Original Article

Biomechanical Risk Profiles, and Ergonomic Determinants of Low Back Pain Among Undergraduate Medical Students: A Cross-Sectional Study

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Abstract

Objective: Low back pain (LBP) is an escalating occupational hazard among healthcare professionals and medical students globally. This study synthesizes empirical findings to evaluate the period prevalence, academic trajectory, postural mechanisms, and nocturnal ergonomic risk factors of LBP in a standardized cohort of undergraduate medical students.

Methodology: A cross-sectional analytical study was conducted among N = 150 medical students across academic years 1 through 5 at a private medical college in Lahore. Data were gathered using the Standardized Nordic Musculoskeletal Questionnaire and Visual Analogue Scale (VAS). Postural postures, continuous sitting duration, lumbar support utilization, mattress firmness, and physical conditioning were evaluated using binary logistic regression.

Results: The overall 12-month period prevalence of LBP was 59.3% (n = 89/150), with a 7-day point prevalence of 32.0% (n = 48/150). LBP rates exhibited a progressive elevation across academic seniority, escalating from 25.0% in Year 1 to 73.7% in Year 5 ($p < 0.001$). Multivariate modeling identified prolonged sitting ≥ 6 hours/day (OR = 3.12, 95% CI: 1.48–6.58), forward slump posture (OR = 4.15, 95% CI: 1.82–9.46), absence of lumbar support (OR = 5.88, 95% CI: 2.65–13.04), soft mattress density (OR = 3.68, 95% CI: 1.71–7.92), and physical inactivity (OR = 8.80, 95% CI: 3.82–20.25) as primary independent predictors of lumbar disability.

Conclusion: Low back pain affects nearly three-fifths of medical students, driven by non-neutral sitting biomechanics, intense academic workloads, and physical deconditioning Institutional ergonomic restructuring and core stabilization programs are urgently required

Keywords: Low back pain; Medical students; Ergonomics; Intradiscal pressure; Spinal biomechanics; Nordic Musculoskeletal Questionnaire.

How to cite this:

Farasat F, Jamshed A, Farooq, Mudassar. Biomechanical Risk Profiles, and Ergonomic Determinants of Low Back Pain Among Undergraduate Medical Students: A Cross-Sectional Study. J Health Advance Res Genom. 2026;1(1): 26-32

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Received: 10-07-2026 **Revised:** 19-09-2026 **Accepted:** 04-11-2026

Introduction

Low back pain (LBP) represents a major global public health challenge, standing as the leading cause of years lived with disability (YLDs) worldwide.[1,2,3] While historically characterized as an occupational condition affecting manual laborers and older adult populations, contemporary epidemiological surveillance highlights an alarming rise in spinal morbidity among young adults enrolled in rigorous professional education.[4,5,6] The landmark Global Burden of Disease studies and Lancet Low Back Pain Series emphasize that early-onset lumbar dysfunction during early adulthood establishes persistent chronic musculoskeletal disability patterns in later professional life.[1,2]

Undergraduate medical education imposes unique, combined biomechanical and psychological stressors.[7,8] Trainees are subjected to prolonged static desk sitting during preclinical lecture modules, extended laboratory sessions, and intensive self-directed study schedules that frequently exceed 6 to 10 hours daily.[9,10] In the clinical phase of training, students encounter abrupt transitions to static standing during hospital ward rounds, prolonged

surgical assistance in operating theaters, and awkward body positioning during patient examinations.[11,12] Despite these recognized physical exposures, formal ergonomic education and posture maintenance training remain largely absent from undergraduate medical curricula.[7,13]

Cross-sectional studies across diverse international medical institutions demonstrate high LBP prevalence rates, ranging from 45.7% in Malaysia[13] and 46.1% in China[9] to 53.4% in Serbia,[14] 59.5% in Austria,[15] and 62.0% in France.[16] Primary regional investigations by Pal et al.[7] and Iqbal et al.[8] further confirm that South Asian medical cohorts experience severe spinal strain secondary to suboptimal study furniture, unsupportive seating, and physical inactivity. However, limited empirical literature has synthesized how structural seating mechanics, nocturnal sleep postures, and cumulative clinical training duration interact to drive lumbar symptom development.[7,8,17]

This study synthesizes empirical data from a standardized cohort of N = 150 undergraduate medical students to establish: (1) the 12-month period prevalence and 7-day point prevalence of LBP across academic training levels; (2) the ergonomic and behavioral predictors governing spinal strain, including continuous sitting duration, posture, lumbar support, mattress firmness, and core physical exercise; and (3) the clinical characteristics and functional impact of LBP on academic performance.

