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PREVALENCE OF MUSCULOSKELETAL DISORDERS ASSOCIATED WITH NON-ERGONOMIC SEATING DESIGNS AMONG HEALTH SCIENCES STUDENTS

Original Research

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ABSTRACT

Background: Musculoskeletal disorders (MSDs) have become an emerging health concern among university students due to prolonged sitting in poorly designed, non-ergonomic classroom and laboratory furniture. Such mismatches between student anthropometry and furniture dimensions contribute to poor posture, placing undue strain on muscles, tendons, joints, and spinal structures, thereby increasing the risk of discomfort, pain, and long-term health complications. Understanding the impact of furniture design on MSD prevalence is essential for improving student well-being and academic performance.

Objective: The aim of this study was to determine the prevalence of musculoskeletal disorders associated with non-ergonomic furniture designs among undergraduate health sciences students.

Methods: A cross-sectional study was conducted over six months (August 2021 to December 2021) with a total sample size of 256 students, equally distributed between Bahria University Medical and Dental College (BUMDC; n=128) and Bahria University Karachi Campus (BUKC; n=128). Participants were recruited through non-probability convenient sampling, and eligibility included male and female students aged 18–25 years. Data were collected using the Nordic Body Map Questionnaire to record musculoskeletal symptoms across nine body regions, along with anthropometric measurements and Body Mass Index (BMI) categorization. Furniture dimensions were measured using a flexible tape and compared with international ergonomic standards. Data were analyzed using SPSS version 23.0, with descriptive and inferential statistics applied, considering $p<0.05$ as significant.

Results: Neck pain was the most prevalent musculoskeletal complaint, reported by 97 students (75.8%) at BUMDC and 116 students (90.6%) at BUKC ($p<0.05$). Significant associations were observed between seating design and average sitting duration in classrooms ($p=0.000$) and laboratories ($p=0.041$). The prevalence of MSDs was consistently higher among students of BUKC compared to BUMDC. Other regions such as shoulders, upper back, and lower back also showed high frequencies of discomfort, although these did not reach statistical significance ($p>0.05$).

Conclusion: The study concluded that non-ergonomic furniture design is a significant contributor to musculoskeletal disorders among health sciences students, with neck pain being the most commonly affected region. These findings highlight the urgent need for ergonomic interventions in academic institutions to reduce MSD burden and enhance student comfort and productivity.

Keywords: Anthropometry, Ergonomics, Health Sciences Students, Musculoskeletal Disorders, Nordic Body Map, Non-ergonomic Furniture, Posture.

INTRODUCTION

Classroom furniture plays a central role in shaping the learning environment, as students spend a substantial amount of time in lecture halls and laboratories in a seated posture (1). Comfort and ergonomic design are therefore crucial for supporting concentration and productivity during academic activities (2). Unfortunately, much of the furniture in educational institutions is not aligned with students' anthropometric dimensions, leading to prolonged sitting in non-ergonomic positions. This mismatch places students at a heightened risk of musculoskeletal disorders (MSDs) and contributes to poor postural habits that may persist into adulthood (3–5). Evidence from prospective studies has consistently emphasized furniture design as a key determinant in the development of MSDs, underscoring the long-term implications of inappropriate classroom ergonomics (6,7). The postural behavior of students is influenced not only by teaching methods and institutional structure but also by furniture design and its compatibility with individual body measurements (8). Anthropometry, the study of human body dimensions, provides critical data for the ergonomic design of classroom furniture (9). Ignoring anthropometric diversity during manufacturing results in equipment that fails to meet basic ergonomic standards, particularly in developing countries where market pressures often overshadow health considerations (9,10). Core features of academic furniture—including chair height, depth, armrest spacing, and desk height—should be tailored to match students' anthropometric data to promote comfort and reduce MSD risk (11–13). Studies consistently demonstrate that neglecting anthropometric principles in furniture design directly results in non-ergonomic products that reinforce poor sitting posture and musculoskeletal strain (14–16). The negative health consequences of this mismatch are profound. Inappropriate furniture design not only precipitates MSDs but also impairs concentration, reduces learning efficiency, and contributes to cumulative trauma disorders among students (14,15). For instance, excessively low furniture is associated with neck and back pain, while poorly proportioned backrests and armrests are linked to lower back discomfort (17).

