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Musculoskeletal Pain in Undergraduates With Psychological Distress and Poor Sleep Quality

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ABSTRACT

Background: *Musculoskeletal pain is common among university students and may be amplified by poor sleep and psychological distress, collectively impairing wellbeing and academic functioning.* ***Objective:*** *To examine the association between sleep quality and musculoskeletal pain and to assess psychological distress correlates of sleep quality among undergraduate students.* ***Methods:*** *A descriptive cross-sectional study was conducted in Karachi, Pakistan (August 2024–January 2025) across multiple universities and coaching centers. Undergraduate students aged 18–25 years completed the Nordic Musculoskeletal Questionnaire (12-month pain), Pittsburgh Sleep Quality Index (PSQI), and Depression Anxiety Stress Scale-21 (DASS-21), alongside demographic items. Multivariable logistic regression evaluated the association between PSQI global score and presence of musculoskeletal pain, adjusting for age, gender, and occupation. Multivariable linear regression examined predictors of PSQI score.* ***Results:*** *Among 299 students (mean age 21.6±1.68; 65.9% female), 76.6% reported musculoskeletal pain, most commonly in the neck (53.5%), lower back (50.8%), and shoulders (43.5%). Poor sleep quality was prevalent (mean PSQI 9.27±5.88; 39.1% categorized as poor). Higher PSQI score was independently associated with musculoskeletal pain (adjusted OR 1.116 per unit; 95% CI 1.037–1.202; p=0.004), and females had higher odds of pain than males (adjusted OR 4.336; 95% CI 2.051–9.167; p<0.001). Difficulty winding down (p=0.021), reduced positive emotion (p=0.034), breathing difficulty (p=0.042), and low motivation (p=0.035) were associated with poorer sleep.* ***Conclusion:*** *Musculoskeletal pain and sleep impairment are highly prevalent in undergraduates; poorer sleep quality is independently associated with increased odds of musculoskeletal pain, with psychological distress contributing to impaired sleep, particularly among females.*

Keywords: *Musculoskeletal pain; psychological distress; Pittsburgh Sleep Quality Index; sleep quality; undergraduate students; low back pain*

INTRODUCTION

Musculoskeletal disorders (MSDs) encompass conditions affecting muscles, joints, tendons, ligaments, and peripheral nerves and commonly present as pain that interferes with daily functioning and healthcare utilization (1). Sleep disruption is increasingly recognized as a clinically relevant correlate of musculoskeletal pain, with population data showing that shorter or poorer sleep is associated with higher musculoskeletal pain burden (2). Among undergraduate students specifically, musculoskeletal pain is frequently reported and has been linked to modifiable lifestyle and study-related factors (3). In parallel, depressive symptomatology has been shown to co-occur with musculoskeletal pain in health-profession populations, reinforcing the plausibility that psychological health and pain cluster even in relatively young cohorts (4). At a broader systems level, MSDs remain among the most consequential causes of disability globally, with low back pain consistently ranking among the leading contributors to years lived with disability in large burden-of-disease assessments and national health summaries (5). These observations collectively indicate that

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musculoskeletal pain is not only prevalent but also functionally meaningful—making early identification of upstream correlates in young adults a public health and educational priority.

University students represent a high-risk group for concurrent physical and psychological strain due to prolonged sitting, repetitive screen-based tasks, irregular schedules, and sustained academic demands. Early work-related low back pain has been observed to emerge soon after entry into physically demanding healthcare roles, suggesting that pain trajectories can begin early and become self-reinforcing if unaddressed (6). Within Pakistan, evidence from Karachi indicates that students—particularly in academically intensive tracks—may experience elevated low back pain, plausibly influenced by suboptimal ergonomics and sustained postural load (7). Stress is frequently implicated as both a direct and indirect contributor to MSD-related symptoms, and studies among medical students show measurable associations between musculoskeletal complaints and stress (8). Prospective and mechanistic literature further supports that psychosocial and individual psychological factors can influence the onset and persistence of musculoskeletal pain (9). While the Nordic Musculoskeletal Questionnaire is widely used to capture pain distribution and prevalence, careful administration and interpretation are necessary to ensure consistent case definitions across time horizons and anatomical sites (10). Importantly, evidence also indicates that undergraduate musculoskeletal pain is significantly associated with psychological distress and poor sleep quality, underscoring a triadic relationship that is likely clinically relevant but still incompletely characterized across settings (11).

