BPR MCS Bulletin of Pioneering Researches of Medical and Clinical Science

Bulletin of Pioneering Researches of Medical and Clinical Science

Available online: https://bprmcs.com
2024 | Volume 3 | Issue 1 | Page: 50-57

The Impact of Non-Classroom Teaching on Musculoskeletal Pain in University Students Amid the COVID-19 Pandemic

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Abstract

The COVID-19 confinement disrupted daily routines and physical activity patterns among Spanish university students. This study investigated musculoskeletal pain, physical activity behaviors, and perceived stress levels in student populations from two universities in Spain during the lockdown. A cross-sectional survey was conducted with 1,198 participants (70.6% women). Data collection involved the Kuorinka Modified Nordic Questionnaire, the Perceived Stress Scale, and a questionnaire on exercise habits. Findings showed a significant decline in musculoskeletal pain ($p < 0.001$) in both male and female students, along with a 12.5% increase in the proportion engaging in physical activity on a regular basis. Strength training emerged as the most preferred activity (15.1%), particularly among women. These results suggest that health authorities should consider strategies to promote not only greater participation in exercise but also balanced and varied activity types to support student well-being and quality of life.

Keywords: Perceived stress, Musculoskeletal disorders, University population, Online learning, Physical activity, COVID-19

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How to Cite This Article: Jaafar NH, Abd Rahman I, Ter KZ, Ahmad B. The Impact of Non-Classroom Teaching on Musculoskeletal Pain in University Students Amid the COVID-19 Pandemic. Bull Pioneer Res Med Clin Sci. 2024;3(1):50-7. https://doi.org/10.51847/UZ9DyvWUrn

Introduction

The COVID-19 pandemic has profoundly altered the daily routines of millions worldwide, largely due to the lockdown measures enforced by governments [1]. In Spain, a state of emergency was declared on March 14, 2020, which imposed strict restrictions on fundamental rights such as free movement, social gatherings, and participation in cultural, recreational, or sporting activities, while also suspending all face-to-face teaching [2]. As a result, the Spanish university system was forced into an abrupt transition to online and distance learning models, without the benefit of a preparatory period [3]. Although institutions sought to adapt as effectively as possible, the state mandated the continuation of existing schedules and workloads, delivered through virtual classes, recorded lectures, and greater emphasis on student autonomy. This shift posed challenges not only for instructors, who had to redesign pedagogical strategies and teaching practices [4, 5], but also for students, who were required to adapt their approaches to skill and knowledge acquisition [6, 7]. These academic disruptions coincided with the broader uncertainty and psychological strain of the pandemic, which research has shown to significantly affect students' emotional well-being [8, 9]. However,

little attention has been given to the impact of lockdown on students' musculoskeletal health.

Previous studies highlight links between stress, anxiety, maladaptive coping, and the onset or aggravation of pain [10–12]. Musculoskeletal pain, beyond causing discomfort, can restrict students' daily and leisure activities, elevate psychological stress, and generate financial costs due to repeated use of healthcare services. Moreover, persistent musculoskeletal pain may negatively influence academic performance and compromise future employability and health outcomes as students transition into the workforce [13]. Such pain is also widely documented among workers, where it arises from physical, psychological, and environmental stressors [14, 15]. University students face similar challenges: long hours of sitting, high academic workloads, and, in many cases, early exposure to professional environments through internships and practical training [16].

Additionally, students spend extensive time using laptops and mobile devices, both for academic purposes and leisure. Poor postural habits during device use are strongly associated with musculoskeletal discomfort, particularly in the spine and upper extremities [17, 18]. These factors create a context of elevated risk, where musculoskeletal pain becomes a threat to students' health, quality of life, and overall well-being.

The lockdown further compounded this risk by limiting opportunities for physical activity (PA), a factor closely linked to musculoskeletal health [19, 20]. In Spain, regulations prohibited outdoor exercise and restricted access to public spaces, likely reducing students' capacity to maintain active lifestyles.