Incorporating anthropometric data in design offers a robust preventive approach, yet challenges remain in collecting accurate measurements due to variation across age, gender, and populations. While global standards such as ISO 7250-1:2017 provide reference data, each community requires localized databases to ensure optimal ergonomic outcomes (18). MSDs are defined as impairments of the musculoskeletal and nervous systems, encompassing muscles, bones, tendons, ligaments, and soft tissues, and remain one of the most significant public health concerns worldwide (19). These disorders reduce mobility, impact academic performance, and may predispose young individuals to chronic disability later in life. Among students, the most commonly affected areas include the neck, shoulders, and lower back, with prolonged forward-bending postures being the primary contributing factor (12). In addition to furniture-related risks, factors such as physical inactivity, fatigue, psychological stress, and prior trauma further exacerbate MSD prevalence (16). Despite increasing awareness of ergonomic principles, the gap between anthropometric requirements and classroom furniture design persists, especially in health sciences education where long seated sessions are routine. Addressing this issue through ergonomically informed furniture design has the potential to not only reduce MSD prevalence but also enhance student productivity and learning outcomes. The present study aims to determine the prevalence of musculoskeletal disorders associated with non-ergonomic classroom furniture among health sciences students and to assess the extent of mismatch between students' anthropometric measurements and the dimensions of available seating. By identifying these gaps, the study seeks to provide evidence that will guide ergonomic interventions and inform furniture manufacturing practices to promote long-term musculoskeletal health and academic performance.

METHODS

The study was conducted as a cross-sectional survey with a total sample size of 256 undergraduate students, including both male and female participants, recruited from Bahria University Medical and Dental College (BUMDC) and Bahria University Karachi Campus (BUKC). The duration of the study was six months, from August 2021 to December 2021. Participants were selected using a non-probability convenience sampling technique. The inclusion criteria comprised male and female students aged between 18 and 25 years, enrolled as regular students, and representing different body physiques. Exclusion criteria included students wearing slings or plaster of Paris (POP), those with acute injuries, students with neurological disabilities, individuals with other medical problems, and students who were concurrently enrolled in any musculoskeletal disorder–related randomized controlled trial. Ethical approval for the study was obtained from the institutional review board, and informed consent was taken from all participants after explaining the objectives and

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

requirements of the study. Data collection was carried out using standardized instruments and structured methods. The anthropometric and health data of the students were first evaluated using a Body Mass Index (BMI) chart, which calculated BMI by measuring height and weight to categorize individuals as underweight, healthy, overweight, or obese. To assess musculoskeletal discomfort, the Nordic Body Map Questionnaire was employed. This validated tool consisted of two parts: demographic details and musculoskeletal symptoms affecting nine body regions (neck, shoulders, upper back, elbows, lower back, wrists/hands, hips/thighs, knees, and ankles/feet). Students were asked to report musculoskeletal discomfort experienced over the past 12 months and the past 7 days, as well as whether these issues had limited their daily activities.

In parallel, detailed measurements of classroom furniture were taken using a flexible measuring tape. The parameters included seat depth, seat width, seat height, lumbar support height, upper edge of the backrest, seat-to-table height, and overall backrest height. These dimensions were recorded for the furniture in both campuses, including classroom chairs, lab stools, and sofa seats. At BUMDC, the furniture consisted of classroom chairs with straight backrests and flat-surfaced stools used in practical labs, whereas at BUKC, students used cushioned classroom chairs and stools in laboratories. The standardized dimensions of the furniture types were documented and presented in tabulated form. The data collection procedure involved approaching students in their classrooms and laboratories after securing informed consent. Each participant was given the Nordic Body Map Questionnaire, and BMI was calculated using height and weight measurements. Furniture dimensions were measured independently and compared with the anthropometric needs of the students. The study particularly focused on analyzing four types of furniture designs, assessing their ergonomic suitability, and their potential association with musculoskeletal symptoms. All collected data were coded and analyzed using SPSS version 23.0. Descriptive statistics were used to summarize demographic variables such as age, gender, BMI, year of study, and duration of sitting. The prevalence of musculoskeletal disorders across body regions was presented using cross-tabulations. Bivariate correlations were performed to assess the relationship between furniture design, duration of sitting, and musculoskeletal discomfort. For inferential statistics, a p-value of less than 0.05 was considered statistically significant, whereas a p-value greater than 0.05 was regarded as not significant. Results were displayed in the form of tables and graphs to enhance clarity and interpretation.