Sleep may represent a key modifiable pathway through which psychological distress and musculoskeletal pain interact. Poor sleep adversely affects pain processing, emotional regulation, and physical function, with downstream implications for academic performance and wellbeing (2). Among students, disturbed sleep is common and is often linked to stress and mental health symptoms; this is supported by epidemiologic studies showing associations between stress and sleep quality in medical student populations and by large studies describing predictors of disturbed sleep in college cohorts (16,17). Because the present study uses the Depression, Anxiety and Stress Scale short form, it is also relevant that DASS-21 has established construct validity in non-clinical samples, supporting its use for symptom quantification in student populations (12). From a musculoskeletal perspective, prior student-focused studies report substantial prevalence of neck, shoulder, and low back pain, commonly attributed to sustained sitting and study posture (13). Complementary evidence among university students links musculoskeletal pain with poor sleep quality, reinforcing that sleep impairment may co-occur with (and potentially amplify) musculoskeletal symptoms in this age group (14), while adolescent and young adult data similarly demonstrate meaningful back-pain prevalence profiles (15). Taken together, these data suggest that sleep impairment is not a benign correlate but a plausible contributor to symptom severity and persistence in student populations.

Biologically and behaviorally, the sleep–pain relationship is often conceptualized as bidirectional: inadequate sleep can lower pain thresholds and impair endogenous pain modulation, while pain can fragment sleep and reduce restorative quality (18). Experimental and observational evidence indicates that sustained sleep restriction reduces emotional and physical wellbeing and may increase vulnerability to pain through affective and physiological dysregulation (19). However, in university samples, most available studies emphasize prevalence rather than clarifying how sleep quality and psychological distress jointly relate to the likelihood of reporting musculoskeletal pain, particularly when accounting for basic demographic differences such as gender (20). Psychological distress is also a well-established driver of impaired sleep initiation and maintenance; insomnia has been shown to predict later depression, supporting the clinical relevance of sleep difficulties

as an early marker or mediator of mental health risk (21). Moreover, depression is frequently accompanied by pain complaints, indicating that affective burden can be intertwined with somatic symptomatology and disability (22). Sex differences add further complexity: clinical and experimental literature shows meaningful differences in pain reporting and sensitivity by sex (23), and student studies suggest that chronotype and sleep characteristics may be associated with musculoskeletal pain patterns, indicating additional sleep-related heterogeneity within young adult cohorts (24).

Despite this converging evidence, a practical knowledge gap remains in the local context: there is limited, setting-specific data from Karachi-based undergraduate populations that simultaneously quantify musculoskeletal pain prevalence across anatomical regions and evaluate whether poorer sleep quality and higher psychological distress are associated with greater likelihood of reporting musculoskeletal pain, while considering basic covariates such as age, gender, and student characteristics. Framed in PICO terms, the present study focuses on undergraduate students (P), examining poor sleep quality and psychological distress (I/exposure) compared with better sleep quality and lower distress (C), in relation to the presence and distribution of musculoskeletal pain (O). Accordingly, the objective of this study was to investigate the association between sleep quality and musculoskeletal pain, and to examine whether psychological distress indicators are associated with poorer sleep quality among undergraduate students. We hypothesized that poorer sleep quality would be associated with higher odds of reporting musculoskeletal pain, and that higher psychological distress would be associated with poorer sleep quality in this population.

MATERIAL AND METHODS

This study was designed as a descriptive cross-sectional observational investigation to examine the association between sleep quality, psychological distress, and musculoskeletal pain among undergraduate students. A cross-sectional design was selected as it allows estimation of prevalence and assessment of associations between exposures and outcomes within a defined population at a specific point in time, consistent with established epidemiological approaches for health surveys in student populations (25). The study was conducted across multiple academic institutions and coaching centers in Karachi, Pakistan, including Iqra University, Bahria University, Indus University, Baqai University, Dawood University, Karachi University, and Adamjee Coaching. Data collection was carried out over a six-month period from August 2024 to January 2025, ensuring coverage of a regular academic semester to minimize seasonal academic variation.