Given these circumstances, this study was designed with the following objectives: (a) to examine the prevalence of musculoskeletal pain among students from two Spanish universities before and during lockdown; (b) to assess students' physical activity habits and self-perceived stress during the lockdown period; and (c) to explore personal variables—including sex, average daily sitting time, household composition during lockdown, and whether students had a dedicated study space or used common areas—that may be related to physical activity habits during confinement.

Experimental Section

Study design and sample

A cross-sectional study was conducted among students from two Spanish universities—Universidad de León and Universidad de Valladolid—using convenience sampling. The total student population comprised 31,293 individuals: 18,650 from Universidad de Valladolid and 12,643 from Universidad de León. To achieve a 99% confidence level with a 4% margin of error, a minimum sample of 1,007 participants was required. Inclusion criteria were: (a) enrollment at either university for at least six months; (b) active participation in virtual teaching during the COVID-19 lockdown in Spain (16 March–11 May 2020); (c) completion of all survey questions; and (d) provision of informed consent in accordance with the Declaration of Helsinki (2013).

Data collection occurred via email in April and May 2020, coordinated by the Research Vice-Rectorates of both universities. Students accessed the questionnaire through a digital link, where they first reviewed and accepted the informed consent form. Completion of all questions was required to submit the survey. Data were anonymized to protect participants' privacy. The study protocol was approved by the Ethics Committee of Universidad de León (ETICA-ULE-015-2020) and the Health Area of East Valladolid (PI 20-1787).

Study variables

The survey included the following instruments and measures:

1. **Spanish Standardized Kuorinka Modified Nordic Questionnaire (SNQ):** Used to assess musculoskeletal symptoms in ergonomic and occupational contexts [21, 22]. The Spanish version demonstrates good to very good test–retest reliability (k = 0.6–0.81), acceptable internal consistency (Kuder–Richardson 20 = 0.74–0.87), and solid construct validity [22]. Only the general section, consisting of 27 yes/no questions covering nine body regions (neck, shoulders, elbows, wrists/hands, upper back, lower back, hips/thighs, knees, and ankles/feet), was employed. Questions were adapted to the lockdown context and pre-tested with a convenience sample of 15 university participants to ensure clarity. For example, questions regarding pain in the last 12 months and the last seven days were modified to specifically refer to the period prior to or during lockdown. The analysis focused on the total number of painful areas reported.

2. **Perceived Stress Scale (PSS, Spanish version):** Assesses individuals' perception of environmental demands as unpredictable and uncontrollable, reflecting perceived control over these demands. The instrument has demonstrated reliability ($\alpha = 0.82$, test–retest $r = 0.77$) and adequate validity and sensitivity [23–25].

3. **Physical Activity (PA) Frequency:** Assessed with the questions "Did you engage in any PA before the lockdown?" and "Did you engage in any PA during the lockdown?" Response options included: (1) no; (2) occasionally (some days per month); and (3) frequently (several days per week).

4. **Type of Physical Activity:** Assessed with the questions "What type of PA did you mainly do before the lockdown?" and "What type of PA did you mainly do during the lockdown?" Response options were: (1) none; (2) aerobic; (3) strength exercises; and (4) other (e.g., stretching).

5. **Additional Variables:** Sex, average daily sitting time, number of household members during lockdown, and whether students used a dedicated space for study and virtual classes or a common area

Statistical analysis

Descriptive statistics were calculated for all study variables, including means to represent central tendency and standard deviations to indicate variability. The Kolmogorov–Smirnov test confirmed normal distribution of the variables ($p > 0.05$), and homogeneity of variances was verified using Levene's test. Independent t-tests were conducted to assess differences between sexes and to compare the prevalence of painful areas before and during the lockdown. One-way ANOVA with Bonferroni correction was applied to examine differences in physical activity patterns across sex groups. Correlation analyses were performed to explore associations between physical activity, reported painful areas, and self-perceived stress.

Logistic regression (logit) was employed to investigate the relationship between independent variables and the dichotomous outcome of musculoskeletal pain during lockdown (0 = no, 1 = yes). Adjusted odds ratios (ORs) with 95% confidence intervals were calculated using a multivariate model, initially adjusted for age. Statistical analyses were conducted using STATA version 12 (StataCorp, College Station, TX, USA), with significance set at $p < 0.05$ for all tests.