RESULTS

The study included 256 participants, with equal representation from both campuses (n=128 from BUMDC and n=128 from BUKC). The mean age of the participants was 20.96±1.95 years, and the majority were female (gender mean 1.75±0.43). The mean BMI score was 2.00±0.59, and the average duration of sitting in a classroom per study year was 557.56±42.54 minutes, whereas the average duration of sitting in a laboratory per study year was 207.84±46.35 minutes. Neck pain was reported by 97 students from BUMDC and 116 students from BUKC. Statistical analysis demonstrated that the association between furniture design and average duration of sitting in a classroom was highly significant (p=0.000). Similarly, a significant association was also found between furniture design and the average duration of sitting in a laboratory (p=0.041). The prevalence of musculoskeletal disorders was higher among BUKC students compared to BUMDC students, reflecting a mismatch between the available furniture dimensions and standard ergonomic dimensions. Analysis of musculoskeletal pain distribution revealed that in BUMDC, the most common complaints were neck pain (n=97), shoulder pain (n=65), upper back pain (n=61), and lower back pain (n=67). In BUKC, the most frequent complaints were neck pain (n=116), shoulder pain (n=67), upper back pain (n=63), and lower back pain (n=84). Other pain sites such as elbows, hips, knees, feet, and hands were also reported, although less frequently. Notably, lower back and neck pain were consistently the most prevalent across both institutions.

The relationship between seating design and musculoskeletal pain was also analyzed. Students using chairs reported higher rates of neck and lower back pain compared to those using sofas or lab stools. In BUMDC, students using chairs (n=84) were more likely to report neck pain compared to sofa users (n=7) or stool users (n=6). Similarly, in BUKC, students using chairs (n=96) reported higher rates of neck pain compared to sofa users (n=20) and stool users (n=7). The correlation between furniture design and musculoskeletal pain was statistically significant for neck pain (p=0.008), while other body regions did not show significant associations. Comparison of furniture dimensions revealed notable disparities when measured against standard ergonomic dimensions. For classroom chairs, the seat height in BUKC was 33.5 inches, which was considerably higher than the standard 17.3 inches, suggesting a likely design or reporting error. In contrast, BUMDC chairs measured 19 inches in seat height, closer to standard values. Both campuses used lab stools with seat height of 29 inches and seat width of 12 inches, which were narrower than the standard width of 14 inches. The backrest dimensions of classroom chairs in both campuses were also considerably lower than standard ergonomic recommendations. Overall, the findings

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INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

indicated that musculoskeletal disorders were more prevalent among BUKC students, particularly neck and lower back pain, and that significant mismatches existed between furniture dimensions and ergonomic standards.

Table 1: Descriptive Statistics

Variables	**Mean± S.D**
Gender	1.75±0.436
Age of participant	20.96±1.957
Year of study	2.4805±1.48179
BMI of participant	2.00±0.597
Average duration of sitting in a classroom per study year	557.56±42.547
Average duration of sitting in a lab per study year	207.84±46.359

Table 2: Descriptive statistics of BMI with relationship to musculoskeletal disorder