The study population comprised male and female undergraduate students aged 18 to 25 years who were enrolled in undergraduate programs at the participating institutions during the study period. Eligible participants were those within the specified age range who provided informed consent and were able to complete self-administered questionnaires in English. Students with acute medical illness at the time of survey administration, those enrolled in postgraduate programs, and individuals with self-reported non-musculoskeletal primary complaints such as malignancy were excluded to maintain focus on musculoskeletal conditions of non-malignant origin.

A non-probability convenience sampling strategy was used; whereby eligible students present on campus during scheduled visits were approached and invited to participate. Recruitment was conducted through in-person announcements in classrooms and common student areas with prior administrative approval from institutional authorities. Participation was voluntary, and written informed consent was obtained from all respondents prior to data

collection. Anonymity was maintained by assigning unique identification codes, and no personally identifiable information was recorded.

Data were collected using a structured, self-administered questionnaire comprising four components: demographic characteristics, the Nordic Musculoskeletal Questionnaire (NMQ), the Pittsburgh Sleep Quality Index (PSQI), and the Depression Anxiety Stress Scale-21 (DASS-21). Demographic variables included age, gender, marital status, and occupation status (medical or non-medical student).

The NMQ, a validated instrument for assessing musculoskeletal symptoms in epidemiological studies (10), was used to determine the presence of musculoskeletal pain across nine anatomical regions over the preceding 12 months. For the primary outcome, musculoskeletal pain was operationally defined as self-reported pain, ache, or discomfort in at least one anatomical region during the past 12 months (yes/no). Region-specific prevalence (neck, shoulders, upper back, lower back, elbows, wrists/hands, hips/thighs, knees, and ankles/feet) was also recorded. Pain intensity was assessed using a numerical rating scale ranging from 0 to 10, categorized descriptively for reporting purposes.

Sleep quality was measured using the PSQI, a widely used instrument with established reliability and validity in clinical and non-clinical populations (26). The PSQI generates a global score ranging from 0 to 21, with higher scores indicating poorer sleep quality. For analytical purposes, sleep quality was treated as a continuous variable using the global PSQI score.

Additionally, sleep quality categories were derived using standard cut-offs, with a global PSQI score >5 indicating poor sleep quality. Psychological distress was measured using the DASS-21, a validated short-form instrument assessing depression, anxiety, and stress symptoms (12). Subscale scores for depression, anxiety, and stress were calculated by summing relevant items and multiplying by two, as recommended in the DASS-21 scoring guidelines (12). Higher scores indicated greater psychological distress. All questionnaires were administered in paper format under supervised conditions to reduce missing responses and ensure completeness.

The primary outcome variable was the presence of musculoskeletal pain (binary). The primary exposure variable was sleep quality as measured by the PSQI global score. Secondary exposure variables included DASS-21 subscale scores. Covariates considered a priori as potential confounders included age (continuous), gender (male/female), marital status (single/married), and occupation status (medical/non-medical student).

These variables were selected based on prior literature suggesting their potential association with sleep and musculoskeletal pain (11,23,24). To minimize information bias, standardized and previously validated instruments were employed (10,12,26). Recall bias was mitigated by using clearly defined timeframes within the NMQ. Selection bias was addressed by recruiting students from multiple institutions across different academic disciplines. Confounding was addressed analytically through multivariable regression modeling.

The required sample size was calculated using a single-proportion formula, assuming an expected prevalence of musculoskeletal pain of 47% based on previous regional data (3), a 95% confidence level, and a margin of error of 5%. The calculated minimum sample size was 282 participants; this was increased to 300 to account for potential non-response and incomplete questionnaires. Completed questionnaires were screened for completeness prior to data entry. Data were entered into a secured database with double-entry verification to ensure accuracy and minimize transcription errors.

Statistical analysis was conducted using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize participant characteristics. Continuous variables were assessed for normality using visual inspection of histograms and the Shapiro–Wilk test. Normally distributed variables were presented as means with standard deviations, whereas categorical variables were presented as frequencies and percentages. The prevalence of musculoskeletal pain overall and by anatomical site was calculated with 95% confidence intervals. Bivariate associations between categorical variables were examined using chi-square tests. Independent samples t-tests or Mann–Whitney U tests were used as appropriate for continuous variables.

