Prevalence and factor associated work-related musculoskeletal disorders of students in virtual classroom

Phatcharawadee Srirug [a,b], Khemika Jongjit [a], Orawanya Muansri [a], Yanisa Somton [a], Nutthida Kongbankhong [a], Praphatson Sengsoon [a,b,*]

[a] Department of Physical Therapy, School of Allied Health Sciences, Walailak University, Nakhon Si Thammarat, Thailand
[b] Movement Sciences and Exercise Research Center, Walailak University (MoveSE-WU), Nakhon Si Thammarat, Thailand

ARTICLE INFO	ABSTRACT
	Objective: This study examined the prevalence of musculoskeletal disorders (MSDs) and their associated factors among 1st to 4th-year students at Walailak University who attended virtual classrooms for 1 week, 1 month, and 3 months. *Method:* A cross-sectional study was conducted among 382 students aged 18–23 years with no history of musculoskeletal disease or psychiatric disorder who had at least three months of virtual classroom learning. Statistical analysis was performed using chi-squared and Fisher's exact tests. *Results:* Most musculoskeletal abnormalities occurred in the shoulders, head and neck, and lower back at 1 week, 1 month, and 3 months, respectively. At one week and one month in virtual classrooms, the occurrence of MSDs among the students was correlated with psychosocial factors ($p < 0.05$), and at three months, MSDs were associated with personal factors such as body mass index and psychosocial factors ($p < 0.05$). *Conclusion:* Stress management for students should be implemented in virtual classrooms to prevent MSDs.

1. Introduction

Work-related musculoskeletal disorders (WMSDs) are injuries and discomfort caused by repetitive behaviors that involve performing the same activities for a long period, which increases the risk of disease. The disease area with the highest prevalence of MSDs was the lower back, with the most prevalent condition in 134 of the 204 countries analyzed [1].

From 2019 to 2020, the UK Department of Labor Statistics found 480,000 people with WMSDs and an incidence rate of 1420 per 100,000. Workers in many occupations lost more than 8.9 million working days in a year, accounting for 30.00% of cases of WMSDs and 27.00% lost days at work [2]. The statistics of occupational musculoskeletal diseases reported by the Health Data Center (HDC) system in Thailand show a high yearly morbidity rate, reflecting occupational diseases among the working age. The most common occupational musculoskeletal diseases among the working age include lower back pain, tendinitis, and myofascial pain syndrome [3]. Moodley et al. have assessed WMSDs among undergraduate nursing students at the University of Johannesburg, and it was found that the prevalence of musculoskeletal disorders among students was 83.00% out of 125 students, most of whom had lower back pain (LBP)

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* Corresponding author. Physical Therapy Department, School of Allied Health Sciences, Walailak University, Nakhon Si Thammarat 80160, Thailand.
E-mail address: praphatson.kl@wu.ac.th (P. Sengsoon).

(81.10%). Fifty-nine (47.2%) nursing students spent under 10 h per week sitting in the classroom. Time spent sitting in the classroom showed a statistically significant effect on the prevalence of MSDs [4].

The factors associated with MSDs can be divided into three main categories: individual, physical, and psychosocial factors [5]. Concerning individual or personal factors, a previous study showed that females were more at risk than males [6], older men were at higher risk than younger men [7], persons with an overweight body mass index (BMI) were at a higher risk than those with an underweight BMI [8], non-exercisers were at a higher risk than exercisers, and smokers were at a higher risk than non-smokers [9]. Physical factors are often related to improper equipment and workstations, work posture, work experience, work time, and break time [10]. A previous study found that an overly high keyboard position was associated with the occurrence of thoracic symptoms among students in their higher undergraduate years of study. Computer use for >3 h/day is related to the occurrence of lumbar symptoms [11]. Psychosocial factors such as work demands, job control, and social support at work are of concern and can increase work-related risk factors that cause or exacerbate MSDs [12].