Results

A total of 1,198 students participated, of whom 846 were women (70.6%; **Table 1**), yielding a response rate of 3.8%. Significant sex differences were observed in age, the number of painful areas reported in the year prior to lockdown, areas of pain limiting daily activities in the previous year, painful areas experienced during lockdown, and perceived stress. Women were significantly younger and reported higher values in all other variables showing significant differences. Conversely, the number of household members and the type of study space (dedicated or common) did not differ significantly between sexes.

Table 1. Descriptive statistics of the sample (data provided average ± standard deviation)

	All (*n* = 1198)	**Men (*n* = 352)**	**Women (*n* = 846)**
Age (years)	22.8 ± 5.9	23.5 ± 7.1 **	22.5 ± 5.3 **
Hours sitting daily (*n*)	7 ± 2.6	6.7 ± 2.7 *	7.1 ± 2.6 *
People with whom lived (*n*)	2.5 ± 1.1	2.4 ± 1	2.5 ± 1.2
PA12 (*n*)	3.7 ± 2.2	3.1 ± 2.2 ***	3.9 ± 2.2 ***
AL12 (*n*)	0.9 ± 1.4	0.6 ± 1 ***	1 ± 1.5 ***
PAC (*n*)	3.2 ± 2	2.7 ± 1.9 ***	3.4 ± 2 ***
PSS (score)	21.9 ± 4.8	20.8 ± 5 ***	22.4 ± 4.6 ***
	Workspace (frequency (percentage))		
Specific	885 (73.9%)	254 (72.2%)	631 (74.6%)
Improvised common area	313 (26.1%)	98 (27.8%)	215 (25.4%)

PA12: painful areas during de previous 12 months; AL12: areas with limiting pain during the previous 12 months; PAC: painful areas during lockdown; PSS: Perceived stress scale. The t-test between sex: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Analysis comparing musculoskeletal pain reported during the 12 months prior to the lockdown with pain experienced during the confinement period showed a significant overall decrease in the number of painful areas for the entire sample as well as for both male and female subgroups ($p < 0.001$) **(Table 1)**.

Nonetheless, when focusing on the spinal regions—the cervical, dorsal, and lumbar areas—an increase in reported pain was observed across the total sample and in both sexes. This increase reached statistical significance only for dorsal pain in the total sample and among women ($p = 0.01$ for both) **(Table 2)**. In contrast, pain in other body regions generally declined during the lockdown, except for women, who exhibited a significant rise in bilateral shoulder pain ($p = 0.03$).

Table 2. Prevalence of pain during the year prior to the lockdown and during it (data provided in (percentage))

		All (*n* = 1198)	**Men (*n* = 352)**	**Women (*n* = 846)**
		Painful Areas During the Previous 12 Months		
Neck		824 (68.8%)	200 (56.8%)	624 (73.8%)
Dorsal		468 ** (39.1%)	113 (32.1%)	355 ** (42%)
Lumbar		742 (61.9%)	176 (50%)	566 (66.9%)
Shoulders:				
	In one	189 *** (15.8%)	62 (17.6%)	127 *** (15%)
	In both	386 (32.2%)	76 * (21.6%)	310 * (36.6%)
Elbows				