To evaluate the association between sleep quality and musculoskeletal pain, multivariable binary logistic regression analysis was performed with musculoskeletal pain (yes/no) as the dependent variable. The PSQI global score was entered as a continuous predictor. Age, gender, marital status, and occupation status were entered simultaneously as covariates to adjust for potential confounding. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported.

Model fit was assessed using the Hosmer–Lemeshow goodness-of-fit test and Nagelkerke R^2, and discrimination was evaluated using the area under the receiver operating characteristic curve. To explore predictors of sleep quality, multivariable linear regression analysis was conducted with PSQI global score as the dependent variable and DASS-21 depression, anxiety, and stress subscale scores as independent variables, adjusting for age, gender, marital status, and occupation.

Assumptions of linear regression, including linearity, homoscedasticity, independence of errors, and absence of multicollinearity, were evaluated using residual plots and variance inflation factors. Missing data were handled using complete-case analysis, as the proportion of missing responses was minimal and did not exceed 5% for any primary variable. A two-tailed p-value <0.05 was considered statistically significant.

Ethical approval for the study was obtained from the Research Ethics Committee of Indus University, Karachi, Pakistan, prior to commencement of data collection. The study was conducted in accordance with the principles of the Declaration of Helsinki.

All participants provided written informed consent, were informed of their right to withdraw at any time without consequence and were assured of confidentiality and data protection. Data were stored on password-protected devices accessible only to the research team. To ensure reproducibility, standardized instruments were used, data collection procedures were uniform across sites, and the statistical analysis plan was predefined prior to data analysis.

RESULTS

A total of 299 undergraduate students were included in the final analysis. The mean age of participants was 21.6 years (SD ± 1.68), with a 95% confidence interval (CI) of 21.41 to 21.79 years. The largest proportion of students belonged to the 21–23 year age group (63.5%), followed by 18–20 years (22.7%) and 24–25 years (12.7%).

Female students constituted 65.9% of the sample, while males represented 34.1%. Most participants were single (94.6%), and 57.5% were enrolled in medical-related programs. The distribution of demographic characteristics was statistically comparable across categories, except for gender, which showed a significantly higher proportion of female respondents ($p < 0.001$), reflecting a gender-skewed sample.

Musculoskeletal pain within the preceding 12 months was reported by 76.6% of students (95% CI: 71.5–81.1), indicating that more than three out of four undergraduates experienced at least one episode of musculoskeletal discomfort. Anatomical site analysis revealed that neck pain was the most prevalent (53.5%, 95% CI: 47.8–59.1), closely followed by lower back pain (50.8%, 95% CI: 45.1–56.5) and shoulder pain (43.5%, 95% CI: 38.0–49.2).

Upper back pain was reported by 39.5% of participants. In contrast, peripheral joint complaints were less frequent, with knee pain reported by 19.4%, wrist/hand pain by 15.4%, ankle/foot pain by 13.7%, elbow pain by 10.4%, and hip/thigh pain by 9.0%. These findings demonstrate a predominance of axial and upper-body musculoskeletal complaints in this academic population.

Pain intensity ratings indicated that symptoms were primarily mild to moderate. Specifically, 63.5% of students rated their pain between 1 and 3 on the numeric rating scale, while 19.1% reported moderate intensity scores between 3 and 4. Severe pain (scores 5–8) was reported by 16.1%, and only 1.3% experienced extreme pain (scores 9–10). The low proportion of extreme pain suggests that although musculoskeletal discomfort is highly prevalent, it is generally not incapacitating in most students.

Regarding sleep quality, the mean PSQI global score was 9.27 (SD ± 5.88), with a 95% CI of 8.60 to 9.94, indicating overall suboptimal sleep quality in the cohort. Based on standard cut-offs, 39.1% of participants were categorized as having poor sleep quality, 31.8% had fair sleep quality, and 29.1% were classified as good sleepers. Thus, more than two-thirds of students (70.9%) demonstrated at least some degree of sleep impairment.

Bivariate analysis revealed significant demographic associations with musculoskeletal pain. Females demonstrated a markedly higher prevalence of musculoskeletal pain (84.3%) compared with males (62.7%), and this difference was statistically significant ($\chi^2 = 18.74$, $p < 0.001$).