Due to the worldwide spread of COVID-19, social distancing has been implemented to reduce its spread. Many universities have modified teaching using e-learning systems conducted on digital platforms [13]. Virtual classrooms refer to learning experiences facilitated through the Internet or online with computers used for teaching through electronic media systems, which has become a new form of education in a world without borders [14]. Various types of electronic devices have been used for learning, such as desktop computers, notebook computers, tablets, and smartphones, which are accompanied by risk factors such as poor working posture, device design, and workstations that result in MSDs [15]. In 2021, the use of notebook computers for online learning among children was 40.60%, and the use of smartphones for online learning was 61.70% [16]. Desktop computers, notebook computers, and smartphones are essential learning tools in today's virtual classrooms. The advantage is that learning can occur anywhere, including outside the classroom. However, there may be disadvantages, such as sitting for a long period, inappropriate ergonomic posture, and inappropriate workstations.

No studies have investigated the incidence of WMSDs among students enrolled in virtual classrooms. Therefore, this research aimed to study the prevalence of and factors associated with MSDs among students in virtual classrooms. The results of this study can help identify methods to prevent WMSDs among students in virtual classroom settings.

2. Materials and methods

2.1. Ethical consideration

The Human Research Ethics Committee of Walailak University, Thailand, approved the study protocol (Reference Number: WUEC-22-066-01).

2.2. Study population

A cross-sectional study using convenience sampling was conducted between March and April 2022. The participants included 382 students studying at Walailak University in Thailand, selected by convenience sampling. A Google Forms questionnaire was created and sent to the undergraduate students. All participants were informed of the study protocol and signed a consent form before participating.

A total of 382 participants (100%) were divided according to their years of study as a percentage of the total number of students. There were 127 1st-year students (33.12%), 101 2nd-year students (26.56%), 68 3rd-year students (17.74%), and 86 4th-year students (22.58%). All participants were 18–23 years old, studying in virtual classrooms (learning experience through the inter/online with computers in an asynchronous classroom where students interacted with instructors and other students and were not dependent on their physical location for participating in this online learning experience) for more than three months and had never received a medical diagnosis or physical therapy for bone diseases or muscles that could affect the use of electronic devices in virtual classrooms. The participants were not menstruating or pregnant, not clinically diagnosed with psychiatric disorders, and had never been injured by exercise or playing sports. In addition, the participants were never involved in any accidents that could have affected their use of electronic devices in the virtual classrooms during the 3-month study period. Moreover, the participants did not engage in supplementary occupations/activities that could affect muscles and exacerbate orthopedic injuries and had not undergone other forms of learning, such as internships or cooperative education.

2.3. Procedure

The questionnaire used in this study consisted of two parts. Part I consisted of a questionnaire on prevalence, including questions that assess the symptoms and duration of musculoskeletal pain over the past 1 week, 1 month, and 3 months. The collected data were derived from three main aspects. Part II consisted of a questionnaire on personal, physical, and psychosocial factors. Personal factors included sex, age, BMI, exercise, and smoking status. Physical factors included using electronic devices, posture, workstation, online learning experience, and study duration and rest. Psychosocial factors included psychological distress, which was classified according to the measured stress level (developed by Suanprung Hospital, Ministry of Public Health, Thailand). The Suanprung Stress Test-20 (SPST-20) was shown to have an overall Cronbach's alpha greater than 0.7 [17] and consisted of 20 items, each of which had a scoring criterion ranging from 1 (slightly stressed) to 5 (most stressed). The total score was no more than 100, where a score of 0–23 points indicated a low level of stress, a score of 24–41 points indicated a moderate level of stress, a score of 42–61 points indicated a

high level of stress, and a score of 62 points indicated severe stress. SPST-20 was used to assess participants' stress levels after studying virtual classroom events. The questionnaire used in this study was answered by ten Walailak University students who were part of the sample group. This test was conducted to test the clarity and suitability of the questions. The characteristics of the sample group followed the same criteria as those of the participants. The questionnaire was then improved to clarify the questions that were unclear, following which the researcher handed this questionnaire to three musculoskeletal experts (experience in musculoskeletal diseases >5 years) who assessed and assigned a content validity score of $\geq$0.50 (IOC: Index of item objective congruence).

The researcher corrected the questions in the questionnaire following the advice of the experts. The final version of the questionnaire was answered by 30 students to test its clarity and suitability. The completed questionnaire was used to create an online questionnaire to collect data from Walailak University students in Thailand. Subsequently, information obtained from the inquiry was collected, and the data were statistically analyzed.

2.4. Sample size calculation

The required sample size was estimated by using the Taro Yamane formula as shown in Equation (1).

$$n = \frac{N}{1 + NE^2} \tag{1}$$

where N represents the population size (1st to 4th-year students at Walailak University), n represents the sample size, and E represents the significance level (0.05). Therefore, the required sample size was 382.