Prevalence of Muscular pain in different body region		**College campus**							
		BUMDC				BUKC			
		BMI of participant				BMI of participant			
		underweight	Healthy	Over weight	Obese	underweight	Healthy	Over weight	Obese
Muscular pain in Neck	yes	7	74	14	2	28	79	7	2
	No	2	57	6	1	9	21	6	1
Muscular pain in upper back	yes	6	43	9	3	21	37	3	2
	No	6	57	9	0	9	46	7	1
Muscular pain shoulder	yes	3	49	11	2	19	39	6	3
	No	3	51	7	1	11	44	4	0
Muscular pain in elbow	yes	2	17	5	0	7	9	3	0
	No	7	83	13	3	23	74	7	3
Muscular pain in hands	yes	3	25	6	0	12	27	7	0
	No	6	75	12	3	18	56	3	3
Muscular pain in hips	Yes	3	21	7	1	10	21	4	1
	No	6	79	11	2	20	62	6	2
Muscular pain in lower back	Yes	5	49	11	2	20	52	4	2
	No	4	51	7	1	10	31	6	1
Muscular pain in knees	Yes	2	29	8	1	10	25	4	1
	No	7	71	10	2	20	58	6	2
Muscular pain in feet	Yes	3	28	8	0	10	22	6	2
	No	6	72	10	3	20	61	4	1

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Table 3: Relationship between Seating Designs with Average Duration of Sitting in Classroom and Laboratory per Study Year

Furniture/Seating Design	Classroom (Average Duration of Sitting per Study Year)					Laboratory (Average Duration of Sitting per Study Year)				
	4th Year	3rd Year	2nd Year	1st Year	Total	4th Year	3rd Year	2nd Year	1st Year	Total
Chair	22	15	26	108	171	131	15	25	131	171
Sofa Seats	14	8	10	20	52	32	10	10	32	52
Lab Stools	16	8	6	3	33	18	10	5	18	33
Total	52	31	42	131	256	181	35	40	181	256

Table 4: Correlation between furniture design and average duration of sitting in a classroom per study year

		Furniture/seating design	Average duration of sitting in a classroom per study year
Furniture/seating design	p-value		0.000
	N	256	256
Average duration of sitting in a classroom per year	p-value	0.000	
	N	256	256

Table 5: Correlation between furniture design and average duration of sitting in a lab per year

		Furniture/seating design	Average duration of sitting in a lab per study year
Furniture/seating design	p-value		.041
	N	256	256
Average duration of sitting in a lab per year	p-value	.041	
	N	256	256

Table 6: Relationship of Furniture/ Seating design with prevalence of Muscular pain in different body regions

Prevalence of Muscular pain in different body region		College Campus						P- Value
		BUMDC			BUKC			
		Furniture/seating design			Furniture/seating design			
		Chair	Sofa	Lab stool	Chair	Sofa	Lab stool	
Pain in Neck	Yes	84	7	6	96	20	7	0.008
	No	21	10	2	7	3	2	
Pain shoulder	Yes	56	7	2	58	9	5	0.22
	No	49	10	16	45	15	1	
Pain in upper back	Yes	49	11	1	53	10	3	0.87
	No	56	6	7	50	13	2	
Pain in elbow	Yes	22	2	0	15	4	4	0.24
	No	83	15	8	88	19	0	
Pain in hands	Yes	31	3	0	38	8	5	0.70
	No	74	17	8	65	12	1	
Pain in lower back	Yes	54	13	3	68	10	3	0.13
	No	51	7	5	35	13	3	
Pain in hips	Yes	29	2	1	31	5	4	0.89
	No	76	18	7	72	18	2	
Pain in knees	Yes	33	6	2	31	9	1	0.89
	No	72	14	6	72	14	0	
Pain in feet	Yes	33	5	1	33	7	1	0.36
	No	72	15	7	70	16	0	

INSIGHTS-JHR
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Table 7: Comparison of Standard, BUMDC, and BUKC Furniture Dimensions (Classroom Chairs and Lab Stools)

