 (27%)
	Level 9 - 10	12 (10%)
	Level 11 - 12	14 (12%)
GPA	Excellent	72 (63%)
	Very Good	40 (35%)
	Good	3 (3%)
Hours spend daily on virtual classes	2 – 4 hours	33 (28%)
	5 – 7 hours	64 (55%)
	8 – 10 hours	20 (20%)
Hours spent per day studying and doing assignments	2 – 4 hours	33 (28%)
	5 – 7 hours	53 (45%)
	8 – 10 hours	31 (26%)
Devices used for E-learning	Laptop	70 (31%)
	Desktop	4 (2%)
	Ipad	98 (44%)
	Phone	52 (23%)
Preferred body position during E-learning	Sitting on a desk	72 (56.6%)
	Laying on a sofa	77 (61.6%)
	Moving around	13 (10%)
	Using only one position	35 (28%)

Most participants (55%) indicated that they spent five to seven hours on virtual classes daily, while 28% spent two to four hours and (20%) spent eight to ten hours. Regarding their hours spent studying and completing assignments daily, 45% took five to seven hours, 28% spent two to four hours, and 26% spent eight to 10 hours. The device used by participants for their e-learning varied, with 23% using a phone, 2% using a desktop computer, 44% using an iPad, and 31% using a laptop (Table 1).

Musculoskeletal pain

Table 2 demonstrates the prevalence of musculoskeletal symptoms as per the NMQ responses. MSK pain was present in each region over the seven days previous to participants' responses as follows: the neck (55%), the lower back (48%), the shoulders (43%), and the upper back (34%). Meanwhile, MSK pain was present in each region in the last 12 months as follows: the neck (79%), the shoulders (72%), the upper back (62%), and the lower back (65%).

The 'Perceived Stress Scale'

According to the PSS results, 26% of students had high stress levels, 70% had moderate stress levels, and 4% had mild stress levels. A Kruskal-Wallis test revealed a statistically significant difference in NMQ scores between the different PSS categories: $\chi2(2) = 8.27$, $p = 0.016$, $df = 2$. A significant difference was also observed between the PSS groups vis-à-vis low stress and severe stress ($p = 0.01$) and vis-à-vis

Table 2: Students' responses to each question of the NMQ, as number and percentage N (%)

Body region	Symptoms in the last 12 months	Impairment in DLAs	Seeing a physician due to symptoms	Symptoms in the last 7 days
Neck	92 (79%)	34 (29%)	7 (6%)	64 (55%)
Shoulder	84 (72%)	25 (21%)	8 (7%)	50 (43%)
Upper back	73 (62%)	15 (13%)	4 (3%)	40 (34%)
Elbow	18 (15%)	6 (5%)	0 (0%)	12 (10%)
Wrist/ hand	58 (50%)	25 (21%)	3 (3%)	29 (25%)
Lower back	76 (65%)	22 (19%)	4 (3%)	56 (48%)
Hip/ thigh	35 (30%)	9 (8%)	1 (1%)	15 (13%)
Knee	53 (45%)	17 (15%)	3 (3%)	25 (21%)
Feet/ankle	31 (26%)	10 (9%)	3 (3%)	15 (13%)

moderate stress and severe stress (p = 0.04).

Attitudes

Most participants (58%) exhibited a negative attitude toward e-learning, while 38% expressed a neutral attitude and only 4% expressed a positive attitude (Figure 1). A significant difference was found among the three categories of students' attitudes (positive, neutral, and negative): $\chi 2(2) = 16.88$, p = 0.001, df = 2. A post-hoc test revealed a significant difference between positive attitudes and negative attitudes (p = 0.003) and between neutral attitudes and negative attitudes (p = 0.001). Moreover, a comparison of PSS scores across attitude categories showed a significant difference: $\chi 2(2) = 18.19$, p = 0.001, df = 2. A significant difference was also observed between positive attitudes and negative attitudes (p = 0.029) and between neutral attitudes and negative attitudes (p = 0.001).