Methodology

Study Design and Participant Sampling

A cross-sectional analytical design was executed across undergraduate medical cohorts (Years 1 through 5, MBBS program) at the University College of Medicine and Dentistry Lahore. A total sample size of N = 150 students was established using stratified random sampling to ensure proportionate representation across academic seniority levels and gender. Inclusion criteria comprised active enrollment in the undergraduate medical program, age between 18 and 26 years, and willingness to participate. Students with a history of congenital spinal anomalies, prior lumbar spinal surgery, traumatic vertebral fractures, or diagnosed inflammatory spondyloarthropathies were excluded from the analytical sample.

Data Collection Protocol & Diagnostic Survey: Data collection was accomplished using a structured, self-administered diagnostic questionnaire adapted from the validated Standardized Nordic Musculoskeletal Questionnaire.[18] The instrument systematically evaluated: (1) anatomical localization of low back symptoms using body map charts; (2) 12-month period prevalence and 7-day point prevalence of LBP; (3) average daily sitting duration during study modules; (4) habitual study posture (erect supported sitting, forward slumped sitting, or lateral leaning); (5) presence and type of back support cushions; (6) bedding characteristics (firm vs. soft mattress) and sleeping posture (supine vs. lateral flexed); and (7) weekly engagement in physical conditioning.

Subjective pain severity among symptomatic participants was quantified using a standardized 10-cm Visual Analogue Scale (VAS), anchored from 0 ('no pain') to 10 ('unbearable pain'). Pain intensity was classified into mild (VAS 1–3), moderate (VAS 4–6), and severe (VAS 7–10) pain categories. Functional impact was measured via self-reported sick leave, academic absence, and restriction of clinical ward participation over the preceding 12 months.[19]

Statistical processing was executed using IBM SPSS Statistics for Windows, Version 24.0 (IBM Corp., Armonk, NY). Categorical variables were presented as absolute counts and percentages (n, %), while continuous variables were reported as mean ± standard deviation (SD). Pearson's Chi-square (χ^2) test and Fisher's exact test were applied to evaluate bivariate associations between demographic/ergonomic variables and LBP prevalence. Variables demonstrating significant associations in bivariate testing ($p < 0.05$) were entered into a multivariable binary logistic regression model to determine adjusted Odds Ratios (aOR) with 95% Confidence Intervals (CI).

Results

The studied cohort comprised N = 150 medical trainees (mean age: 21.2 ± 2.4 years), including 93 females (62.0%) and 57 males (38.0%). The overall 12-month period prevalence of low back pain in the sample was 59.3% (n = 89/150), while the 7-day point prevalence reached 32.0% (n = 48/150). Female students experienced a higher 12-month LBP prevalence (64.5%, n = 60/93) compared to male counterparts (50.9%, n = 29/57; $\chi^2 = 2.76$, $p = 0.097$).

Analysis across academic seniority revealed a striking, statistically significant linear escalation in LBP rates ($p < 0.001$). Preclinical Year 1 students reported the lowest prevalence (25.0%, n = 8/32), whereas senior clinical trainees in Year 4 (80.0%, n = 24/30) and Year 5 (73.7%, n = 14/19) exhibited the highest burden of symptoms . Demographic stratification and symptom rates across academic years are detailed in Table 1.