Furniture / Seating Dimension	Standard Dimension – Chairs (inch)	Standard Dimension – Lab Stools (inch)	Chairs in BUMDC (inch)	Chairs in BUKC (inch)	Lab Stools in BUMDC (inch)	Lab Stools in BUKC (inch)
Seat Height (SH)	17.3	25–33	19	33.5	29	29
Seat Width (SW)	16.5	14	18	18	12	12
Seat Depth (SD)	16.5	15–17	18.5	17.6	11.5	11.5
Seat to Table Height (STH)	3.7	0.00	10.5	8.3	0.00	0.00
Lumbar Support (LS)	12	0.00	9	10	0.00	0.00
Upper Edge of Backrest (UEB)	17.3	0.00	17.5	17	0.00	0.00
Backrest Height (BH)	21.2	0.00	10	7	0.00	0.00

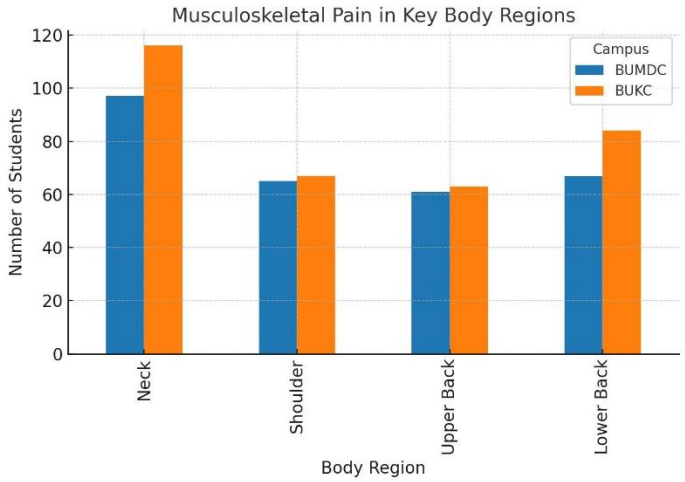

Figure 1 Musculoskeletal Pain in Key Body Regions

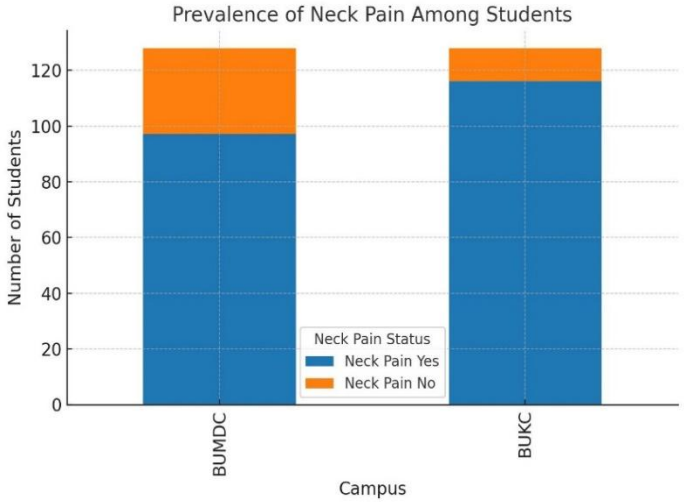

Figure 2 Prevalence of Neck Pain Among Students

DISCUSSION

The findings of the present study highlighted a significant prevalence of musculoskeletal disorders (MSDs) among health sciences students, which was directly associated with the use of poorly designed and non-ergonomic classroom furniture. The results demonstrated that the most affected body region was the neck, followed by hips, knees, upper back, hands, feet, elbows, shoulders, and lower back. This distribution underscores the considerable physical strain experienced by students due to mismatched furniture dimensions and extended sitting hours. Such outcomes are consistent with earlier research reporting that injuries, strains, and sprains affecting muscles, tendons, joints, and spinal discs are common consequences of non-ergonomic workstation designs (16,17). The prevalence of MSDs among students in this study was found to be higher in those considered to have healthy BMI compared to underweight, overweight, or obese peers. This finding contrasts with some earlier studies that reported no association between BMI and musculoskeletal pain, indicating that BMI alone may not be a protective or risk factor, and that environmental contributors such as furniture design may play a more dominant role. The present results also align with reports that prolonged sitting in non-ergonomic postures is one of the strongest determinants of musculoskeletal dysfunction among students (18,19). When compared with international literature, there appears to be variability in the most frequently reported anatomical sites of pain. Several authors documented lower back pain as the most prevalent musculoskeletal complaint among students, followed by neck and shoulder pain (19,20). In contrast, the

current study observed neck pain as the leading musculoskeletal disorder, suggesting potential variations in furniture design, posture-related habits, and learning environments across different institutions. Despite these differences, the consistent association between non-ergonomic seating and musculoskeletal discomfort across multiple studies strengthens the evidence for poor furniture design as a universal risk factor.