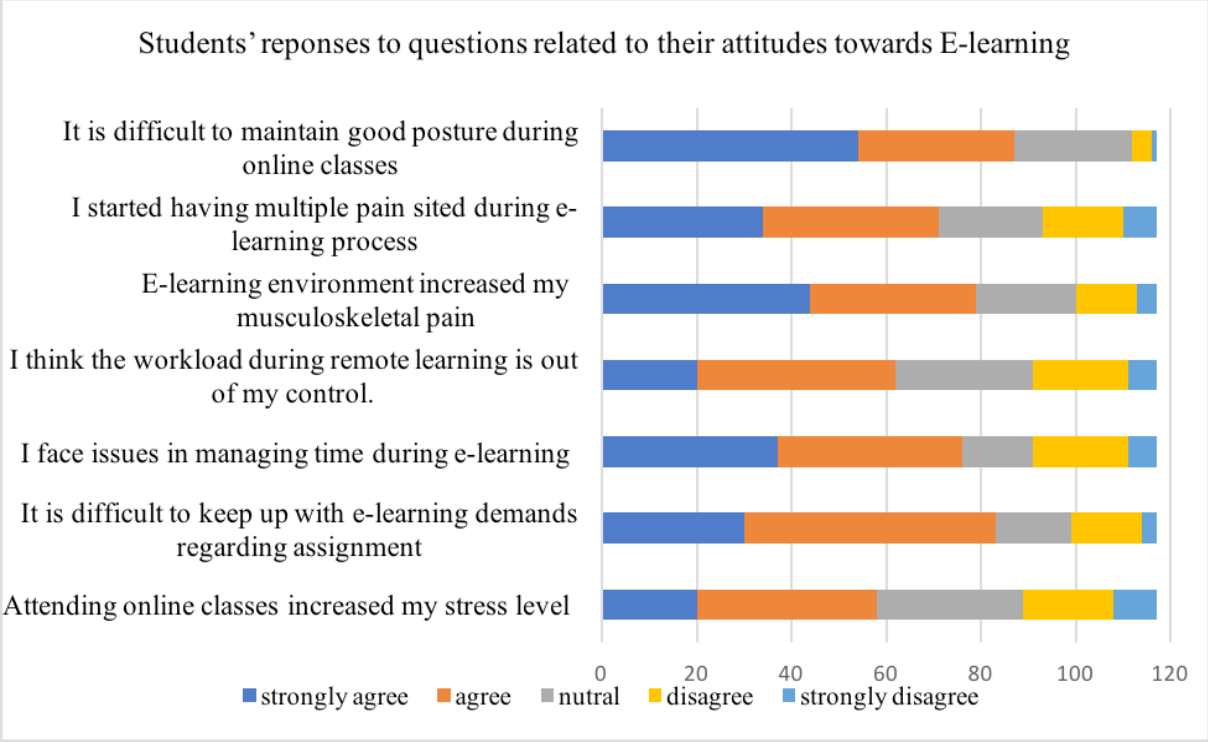


Figure 1: Students' responses to questions related to their attitudes towards E-learning

Correlations

The correlation between the NMQ, the PSS, attitudes, and time spent on e-learning

A positive, significant, weak correlation was found between the NMQ and total time spent on virtual classes and studying (p = 0.27, p < 0.01), between the NMQ and the PSS (p = 0.30, p < 0.01), and between the NMQ and students' attitudes (p = 0.35, p < 0.01) (Table 3). Moreover, a further correlation was found between students' stress, the NMQ for the neck region (p =

Table 3: Correlations among NMQ, PSS, Students' attitudes and Total time spent during virtual classes and studying.

	NMQ	PSS-10	Students' attitudes	Total time spend during virtual classes and studying
NMQ	1	0.30**	0.35**	0.27**
PSS-10		1	0.52**	0.16
Students' attitudes			1	0.27**
Total time spend during virtual classes and studying				1

** correlation is significant at 0.01 level.

0.31, $p < 0.01$), and the NMQ for the lower back region ($p = 0.23$, $p < 0.05$) (Table 4). Additionally, a weak, positive, significant correlation was found between students' attitudes and their total time spent on virtual classes and studying ($p = 0.27$, $p < 0.01$). A positive, significant, moderate correlation was found between students' stress and attitudes ($p = 0.52$, $p < 0.01$). On the other hand, no significant correlation was found between students' stress and their total time spent on virtual classes and studying (Table 3). Students' attitudes correlated positively with pain in the neck region ($p = 0.37$, $p < 0.01$), the upper back region ($p = 0.32$, $p < 0.01$), the wrist and hand region ($p = 0.21$, $p < 0.05$), and the lower back region ($p = 0.18$, $p < 0.05$) (Table 4).