Table 1: *Demographic Profiles and 12-Month LBP Prevalence Stratified by Academic Year and Gender (N=150). *Statistically significant at p < 0.05..*

Demographic Subgroup	Total N	LBP Present (n)	12-Mo Prevalence (%)	p-Value (χ^2)
Academic Training Level				
Year 1 (Preclinical)	32	8	25.00%	
Year 2 (Preclinical)	35	18	51.40%	
Year 3 (Preclinical/ Clinical)	34	25	73.50%	< 0.001*
Year 4 (Clinical Wards)	30	24	80.00%	
Year 5 (Final Clinical)	19	14	73.70%	
Gender Subgroup				
Female	93	60	64.50%	0.097
Male	57	29	50.90%	
Overall Total Cohort	150	89	59.30%	—

Ergonomic exposure analysis identified continuous study sitting duration, seating posture, lumbar support cushion utilization, mattress density, and exercise habits as major risk determinants. Trainees sitting for ≥ 6 hours daily experienced a significantly elevated LBP prevalence of 65.2% (n = 60/92) compared to 50.0% (n = 29/58) among those sitting < 6 hours (p = 0.062). Multivariable binary logistic regression confirmed that continuous prolonged sitting increased LBP odds by over three-fold (aOR = 3.12, 95% CI: 1.48–6.58)

Suboptimal posture during desk study heavily influenced lumbar outcomes. Students adopting a forward slumped posture demonstrated an LBP prevalence of 66.3% (n = 65/98), compared to 31.0% (n = 9/29) among students maintaining an erect supported posture (aOR = 4.15, 95% CI: 1.82–9.46; p < 0.001). Furthermore, the absence of a dedicated lumbar support cushion yielded an LBP prevalence of 73.0% (n = 73/100) versus 32.0% (n = 16/50) in cushion users (aOR = 5.88, 95% CI: 2.65–13.04; p < 0.001)

Table 2: *Bivariate and Multivariate Analysis of Ergonomic, Postural, and Lifestyle Risk Factors (N = 150).*

Ergonomic / Lifestyle Variable	LBP Rate (%)	Bivariate p-Value	Adjusted OR	95% CI
Daily Sitting Duration				
< 6 hours / day	50.00%	0.062	1.00 (Ref)	—
≥ 6 hours / day	65.20%		3.12	1.48 – 6.58*
Study Sitting Posture				
Erect Supported	31.00%	< 0.001*	1.00 (Ref)	—
Forward Slumped	66.30%		4.15	1.82 – 9.46*
Lateral Leaning	65.20%		3.85	1.45 – 10.22*
Lumbar Support Cushion				
Present (Used)	32.00%	< 0.001*	1.00 (Ref)	—
Absent (Not Used)	73.00%		5.88	2.65 – 13.04*
Mattress Firmness				
Firm / Orthopaedic	36.40%	0.002*	1.00 (Ref)	—
Soft / Sagging	65.60%		3.68	1.71 – 7.92*
Physical Exercise Frequency				
≥ 3 times / week	32.30%	< 0.001*	1.00 (Ref)	—
1–2 times / week	52.50%		2.45	0.98 – 6.12
None (Inactive)	80.00%		8.8	3.82 – 20.25*

**Statistically significant odds ratios (p < 0.05).*

Table 3: *Clinical Profiles, Pain Severity Spectrum, and Functional Impairment Outcomes Among Symptomatic Students (n = 89) [1, 2, 26].*

Clinical / Functional Feature	Symptomatic (n)	Percentage (%)	Cohort Share (N=150)
Onset Mechanism			
Gradual / Insidious Postural Onset	60	67.40%	40.00%
Acute / Activity-Triggered Onset	29	32.60%	19.30%
Pain Severity Category (VAS Score)			
Mild Discomfort (VAS 1–3)	39	43.80%	26.00%
Moderate Pain (VAS 4–6)	40	44.90%	26.70%
Severe Debilitating Pain (VAS 7–10)	10	11.20%	6.70%
Healthcare & Academic Impact			
Formal Sick Leave / Ward Absence	10	11.20%	6.70%
Pharmacological Analgesic Use	22	24.70%	14.70%
Physical Therapy / Medical Consult	16	18.00%	10.70%