	In one	65 * (5.4%)	20 (5.7%)	45 (5.3%)
	In both	40 * (3.3%)	12 (3.4%)	28 (3.3%)
Hands				
	In one	200 ** (16.7%)	60 (17%)	140 ** (16.5%)
	In both	104 *** (8.7%)	35 *** (9.9%)	69 * (8.2%)
Hips		218 ** (18.2%)	51 (14.5%)	167 *** (19.7%)
Knees		414 ** (34.6%)	110 * (31.3%)	304 * (35.9%)
Ankles		200 *** (16.7%)	63 *** (17.9%)	137 (16.2%)
Painful Areas During Lockdown				
Neck		837 (69.9%)	213 (60.5%)	624 (73.8%)
Dorsal		493 ** (41.2%)	122 (34.7%)	371 ** (43.9%)
Lumbar		759 (63.4%)	182 (51.7%)	577 (68.2%)
Shoulders:				
	In one	162 *** (13.5%)	60 (17%)	102 *** (12.1%)
	In both	385 (32.1%)	64 * (18.2%)	321 * (37.9%)
Elbows				
	In one	57 * (4.8%)	18 (5.1%)	39 (4.6%)
	In both	34 * (2.8%)	11 (3.1%)	23 (2.7%)
Hands				
	In one	185 ** (15.4%)	57 (16.2%)	128 ** (15.1%)
	In both	71 *** (5.9%)	17 *** (4.8%)	54 * (6.4%)
Hips		177 ** (14.8%)	49 (13.9%)	128 *** (15.1%)
Knees		377 ** (31.5%)	94 * (26.7%)	283 * (33.5%)
Ankles		159 *** (13.3%)	38 *** (10.8%)	121 (14.3%)

Comparison between painful areas during the previous 12 months vs. during lockdown: * $p < 0.05$; ** $p < 0.01$;*** $p < 0.0001$.

Physical activity patterns shifted significantly during the lockdown (pre- vs. post-lockdown comparison: $p < 0.001$ for the total sample and for both sexes) **(Figure 1)**. Among women, the proportion engaging in frequent physical activity rose by over 12%. In contrast, 5.1% more men reported not exercising at all during lockdown ($p = 0.03$), reflecting a decline in the percentages of men performing physical activity either occasionally or regularly.

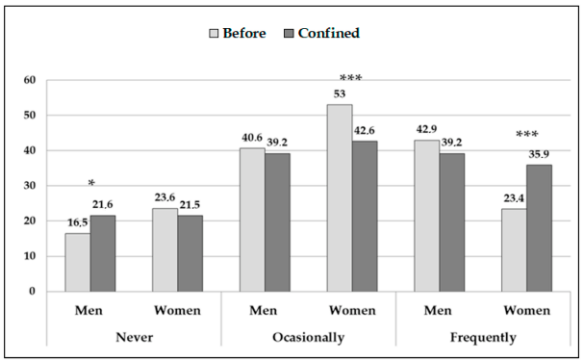

Figure 1. Frequency of physical activity before and during lockdown. Percentages are shown. Asterisks denote statistically significant differences within the same category for men and women (*$p < 0.05$; ***$p < 0.001$)

Lockdown led to notable changes in the types and frequency of physical activity (pre- vs. post-lockdown: $p < 0.001$ for both sexes and the total sample) **(Figure 2)**. Among female students, engagement in aerobic exercise and other activities declined ($p = 0.01$ and $p < 0.001$, respectively), while participation in strength training rose significantly ($p < 0.001$). Male students mainly reduced aerobic exercise ($p = 0.01$) and showed an increase in the proportion reporting no physical activity ($p = 0.03$).

Further analyses using ANOVA revealed no significant associations between activity frequency or type and age, daily sitting hours, number of painful areas, or perceived stress in men ($p > 0.05$). In contrast, female students displayed significant patterns: those who did not exercise at all were older (23.5 ± 7 years) than those exercising frequently (21.8 ± 4.2 years; $p = 0.01$) and lived with fewer household members (2.3 ± 1.1 vs. 2.6 ± 1.2; $p = 0.01$). Additionally, non-active women lived with fewer people than those engaging in occasional activity (2.3 ± 1.1 vs. 2.5 ± 1.2; $p = 0.03$).

Examining activity type in women also revealed significant differences. Participants performing no activity or aerobic exercises were younger than those engaging in other activities ($p < 0.001$). Moreover, women who did not exercise were older than those who practiced strength training (23 ± 6.1 vs. 21.7 ± 3.6 years; $p = 0.03$). Daily sitting time varied as well: women doing aerobic exercise sat longer (8.2 ± 2.8 h) compared to non-active women (7.3 ± 2.7 h; $p = 0.04$), and also relative to those practicing strength training (6.9 ± 2.5 h; $p < 0.001$) or other forms of exercise (6.9 ± 2.6 h; $p = 0.01$).