2.5. Statistical analysis

Data were analyzed using SPSS Version 26.0. Statistical significance was set at $P < 0.05$. Descriptive statistics were used to analyze the frequency and percentage of personal, physical, and psychosocial factors. The relationships between personal, physical, and psychosocial factors and WMSDs at 1 week, 1 month, and 3 months were analyzed using chi-squared and Fisher's exact tests.

3. Results

3.1. Prevalence of musculoskeletal disorders among students in virtual classrooms at 1 week, 1 month, and 3 months

The prevalence of MSDs in nine body parts, including the head and neck, shoulders, arms, elbows, wrists and hands, upper back, lower back, hips and thighs, knees, ankles, and feet. The most common MSDs found at one week among the 382 participants, with a 100% response rate, the most common MSDs found at 1 week are shown in Table 1. At 1 week, the most common areas with MSDs were the shoulders of 237 participants (62.04%), head and neck of 233 participants (60.99%), and lower back of 225 participants (58.90%). At one month, the most common areas with MSDs were the head and neck (223 participants, 58.38%), arms and elbows (205 participants, 53.66%), and shoulders (180 participants, 47.12%). At 3 months, the most common areas with MSDs were the shoulders (190 participants, 49.74%), head and neck (185 participants, 48.43%), and lower back (174 participants, 45.55%).3.2 Frequency and percentage of personal, physical, and psychosocial factors.

3.1.1. Personal factors

From the survey of the prevalence and factors associated with MSDs among students in virtual classrooms, most of them were female, aged 20–21 years, had an average BMI of 21.76 ± 4.42 kg/m^2, exercised regularly, and did not smoke, as shown in Table 2.

3.1.2. Physical factors

A survey of students in virtual classrooms found that the most common posture and foot placement were hunchbacks in a chair with the chin out and feet flat on the ground. Tablets were the main devices used in virtual classrooms. The Bluetooth pen was the most popular accessory used with tablets. The workstation consisted of a table with a chair and a backrest. The participants had more than 6–9 months of virtual classroom experience. The duration of each class with no break time was 2 h. The average study duration in class was 5–6 h per day and 5–6 days per week. The rest time between classes ranged from 1 to 15 min, as shown in Table 3.

3.1.3. Psychosocial factors

According to the Suanprung Stress Test (SPST-20), the stress level among most students in virtual classrooms was moderate, as

Table 1
Prevalence of WMSDs at 1 week, 1 month, and 3 months (n = 382).

WMSDs	1 week	1 month	3 months
	n (%)	n (%)	n (%)
No	47 (12.30)	62 (16.20)	112 (29.30)
Yes	335 (87.70)	320 (83.80)	270 (70.70)

Table 2
Personal factors data (n = 382).

Personal factors	n (%)
Sex	
Male	78 (20.40)
Female	304 (79.60)
Age (years)	
18–19	116 (30.40)
20–21	173 (45.30)
22–23	93 (24.30)
BMI (kg/m^2)	
< 18.50	87 (22.80)
18.50–22.90	196 (51.30)
23–24.90	40 (10.50)
25–29.90	30 (7.90)
> 30	29 (7.60)
Exercise	
No	128 (33.51)
Yes	254 (66.49)
Smoking	
No	376 (98.43)
Yes	6 (1.57)

shown in Table 4.

3.2. Association between personal, physical, and psychosocial factors and musculoskeletal disorders at 1 week, 1 month, and 3 months

Personal factors associated with MSDs at 3 months were significantly associated with BMI and musculoskeletal disorders. The statistical significance level of the association was high in the same direction (phi = 0.158, $p < 0.05$).

Psychosocial factors were significantly associated with MSDs at 1 week at a very high level and in the same direction (phi = 0.289, $p < 0.05$). At one month, there was a statistically significant association with MSDs at a high level and in the same direction (phi = 0.297, $p < 0.05$). At three months, there was a statistically significant association with MSDs at a high level and in the same direction (phi = 0.247, $p < 0.05$), as shown in Table 5.