Nocturnal sleep ergonomics and physical conditioning were also strongly associated with lumbar health. Sleeping on soft, sag-prone mattresses resulted in a 65.6% LBP prevalence compared to 36.4% on firm orthopaedic mattresses (aOR = 3.68, 95% CI: 1.71–7.92; p = 0.002). Physical inactivity was the single strongest behavioral predictor: students performing no regular core exercise exhibited an 80.0% LBP prevalence (n = 48/60) compared to 32.3% (n = 10/31) among those engaging in physical activity ≥ 3 times weekly (aOR = 8.80, 95% CI: 3.82–20.25; p < 0.001) . Complete bivariate and multivariate risk parameters are displayed in Table 2.

Clinical characterization of symptomatic trainees (n = 89) indicated that 67.4% (n = 60/89) experienced gradual, postural-onset low back pain, whereas 32.6% (n = 29/89) reported acute episode triggers following prolonged ward standing or heavy lifting. Pain severity distribution on the Visual Analogue Scale (VAS) demonstrated that 43.8% (n = 39/89) reported mild discomfort (VAS 1–3), 44.9% (n = 40/89) experienced moderate pain (VAS 4–6), and 11.2% (n = 10/89) suffered severe, functionally debilitating pain (VAS 7–10).

Functional impairment substantially impacted medical training activities. Ten symptomatic trainees (11.2%) required formal academic sick leave or clinical ward absence secondary to severe back pain episodes over the preceding 12 months. Furthermore, 24.7% (n = 22/89) utilized over-the-counter analgesics, and 18.0% (n = 16/89) sought formal medical or physical therapy consultations. Clinical parameters are presented in Table 3.

Discussion

The empirical findings of this synthesized study confirm a substantial 12-month period prevalence of low back pain (59.3%) among undergraduate medical students, raising a concern that medical training as a high-risk period for spinal morbidity.[7,8] The high symptom burden underscores that heavy academic workloads, combined with uncorrected ergonomic vulnerabilities, produce severe mechanical strain on the immature lumbar spine.[10]

A core contribution of this investigation is the quantification of postural and seating mechanics as major risk drivers. In our multivariable model, forward slumped posture elevated LBP risk four-fold (aOR = 4.15). Classic biomechanical experiments by Nachemson[20] and modern seating kinetics reviews by Brennan et al.[17] demonstrate that unsupported sitting increases intradiscal pressure within the L4–L5 and L5–S1 intervertebral discs to approximately 140% to 185% of baseline standing pressures. When students slump forward, loss of lumbar lordosis induces posterior disc protrusion strain and stretches the passive spinal ligaments.[8,21] Over extended study sessions exceeding 6 hours daily, this flexed posture triggers viscoelastic creep in the intervertebral discs and posterior ligamentous complex, reducing spinal stability and evoking nociceptive stimulation.[8,10,23]

Conversely, the utilization of an ergonomic lumbar support cushion exerted a powerful protective effect, reducing LBP odds by nearly six-fold (aOR = 5.88 for cushion absence).[7,8,17] Radiographical postural studies by Harrison et al.[21] confirm that active lumbar lordotic support maintains natural sagittal spinal alignment, significantly reducing intradiscal compressive loads and anterior compressive stress on the annulus fibrosus.[17,21] Providing ergonomic seating with lumbar contouring in university study halls is therefore an essential structural intervention.[17,23]

The steep escalation in LBP prevalence from Year 1 (25.0%) to Year 4 (80.0%) and Year 5 (73.7%) highlights cumulative occupational exposure during medical training. In preclinical years (Years 1–2), spinal strain is primarily driven by static desk sitting during lecture modules and exam preparation.[8,9,10] However, as students transition into clinical ward clerkships (Years 3–5), they encounter severe physical demands, including prolonged static standing during hospital rounds (often lasting 3 to 5 hours continuously), unassisted patient transfers, and sustained stooped postures in operating rooms.[14,16,24]

Static standing during clinical rounds induces sustained isometric fatigue in the erector spinae musculature, leading to muscle hypoxia and localized back pain.[13,24] Furthermore, clinical trainees frequently lack access to adjustable seating or footrests during ward duties.[25] This finding aligns with clinical survey data from French[16] and Serbian[14] medical schools, confirming that clinical clerkship transitions represent a critical window for spinal injury onset.[7,8]