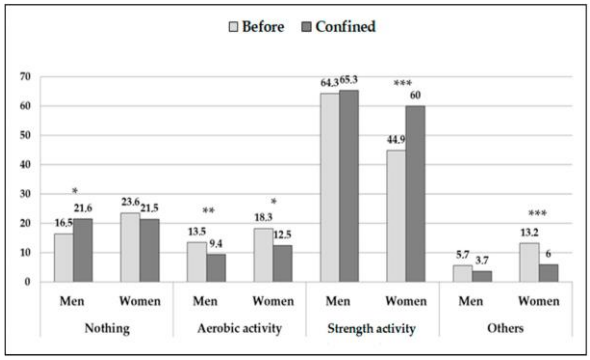

Figure 2. Type of physical activity before and during lockdown. Percentages are shown. Asterisks indicate significant differences within the same response category for men and women: *p < 0.05; **p < 0.01; ***p < 0.001

Among women, differences were observed between those who performed no physical activity and those engaged in strength training during lockdown. Non-active women lived with fewer household members (2.3 ± 1.1) compared to women performing strength exercises (2.6 ± 1.1; p = 0.01). Additionally, women practicing strength training reported fewer areas of musculoskeletal pain during lockdown (3.2 ± 2) than those who did not exercise (3.7 ± 1.9; p = 0.01).

Correlation analyses revealed that older students spent more time sitting (r = 0.6; p = 0.03) and experienced pain in a greater number of body regions during lockdown (r = 0.68; p = 0.01). Sitting time was inversely associated with the frequency of physical activity (r = −0.8; p < 0.01) and positively correlated with perceived stress (r = 0.96; p < 0.001). Furthermore, the frequency of physical activity was positively related to the number of household members (r = 0.68; p = 0.02) and inversely related to the number of painful areas reported (r = −0.83; p = 0.01).

Logistic regression analysis identified sex (0 = male; 1 = female), age, and frequency of physical activity as significant predictors of musculoskeletal pain during lockdown **(Table 3)**. These variables collectively increased the likelihood of experiencing pain (OR range: 0.632–1.852; p < 0.02). In contrast, daily sitting time and self-perceived stress did not show significant effects in the regression model.

Table 3. Binomial logistic regression of musculoskeletal pain according to gender, physical activity, and perceived stress

Variable	OR	SE	*p*	IC 95%
Sex	1.852	0.506	0.02	1.084–3.164
Age	1.141	0.057	0.008	1.035–1.258
Frequency of PA during the lockdown	0.632	0.091	0.001	0.476–0.839
Time spent sitting down daily	1.045	0.048	0.34	0.954–1.143
Self-perceived stress	1.031	0.024	0.19	0.985–1.079

OR: odds ratio; SE: standard error; IC 95%: 95% confidence interval.

Discussion

This study aimed to examine the prevalence of musculoskeletal pain among students from two Spanish universities before and during the COVID-19 lockdown, assess their physical activity (PA) patterns and perceived stress during confinement, and identify personal factors associated with PA habits. The findings indicate a slight overall reduction in musculoskeletal pain alongside changes in both the frequency and type of PA. However, these factors did not appear to influence self-perceived stress.

Although the reduction in pain prevalence was statistically significant, the magnitude was small. This limited change may be attributed to the relatively young age of the participants, the short duration of the lockdown, and the low baseline prevalence of musculoskeletal pain prior to confinement. Women reported a greater number of painful areas than men both before and during lockdown, although both sexes experienced a significant reduction in pain. Previous research has shown similar patterns, suggesting that prolonged sitting in front of screens increases the likelihood of musculoskeletal discomfort, particularly in women [26–28]. While sex-based differences in pain prevalence have been widely documented [29, 30], evidence for such disparities in early adulthood remains limited. Nonetheless, existing studies indicate that lumbar pain is common among adolescents and young adults, with symptoms often persisting longer in women [31, 32], aligning with our findings.