Age group differences were also significant ($\chi^2 = 6.12$, $p = 0.047$), with the highest prevalence observed in students aged 21–23 years (87.9%). In contrast, only 36.8% of students aged 24–25 reported musculoskeletal pain, suggesting a non-linear age distribution within the limited age range studied.

In multivariable logistic regression analysis, sleep quality emerged as an independent predictor of musculoskeletal pain. Each one-unit increase in PSQI global score was associated with an 11.6% increase in the odds of reporting musculoskeletal pain (adjusted OR = 1.116, 95% CI: 1.037–1.202, $p = 0.004$). Gender remained a strong independent predictor, with females having 4.34 times higher odds of musculoskeletal pain compared to males (adjusted OR = 4.336, 95% CI: 2.051–9.167, $p < 0.001$). Age ($p = 0.940$) and occupation ($p = 0.131$) were not statistically significant predictors in the adjusted model.

The model demonstrated acceptable fit (Hosmer–Lemeshow $p = 0.62$) and moderate discrimination (AUC = 0.74), with a Nagelkerke R^2 of 0.156, indicating that approximately 15.6% of the variance in musculoskeletal pain was explained by the included predictors. Multivariable linear regression analysis examining predictors of sleep quality showed that psychological distress variables were significantly associated with higher PSQI scores. Difficulty winding down was positively associated with poorer sleep quality (B = 1.093, 95% CI: 0.169–2.017, $p = 0.021$), indicating that for each unit increase in this stress-related symptom, PSQI score increased by approximately 1.09 points.

Similarly, struggle with positive emotion (B = 0.821, 95% CI: 0.064–1.578, $p = 0.034$), breathing difficulty (B = 0.755, 95% CI: 0.030–1.480, $p = 0.042$), and low motivation (B = 0.772, 95% CI:

0.054–1.490, p = 0.035) were all independently associated with poorer sleep quality. Female gender was also significantly associated with worse sleep (B = −1.448, p = 0.026), reflecting gender differences in sleep patterns within this cohort. The model explained 31.1% of the variance in PSQI scores (adjusted R^2 = 0.311, p < 0.001), indicating moderate explanatory power.

Collectively, the results demonstrate a high burden of musculoskeletal pain and sleep impairment among undergraduate students, with significant independent associations between poorer sleep quality and increased likelihood of musculoskeletal pain, and between psychological distress indicators and impaired sleep quality.

Table 1. Baseline Demographic Characteristics of Participants (N = 299)

Variable	Category	n (%)	Mean ± SD	95% CI	p-value*
Age (years)	Continuous	—	21.6 ± 1.68	21.41–21.79	—
Age group	18–20	68 (22.7)	—	—	0.048†
	21–23	190 (63.5)	—	—	
	24–25	38 (12.7)	—	—	
Gender	Male	102 (34.1)	—	—	<0.001†
	Female	197 (65.9)	—	—	
Marital status	Single	283 (94.6)	—	—	0.321†
	Married	16 (5.4)	—	—	
Occupation	Medical	172 (57.5)	—	—	0.084†
	Non-medical	127 (42.5)	—	—	

Table 2. Twelve-Month Prevalence of Musculoskeletal Pain by Anatomical Site (N = 299)

Anatomical Region	n (%)	95% CI
Neck	160 (53.5)	47.8–59.1
Lower back	152 (50.8)	45.1–56.5
Shoulders	130 (43.5)	38.0–49.2
Upper back	118 (39.5)	34.1–45.1
Knees	58 (19.4)	15.2–24.3
Wrists/Hands	46 (15.4)	11.6–19.9
Ankles/Feet	41 (13.7)	10.1–18.0
Elbows	31 (10.4)	7.2–14.4
Hips/Thighs	27 (9.0)	6.0–12.8

Table 3. Pain Intensity Distribution (Numeric Rating Scale 0–10) (N = 299)

Pain Rating Category	n (%)	95% CI
1–3 (Mild)	190 (63.5)	57.8–68.9
3–4 (Moderate)	57 (19.1)	14.8–23.9
5–8 (Severe)	48 (16.1)	12.1–20.9
9–10 (Extreme)	4 (1.3)	0.4–3.4