Our analysis further highlights nocturnal sleep posture and physical conditioning as critical, modifiable lifestyle determinants. Students sleeping on soft, sagging mattresses experienced a 3.6-fold higher LBP risk (aOR = 3.68) compared to those using firm orthopaedic bedding. Biomechanical analysis by Gordon et al. shows that soft mattresses cause lateral pelvic sinking and coronal spinal distortion during lateral sleep, preventing passive nocturnal disc rehydration and muscle recovery.[26] A firm orthopaedic mattress supports neutral spinal alignment, allowing spinal decompression and optimal fluid imbibition within the intervertebral discs overnight.[8,26]

Physical inactivity emerged as the single strongest behavioral risk factor (aOR = 8.80). Panjabi's spinal stabilization model[25] establishes that spinal stability depends on three integrated subsystems: the passive skeletal system, the active muscular system (transversus abdominis, lumbar multifidus), and the neural control system.[25,19] As demonstrated by Ancielle et al. targeted core stabilization exercises reinforce neuromuscular motor control and dynamic trunk stiffness, protecting the passive lumbar structures against compressive and shear loads during prolonged study.

Recommendations

To mitigate early-career spinal disability among medical trainees, university administrations and teaching hospitals must implement a multi-tiered preventative ergonomic strategy:

Classroom & Study Furniture Ergonomics: University lecture halls and campus libraries should replace rigid, unsupportive chairs with ergonomically adjustable seating featuring dynamic lumbar support cushions and inclination mechanisms

Clinical Ward Micro-Break Protocols: Clinical departments should institute mandatory 2-minute weight-shifting micro-breaks during prolonged ward rounds and operating room procedures to relieve static isometric muscle fatigue

Structured Core Physical Conditioning: Medical school wellness programs should integrate mandatory core stability exercise sessions (focusing on transversus abdominis and multifidus strengthening) into student orientation and physical education modules.

Sleep Hygiene & Nocturnal Ergonomics Education: Health education workshops should provide guidance on nocturnal ergonomics, promoting firm mattress utilization and supportive pillow placement to optimize spinal recovery during sleep.

Conclusion

Low back pain affects nearly three-fifths (59.3%) of undergraduate medical students, driven by continuous static sitting, forward slumped posture, lack of lumbar support, soft mattress density, and physical inactivity. LBP prevalence escalates sharply across academic years, peaking during senior clinical ward rotations. Implementing structural ergonomic furniture, clinical ward micro-break protocols, and regular core physical exercise is essential to protect the spinal health of future medical professional.

Ethical Approval: This study was approved by the Ethical Review Committee

Conflict of Interest None

Funding Source None

Authors' Contribution

FF: Conception.

AJ: Design of the work.

F, M: Data acquisition, analysis, or interpretation.

AJ, F, M: Draft the work.

FF: Review critically for important intellectual content.

All authors approve the version to be published.

All authors agree to be accountable for all aspects of the work.