The increase in spinal and shoulder pain observed in this study is consistent with prior research linking extended use of electronic devices to discomfort in these areas [33–36]. Ergonomic factors, such as keyboard height relative to the elbows and proper arm support, are known to reduce musculoskeletal risk [37]. The shift from classroom to online teaching, combined with prolonged sitting at home—likely in suboptimal ergonomic conditions—may account for these observations [35,38].

Among women, the frequency of PA increased during lockdown, which may partly explain the reduction in painful areas. Regular physical activity is known to benefit the musculoskeletal system and modulate pain perception through central mechanisms [10–12]. It is likely that women who increased their activity levels reached the minimum recommended guidelines for maintaining health [39, 40].

The most pronounced changes in activity type involved a decline in aerobic exercise, which may be due to its typical

outdoor nature (e.g., running, cycling, walking) [41]. Conversely, strength training increased among women by 15 percentage points. This shift aligns with evidence demonstrating the wide-ranging benefits of vigorous strength training, including improvements in metabolic, cardiovascular, emotional, and musculoskeletal health [41, 42].

Age and living situation were also associated with PA patterns. Women who did not engage in any PA were generally older and lived with fewer people compared to those performing strength exercises. This may reflect the fact that older students often balance work and study responsibilities, reducing available time for exercise [43, 44], and that they tend to live alone or with fewer household members during later academic years. These findings suggest that younger women living with multiple household members were more likely to engage in regular PA, particularly strength training, and consequently experienced fewer areas of musculoskeletal pain.

The social and behavioral context of exercise appears to play a key role in its promotion and maintenance [38]. Both family and peer support can enhance motivation and adherence to PA routines [45–48]. Students living with others may benefit from a form of "motivational contagion," whereby exercising alongside others encourages the development of consistent PA habits. Habit formation itself is a critical factor in sustaining physical activity [49], which may explain why women residing with others increased their exercise frequency during lockdown.

Overall, the combination of youth, living with multiple household members, and participation in strength training appears to contribute to improved musculoskeletal health during periods of confinement.

The findings also reveal that students' self-reported stress levels did not show any significant associations. This may be explained by the fact that the relationship between pain perception and its amplification under environmental or behavioral influences is typically studied in patients experiencing moderate to severe chronic pain [50, 51], a condition that was likely uncommon among the participants in this study.

Several limitations should be acknowledged. First, stress and musculoskeletal pain were assessed through self-reported questionnaires rather than objective clinical evaluations. Similarly, physical activity frequency and type were self-reported rather than measured with accelerometers or pedometers. It would have been valuable to have pre-lockdown stress assessments; in this study, this was approximated indirectly through reported painful areas. Additionally, methodological constraints limit the generalizability of the findings: modifications to the SNQ may affect validity, the cross-sectional design prevents causal inference, and there is potential for recall bias and lack of blinding. These limitations largely reflect the exceptional and sudden circumstances of the lockdown, which allowed minimal preparation time. Finally, since the study population was drawn exclusively from Spanish universities, caution is required in extending these results to other populations.

Despite these limitations, the study has notable strengths. It represents one of the few large-scale investigations examining the interplay between lockdown conditions, university students' physical activity habits, and musculoskeletal pain. The study provides a realistic reflection of the experiences of Spanish students during this unique period and, to our knowledge, is the first to document these direct relationships.

Conclusion

The COVID-19 lockdown between March and May 2020 prompted significant lifestyle changes among university students. In particular, there was an increase in the frequency of physical activity, with a shift toward strength training, especially among women. Concurrently, a slight reduction in the prevalence of musculoskeletal pain was observed.

These findings highlight the importance of considering sex-specific physiological and socio-family factors when designing health-promoting interventions. Health institutions should take these results into account when implementing strategies to encourage appropriate types and amounts of physical activity, both to meet public health guidelines and to enhance students' overall well-being and quality of life.

Acknowledgments: None.

Conflict of interest: None.

Financial support: None.

Ethics statement: None.

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