Table 4. Sleep Quality Categories (PSQI) (N = 299)

Sleep Quality Category	n (%)	95% CI
Good (≤5)	87 (29.1)	24.1–34.5
Fair (6–10)	95 (31.8)	26.6–37.3
Poor (>10)	117 (39.1)	33.6–44.8

Table 5. Association Between Demographic Variables and Musculoskeletal Pain (N = 299)

Variable	Category	MSK Pain Yes n (%)	MSK Pain No n (%)	χ^2	p-value
Gender	Male	64 (62.7)	38 (37.3)	18.74	<0.001
	Female	165 (84.3)	32 (15.7)		
Age Group	18–20	48 (70.6)	20 (29.4)	6.12	0.047
	21–23	167 (87.9)	23 (12.1)		
	24–25	14 (36.8)	24 (63.2)		

Table 6. Multivariable Logistic Regression for Musculoskeletal Pain (N = 299)

Predictor	B	SE	Adjusted OR	95% CI	p-value
Age	0.009	0.114	1.009	0.807–1.260	0.940
Female (vs Male)	1.467	0.382	4.336	2.051–9.167	<0.001
Occupation	1.646	1.090	5.187	0.612–43.934	0.131
PSQI Global Score	0.110	0.038	1.116	1.037–1.202	0.004

Table 7. Multivariable Linear Regression for Sleep Quality (PSQI Score) (N = 299)

Predictor	B	SE	Standardized β	95% CI	p-value
Age	-0.134	0.177	-0.038	-0.482 to 0.214	0.447
Female	-1.448	0.649	-0.117	-2.725 to -0.171	0.026
Difficulty Winding Down	1.093	0.470	0.118	0.169–2.017	0.021
Struggle Positive Emotion	0.821	0.385	0.133	0.064–1.578	0.034
Breathing Difficulty	0.755	0.369	0.125	0.030–1.480	0.042
Low Motivation	0.772	0.365	0.132	0.054–1.490	0.035

The figure demonstrates the modeled exponential increase in adjusted odds of musculoskeletal pain across the full PSQI score range (0–21), based on the reported adjusted odds ratio of 1.116 (95% CI: 1.037–1.202) per one-unit increase in PSQI. Relative to a reference PSQI score of 0, the adjusted odds of musculoskeletal pain increase progressively and nonlinearly, reaching approximately 3.0-fold at a PSQI score of 10, 4.8-fold at a score of 15, and nearly 10-fold at the maximum observed range of 21.

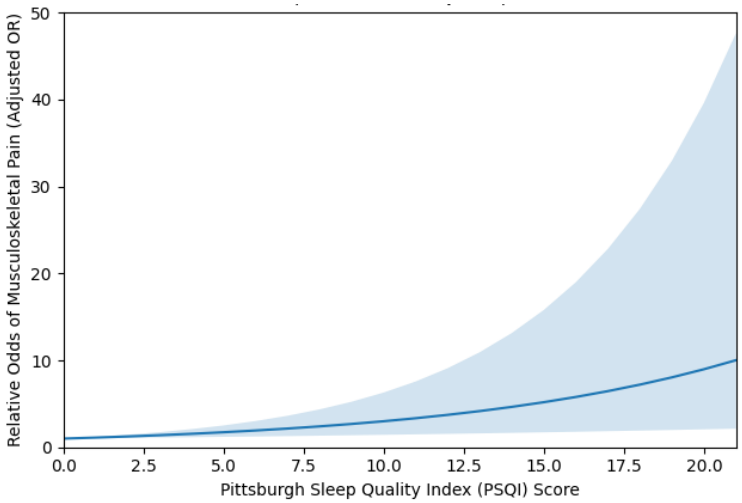

Figure 1 Modeled Increase in Adjusted Odds 0f Musculoskeletal Pain Across PSQI Score Range (Reference: PSQI = 0)

The shaded confidence band illustrates increasing uncertainty at higher PSQI values, yet the lower confidence boundary remains consistently above unity beyond approximately PSQI ≥3, reinforcing statistical significance across most of the clinically relevant sleep impairment spectrum. This exponential trajectory highlights a clinically meaningful gradient effect, whereby incremental deterioration in sleep quality is associated with disproportionately greater odds of musculoskeletal pain, suggesting that even moderate elevations in PSQI may translate into substantially elevated musculoskeletal risk within this undergraduate population