Table 4: Correlation between NMQ regions, PSS-10 and students' attitudes.

	Neck	Shoulder	Upper back	Elbow	Wrist& hand	Lower back	Hip& thigh	Knee	Ankle & feet	PSS-10	Students' attitudes
Neck	1	0.51**	0.49**	0.12	0.30**	0.43**	0.26**	0.23**	0.13	0.31**	0.37**
Shoulder		1	0.33**	0.30**	0.14	0.20**	0.15	0.26**	0.11	0.14	0.18*
Upper back			1	0.22**	0.29**	0.39**	0.26**	0.33**	0.10	0.18*	0.32**
Elbow				1	0.39**	0.07	0.29**	0.27**	0.42**	0.06	0.04
Wrist& hand					1	0.24**	0.29**	0.27**	0.24**	0.09	0.21*
Lower back						1	0.37**	0.24**	0.10	0.23*	0.18*
Hip& thigh							1	0.23**	0.26**	0.09	0.17
Knee								1	0.31**	0.19	0.01
Ankle & feet									1	0.14	0.11
PSS-10										1	0.49**
Students' attitudes											1

** correlation is significant at 0.01 level.

* Correlation is significant at 0.05 level.

The correlation between NMQ scores for different body regions

The highest correlation was detected between the neck and the shoulders ($p = 0.51$, $p < 0.01$), followed by the neck and the upper back region ($p = 0.49$, $p < 0.01$) and the neck and the lower back region ($p = 0.43$, $p < 0.01$). The lowest correlation was de-

tected between the shoulder region and the lower back region ($p = 0.20$, $p < 0.01$) and between the shoulders and the knee region ($p = 0.26$, $p < 0.01$). The hip and thigh region showed a positive, significant, weak correlation with the knee region ($p = 0.23$, $p < 0.01$) (Table 4).

Discussion

This study investigated the prevalence of students' musculoskeletal pain imposed by e-learning, and its relationship to their perceptions of e-learning, and their perceived stress levels. The current study found a positive correlation between musculoskeletal pain, stress level, and time spent on e-learning among university students. Additionally, students' attitudes toward e-learning were significantly correlated with stress levels and MSK symptoms.

Participating students had experienced MSK symptoms during the seven days previous to their questionnaire responses in the neck, lower back, shoulders, and upper back. Algarni et al. [20] sought to determine the prevalence and associated factors of neck, shoulder, and back pain among medical students in Riyadh, Saudi Arabia. They used a modified version of the standardized NMQ, and their results showed that 24.1% of students had reported neck pain in the week previous to their response, while 25.6% had reported shoulder pain [20]. Whereas, the findings of the current study showed a higher percentage of students reporting neck pain (55%), and shoulder pain (43%) reporting shoulder pain over the period of seven days. A similar cross-sectional study by Dighriri et al. [25] at Jazan University, Saudi Arabia, sought to determine the prevalence and associated factors of neck, shoulder, and low-back pain among medical students. These authors found that 44.8%, 52.5%, and 33.4% of respondents reported the respective symptoms in the previous seven days[25]. Another study by Hasan et al. [4] aimed to examine the prevalence of musculoskeletal pain among university students, including medical and nonmedical students. The study reported higher incidents of MSK pain for medical students (88.5%) compared to nonmedical students (64.9%). Additionally, the neck, back, and legs were the most common pain sites [4].

NMQ scores appear to correlate with different body regions; therefore, students who experience MSK symptoms in one region tend to also experience MSK symptoms in another region. This tendency could be related to the biomechanics of students' posture during studying or to students' not changing positions, instead remaining in one position for long periods when learning. According to the current study's results, the percentage of students

who remained in one position during virtual classes was 28% . Despite approximately half of the students spending an average of five to seven hours daily on virtual classes and studying, students usually sat in a single position for long periods, which may lead to musculoskeletal symptoms. Because of symptoms' transition from different body regions, a further investigation of the factors associated with the spread of musculoskeletal symptoms is important. The current study was not intended to explain these findings; rather, it has sought to highlight pain patterns among different body regions.