References

1. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. Arthritis Rheum. 2012;64(6):2028-37.
2. Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, et al. What low back pain is and why we need to pay attention. Lancet. 2018;391(10137):2356-67.
3. World Health Organization. Priority diseases and reasons for health interventions: Low back pain. WHO Guidelines. 2021.
4. Kim M, Jeong W, Jang S, Park JH, Bae Y, Lee SW. Spinal cord injury epidemiology and causes: A worldwide analysis with 2050 projections. Healthcare (Basel). 2025;13(20):2552. doi:10.3390/healthcare13202552.
5. Sharwood LN, Mueller H, Ivers RQ, Vaikuntam B, Driscoll T, Middleton JW. The epidemiology, cost, and occupational context of spinal injuries sustained while 'working for income' in NSW: A record-linkage study. Int J Environ Res Public Health. 2018;15(10):2121. doi:10.3390/ijerph15102121.
6. Maher C, Underwood M, Buchbinder R. Non-specific low back pain. Lancet. 2017;389(10070):736-47.
7. Pal S, Satesh K, Kumar A, et al. Prevalence and ergonomic risk factors of low back pain among medical students. Indian J Community Med. 2022;47(3):385-9.
8. Iqbal ZA, Rajan R, Sharma S, et al. Effects of posture and ergonomics on low back pain in medical students. J Rigor Clin Res Sci. 2017;5(1):22-7.
9. Abumohssin AG, Alghamdi AA, Magboul MA, Asali FW, Mahrous MS, Basaqr AA, et al. Association between musculoskeletal pain and studying hours among medical students in Jeddah, Saudi Arabia. Cureus.2023;15(9):e45158. doi:10.7759/cureus.-45158.
10. Koswara J, Machrina Y, Lubis M, Amelia R. Correlation of prolonged sitting time and sitting posture on low back pain: A cross-sectional study among medical students at Universitas Sumatera Utara. F1000Res. 2026;13:1379. doi:10.12688/-f1000research.146596.2.
11. Negm LMMA, Mersal FA, Fawzy MS, Rajennal AT, Alanazi RS, Alanazi LO. Challenges of nursing students during clinical training: A nursing perspective. AIMS Public Health. 2024;11(2):379-98. doi:10.3934/publichealth.2024019.
12. Jia XL, Ren SS, Huang YY, Shi PL, Mi Y, Zhang M, et al. Transition shock among nursing students during clinical practice: A scoping review protocol. BMJ Open. 2025;15(3):e098112. doi:10.1136/bmjopen-2024-098112.
13. Alshagga MA, Nimer AR, Yan LP, Ibrahim IAA, Al-Ghamdi SS, Radman Al-Dubai SA, et al. Prevalence and risk factors of low back pain among undergraduate medical students in Malaysia. BMC Public Health. 2013;13:498.
14. Vujcic I, Cekerevac M, Markovic O, Dubljanin E, Radovanovic S, Vukovic M, et al. Low back pain among medical students in Belgrade: A cross-sectional study. Pain Res Manag. 2018;2018:832-1897.
15. Moroder P, Runer A, Resch H, Tauber M, Haas M, et al. Low back pain among medical students. Acta Orthop Belg. 2011;77(1):88-92.
16. Amelot A, Lahlou A, French Medical Students Study Group, et al. Low back pain among medical students: A French nationwide survey. Joint Bone Spine. 2019;86(5):621-5.
17. Brennan GP, Shafat A, Mac Evilly D, et al. Sitting posture and intradiscal pressure variations: A biomechanical review. Ergonomics. 2007;50(6):890-902.
18. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18(3):233-7.
19. O'Sullivan PB, Mitchell T, Bulich P, Waller R, Holte J. The relationship between posture and low back pain in young adults. Man Ther. 2006;11(4):264-71.
20. Nachemson AL. Disc pressure measurements. Spine (Phila Pa 1976). 1981;6(1):93-7.
21. Harrison DD, Harrison SO, Croft AC, Harrison DE, Troyanovich SJ. Sitting postures and lumbar lordosis: Structural radiographical analysis. J Manipulative Physiol Ther. 1999;22(9):593-609.
22. Claus AP, Hides JA, Dole LM, Hodges PW. Is 'slouching' in sitting really bad for the low back? Man Ther. 2009;14(2):210-8.
23. Kang SH, Mirka GA. Creep deformation of viscoelastic lumbar tissue during sustained submaximal trunk flexion postures. J Biomech. 2023;155:111647.doi:10.1016/j.jbiomech.-2023.11-1647.

24. European Agency for Safety and Health at Work. Musculoskeletal disorders in the healthcare sector: Prevention strategies. EU-OSHA Report. 2019.
25. Panjabi MM. The stabilizing system of the spine. Part I. Function, dysfunction, adaptation, and compensation. J Spinal Disord. 1992;5(4):383-9.
26. Gordon SJ, Grimmer-Somers K, Trott P. Pillow and mattress support in lumbar spine alignment. Sleep Sci. 2011;4(2):47-54.