4. Discussion

This study assessed MSDs among Walailak University students attending virtual classrooms over one week, one month, and three months and found that most students tended to have an awkward posture owing to the choice of tablets (76.18%) and smartphones (54.97%) as their main devices. During the study period, these devices resulted in a hunchbacked sitting posture and a protruding neck (43.19%). Body discomfort and disorders were observed in the shoulders (62.04%), head and neck (60.99%), and lower back (58.90%). In the United States, the prevalence of symptoms during device use is 67.9%. Most symptoms were reported in the neck (84.6%), upper back/shoulder areas (65.4%) [18]. In Thailand, a few studies have surveyed the prevalence of WMSDs among university students and office workers and found that WMSDs were prevalent in the neck, shoulders, and lower back areas [19–21]. This may be due to inappropriate ergonomic posture, prolonged awkward posture, long working hours, or inadequate resting time. Moreover, a study on the prevalence and risk factors of musculoskeletal disorders among smartphone users also found that the common areas of WMSDs were in the upper part of the body, where factors that affected the risk of MSDs included posture during smartphone use, duration of smartphone use, and characteristics of smartphone use [22].

BMI and psychosocial factors were significantly associated with MSDs at a significance level of 0.05. Factors that were not related to MSDs with statistically significant at the 0.05 level were sex, age, physical activity, smoking, and physical factors. This study found that most participants' BMI was within the normal range (18.50–22.90 kg/m^2) at 51.30%. However, previous studies have mentioned that even with a well-proportioned body or normal BMI, people who sat for long hours in bad posture developed imbalanced muscle function, thereby leading to musculoskeletal disorders [7,22].

In addition, regarding age, a previous study found that younger people using a computer for more than 3 months developed repetitive movements, thereby leading to cumulative trauma disorder (CTD) [23] and pain symptoms from abnormal muscle function.

Some of the main theories have linked stress-induced physiological changes to MSDs. These physiological changes include increased blood pressure, fluid pressure, reduced growth function, decreased sensitivity to pain, pupil dilation, increased muscle tension, and the body's heightened sensitivity. Psychosocial factors are associated with MSDs [24]. A previous study examined the association between psychosocial risk factors and musculoskeletal disorders in Indian IT professionals. The prevalence of existing pain (shoulders, neck, and lower back) was significantly associated with high psychosocial risk factors [25]. Moreover, an Occupational Safety and Health Administration (OSHA) report on ergonomics found that work-related stress accumulated over prolonged periods of time and developed increased MSDs [26].

Physical factors, including changing posture and taking breaks between sessions in virtual classrooms, were not correlated with musculoskeletal disorders. A study by Dagne et al. found that people who worked in the same position for long periods of time without

Table 3
Physical factors data (n = 382).

Physical factors	n (%)
Posture	
Sit on chair with straight back look forward and feet above floor	3 (0.79)
Sit on floor with straight back and look forward	7 (1.83)
Sit on chair with straight back neck flexion and feet above floor	22 (5.76)
Sit on chair with straight back neck flexion and feet on floor	28 (7.33)
Sit on chair with straight back look forward and feet on floor	28 (7.33)
Prone with back extension	52 (13.61)
Sit on floor with hunch back and chin out	77 (20.16)
Sit on chair with hunch back chin out and feet above floor	81 (21.20)
Sit on chair with hunch back chin out and feet on floor	84 (21.99)
Number of use the main device	
Use 2 devices together	347 (90.84)
Use 1 device	35 (9.16)
Main device	
Desktop computer	35 (9.16)
Notebook computer	193 (50.52)
Tablet	291 (76.18)
Smartphone	210 (54.97)
Accessory device	
Microphone	28 (7.33)
Keyboard	75 (19.63)
Mouse	156 (40.84)
Earphone	258 (67.54)
Bluetooth pen	304 (79.58)
Workstation	
Table and chair without backrest	7 (1.80)
Sofa and floor	12 (3.10)
Computer desk and adjustable chair sitting	38 (9.90)
Bed	57 (14.90)
Low folding table and floor	66 (17.30)
Table and chair with backrest	202 (52.90)
Virtual classroom learning experience	
> 3–6 months	106 (27.70)
> 6–9 months	113 (29.60)
> 9–12 months	62 (16.20)
> 1 year	101 (26.40)
Duration of study in class per a day	
1–2 h	30 (7.90)
3–4 h	104 (27.20)
5–6 h	129 (33.80)
7–8 h	100 (26.20)
> 8 h	19 (5.00)
Frequency of study in class per a week	
1–2 days	42 (11.00)
3–4 days	113 (29.60)
5–6 days	173 (45.30)
1 week	54 (14.10)
Resting time between classes	
1–15 min	237 (62.00)
16–30 min	29 (7.60)
31–45 min	26 (6.80)
46–60 min	60 (15.70)
> 1 h	30 (7.90)

Table 4
Psychosocial factors data (n = 382).