Another important finding of this study was the significant mismatch between the furniture dimensions in both institutions and the standard ergonomic guidelines (ISIRI 9697-1, ISIRI 7494, BS-5874, ISO 7250). For instance, the classroom chair height at BUKC was substantially higher than international standards, highlighting a critical design flaw. Prolonged use of such mismatched furniture exacerbates the likelihood of poor posture, thereby contributing to the development of MSDs. These findings reinforce the claim that a substantial proportion of classroom furniture in educational institutions does not conform to anthropometric needs, leading to cumulative musculoskeletal strain among students (21,22). The implications of these results extend beyond immediate discomfort, as young adults experiencing MSDs are more likely to carry these disorders into later life, leading to chronic health issues and reduced productivity. The educational environment is a critical determinant of students' health, and continued exposure to non-ergonomic designs may limit their academic performance and well-being. Additionally, the study emphasized the significance of comparing furniture dimensions with the actual time students spend in classrooms and laboratories, where statistically significant associations were observed. This highlights that both the design of furniture and the duration of exposure act synergistically to increase the risk of MSDs.

The strengths of the current study included the use of a validated Nordic Body Map Questionnaire for assessing musculoskeletal symptoms and the inclusion of objective furniture measurements compared against international standards. Furthermore, the study assessed both classroom and laboratory furniture, thereby providing a broader understanding of ergonomic shortcomings in health sciences institutions. However, certain limitations must be acknowledged. The cross-sectional design restricted the ability to establish causality, and the sample was limited to two universities, which reduces generalizability. The study did not distinguish between acute and chronic musculoskeletal pain, nor did it comprehensively assess psychosocial or behavioral factors such as stress, computer usage, or physical activity, which are recognized contributors to MSDs. Moreover, anthropometric measurements of students were not directly compared with furniture dimensions, which would have provided stronger evidence of ergonomic mismatch. Future studies should include larger and more diverse student populations, with randomized controlled trials to evaluate interventions aimed at reducing MSDs through ergonomic redesign. Research should also differentiate between acute and chronic pain syndromes and investigate the interplay of psychosocial and lifestyle factors alongside furniture design. Establishing institution-specific anthropometric databases could provide valuable data to guide the design of customized ergonomic furniture, reducing the prevalence of MSDs among students and improving long-term musculoskeletal health outcomes. In conclusion, the findings of this study support growing evidence that non-ergonomic classroom and laboratory furniture contribute significantly to musculoskeletal disorders among students. Neck pain emerged as the most prevalent disorder, with a significant association between seating design, time spent in classrooms and labs, and MSD prevalence. These results emphasize the urgent need for ergonomic interventions in academic institutions to safeguard students' health, improve comfort, and enhance productivity.

CONCLUSION

The study concluded that undergraduate health sciences students experienced a high prevalence of neck pain primarily due to prolonged sitting on poorly designed, non-ergonomic classroom furniture. Such seating arrangements contributed to musculoskeletal discomfort, postural strain, and increased stress among students, highlighting the critical role of ergonomically appropriate furniture in academic environments. These findings emphasize the importance of incorporating anthropometric principles into classroom and laboratory furniture design to safeguard student health, enhance comfort, and support academic performance.

INSIGHTS-JHR
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AUTHOR CONTRIBUTION

Author	Contribution
Shahtaj Shabbir*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Sumayya Sarfraz	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Sarmeen	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Seyyada Tahniat Ali	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Syeda Rida Baqir	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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