Furthermore, participants' total time spent on virtual classes and studying significantly positively correlated with musculoskeletal symptoms in this study. More time spent on virtual classes and studying was associated with musculoskeletal symptoms. This finding resembles a similar finding by Dockrell, Bennett, and Culleton-Quinn [26] about computer use and musculoskeletal symptoms among health sciences undergraduate university students. Those authors found a trend toward an increased prevalence of musculoskeletal symptoms as average daily computer use increased [26]. Hakala et al. studied computer-associated musculoskeletal pain among adolescents, concluding that using a computer for 14 hours or more per week was related to moderate to severe computer-associated pain in all anatomical sites [14].

Additionally, the prevalence of MSK pain could be due to increased stress levels during e-learning. Studies have reported that the spread of musculoskeletal symptoms is associated with an increased prevalence of mental health complaints [27, 28]. Findings from the current study showed that, according to the PSS-10 scale, 26% of students had high stress levels, 70% had moderate stress levels, while the final 4% had mild stress. levels. Comparing the results gathered from the PSS with the results found by the NMQ, we found a significant correlation between stress and pain during e-learning. Also, a significant, positive correlation was found between PSS results and participants' attitudes. However, no significant correlation was found between the PSS and the total time spent on virtual classes and studying.

A study by Abdulghani et al. [29] found that stress was higher among medical students after the COVID-19 pandemic and its related increase in e-learning, revealing a significantly higher prevalence of overall stress among female medical students (40%) compared to male students (16.6%). Furthermore, 22.3% of students felt they had experienced severe stress since they did not prefer online learning [29]. Similarly, students who had not believed in—or

who had refused—online learning or disagreed that 'there is pleasure in the study due to COVID' had significantly higher stress—21.5% mild, 17.8% moderate, and 21.2% severe [29]. Another study conducted in India found that students were generally stressed during the pandemic and its related lockdown, and female students were more stressed than male students since they were constantly under pressure because of life events and apprehensive about their studies [30].

Attitudes include a combination of feelings and behaviors directed towards a particular thing [31.32]. Accordingly, students were asked to select the degree to which they agreed with statements designed to identify whether students believed e-learning had contributed to their MSK pain and stress. In the current study, about 62% of students had negative attitudes toward e-learning; therefore, they believed engaging in e-learning had contributed to their stress and MSK symptoms. Meanwhile, 34% harbored neutral views, and only 4% exhibits a positive attitude. This study found a positive, weak correlation between students' attitudes and NMQ scores. Attitude scores were directly proportional to NMQ scores for the neck region, upper back region, wrist and hand region, and lower back region. Attitude scores increased with increased total time spent on virtual classes and studying. Students who reported higher PSS scores had high attitude scores; therefore, students with higher stress are more likely to express negative attitudes toward e-learning. This finding aligns with findings by Almoayad et al. [12], who assessed students' perceptions and experiences during the COVID-19 pandemic. These authors found that about 24.4% of students reported high levels of anxiety and that students' feelings of responsibility and independence in their learning had increased, correlating negatively with their anxiety levels [12].

The current study encountered several limitations. Its main limitation was its small sample size which was limited to female medical health college students at PNU. We intended to recruit 329 students. However, only 125 students participated and only 117 participants were included. Other limitations are pertaining to the study design and the bias that coup be imposed by online questionnaires. Further studies involving larger samples of non-medical health college students in a variety of universities and genders might provide more representative findings. Additionally, future research may consider the effect of certain postures and types of devises on musculoskeletal pain and stress.

Conclusions

A high prevalence of MSK pain and high stress levels were detected among university students during e-learning. Severe stress was associated with higher disability per the NMQ. Negative attitudes toward e-learning influenced both MSK pain and stress levels. Further studies should investigate the spread of symptoms between anatomical sites and an efficient way to manage stress since stress influences musculoskeletal systems, as this study has shown. With the continued shift to e-learning, efforts must be undertaken to prevent extended musculoskeletal disability and increased stress levels among future healthcare providers.

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