Psychosocial factors	n (%)
Mild stress	34 (8.90)
Moderate stress	137 (35.90)
High stress	133 (34.80)
Severe stress	78 (20.40)

breaks were three times more likely to develop musculoskeletal injuries [27].

The most common sitting posture and foot placement were sitting hunchback on a chair with the neck forward and feet flat on the ground (21.20%). In addition, most participants were aged 18–23 years, exercised regularly, did not smoke, and had a suitable

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Table 5
Association between factors and work-related musculoskeletal disorders (WMSDs) (n = 382).

Factors	WMSDs (p-value)		
	1 week	1 month	3 months
Personal factors			
Sex	0.588	0.645	0.552
Age	0.661	0.503	0.971
BMI	0.621[a]	0.321	0.048* (Phi = 0.158)
Exercise	0.093	0.939	0.200
Smoking	0.452[a]	0.343[a]	0.763[a]
Physical factors			
Main device	0.473[a]	0.886[a]	0.818[a]
Posture	0.094[a]	0.220[a]	0.184
Workstation	0.980[a]	0.910	0.227[a]
Experience	0.608	0.996	0.641
Average duration of study in class	0.100	0.954	0.359
Duration of study in class per a day	0.340	0.092	0.889
Duration of study in class per a week	0.102	0.530	0.810
Rest time between classes	0.567[a]	0.863[a]	0.768
Psychosocial factors	0.000*	0.000*	0.000*
Mild stress	(Phi = 0.289)	(Phi = 0.297)	(Phi = 0.247)
Moderate stress			
High stress			
Severe stress			

Note: * Statistically significant.
[a] Fisher's exact test.

workstation that could reduce the risk of accumulating musculoskeletal injuries. A study by Mehrparvar et al. found that people with ergonomic knowledge could adjust their behavior at work and workstations and implement appropriate regular exercise. This could reduce the risk of developing WMSDs [28]. For these reasons, students can be instructed to maintain the correct posture while studying in virtual classrooms, and teachers can be required to add some interactive links in the teaching method to make students properly active rather than passively listening for a long period of time. Teachers can increase recess and shorten the time of each class to manage effective study time, as stated by Saumya et al. who found that college students' increased screen time on electronic devices during COVID-19 led to a high prevalence of musculoskeletal disorders [29]. Activities can also be designed specifically for students to lead them in exercises during recess in order to reduce the incidence of musculoskeletal diseases.

5. Conclusion

This study found that musculoskeletal disorders among students in virtual classrooms were at their highest prevalence at one week. These disorders commonly occur in the shoulders, head and neck, and lower back. Among the factors affecting musculoskeletal disorders, including personal, physical, and psychosocial factors, only psychosocial factors were associated with MSDs among students in virtual classrooms at 1 week and 1 month. BMI in personal factors, along with psychosocial factors, was associated with MSDs among students in virtual classrooms at 3 months of age.

The results of this study may persuade students to recognize and pay attention to the occurrence of MSDs. Moreover, the information from this study can be used to identify ways to encourage effective learning in virtual classrooms. The basic information obtained can also be used as guidelines for further in-depth studies.

6. Limitations of the study

The data used in this study were obtained from the students at Walailak University. Therefore, the results can possibly be applied only to universities or colleges that provide teaching and learning similar to Walailak University, such as 5–6 h per day for the duration of study in class, 5–6 days per week for the frequency of study in class. In addition, this study used convenience sampling techniques, in which variables such as learning style and the psychological state of the faculty might have had potential effects on student responses. The use of stratified sampling techniques is recommended for future studies.

Author contribution statement

Phatcharawadee Srirug: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Khemika Jongjit, Orawanya Muansri, Yanisa Somton and Nutthida Kongbankhong: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Praphatson Sengsoon: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

No data was used for the research described in the article.
Supplementary content related to this article has been published online at [URL].

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e18461.

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