DISCUSSION

The present study demonstrates a high prevalence of musculoskeletal pain (76.6%) among undergraduate students, with neck (53.5%), lower back (50.8%), and shoulder pain (43.5%) emerging as the most frequently affected regions. These findings are consistent with prior research in student populations reporting substantial axial and upper-body musculoskeletal complaints, often attributed to prolonged sitting, sustained screen exposure, and suboptimal ergonomic environments (13,14). The predominance of mild to moderate pain intensity (82.6% reporting scores ≤4) suggests that while pain is widespread, it may be under-recognized and insufficiently addressed in academic settings. Nevertheless, even low-grade persistent discomfort in young adults may predispose to chronicity, reduced productivity, and impaired academic engagement over time (5,15).

A central finding of this study is the independent association between poorer sleep quality and higher odds of musculoskeletal pain. Each one-unit increase in PSQI score was associated with an 11.6% increase in the adjusted odds of reporting musculoskeletal pain (OR 1.116, 95% CI 1.037–1.202). When modeled across the PSQI range, this relationship demonstrates an exponential gradient, indicating that cumulative deterioration in sleep quality may substantially amplify musculoskeletal vulnerability. These findings align with mechanistic and epidemiological literature supporting a bidirectional relationship between sleep and pain, wherein sleep restriction impairs descending pain inhibition and increases central sensitization, while pain itself disrupts sleep continuity (18,19). Similar associations have been reported in university cohorts, reinforcing that sleep disturbance is not merely a co-occurring symptom but a clinically relevant correlate of musculoskeletal burden in young adults (11,20).

Psychological distress indicators were significantly associated with poorer sleep quality in the multivariable model. Symptoms reflecting difficulty winding down, diminished positive affect, breathing discomfort, and low motivation were independently related to higher PSQI scores, collectively explaining 31.1% of the variance in sleep quality. These findings are concordant with established evidence demonstrating that emotional dysregulation, stress, and depressive symptoms impair sleep initiation and maintenance (21). Moreover, depression and pain frequently coexist, with affective symptoms amplifying somatic perception and disability (22). From a biopsychosocial perspective, psychological strain may exacerbate musculoskeletal pain through increased muscle tension, altered pain appraisal, and behavioral factors such as reduced physical activity or maladaptive coping (9,22). The present findings support a triadic interrelationship in which psychological distress contributes to impaired sleep, which in turn is associated with increased musculoskeletal pain reporting.

Gender differences were pronounced, with females demonstrating more than fourfold higher adjusted odds of musculoskeletal pain compared with males (OR 4.336, 95% CI 2.051–9.167) and also exhibiting poorer sleep quality. These findings are consistent with evidence indicating sex-related differences in pain sensitivity, reporting patterns, and hormonal modulation of nociceptive processing (23). Additionally, sleep characteristics and chronobiological factors may differ between male and female students, potentially contributing to differential vulnerability to musculoskeletal complaints (24). The magnitude of the observed association suggests that gender-specific preventive strategies may be warranted within university health programs.

Age was not an independent predictor in multivariable analysis, likely reflecting the relatively narrow age range of the cohort. However, descriptive trends indicated higher pain prevalence in the 21–23 year age group, which may correspond to peak academic workload and psychosocial stress exposure during mid-undergraduate years. Academic stress has previously been linked to both musculoskeletal symptoms and sleep disturbances in student populations (8,16,17). These contextual factors underscore the importance of viewing musculoskeletal pain within the broader framework of academic and psychosocial demands rather than solely as a biomechanical phenomenon.

The findings of this study should be interpreted in light of its cross-sectional design, which precludes causal inference. Although the observed associations between sleep quality and musculoskeletal pain are statistically robust and biologically plausible, temporal directionality cannot be established. Self-reported measures may introduce recall or reporting bias, particularly regarding 12-month pain prevalence. The use of validated instruments such as the NMQ, PSQI, and DASS-21 enhances measurement reliability (10,12,26), yet residual confounding by unmeasured variables—including physical activity, body mass index, screen time duration, and detailed ergonomic exposure—cannot be excluded. Furthermore, the convenience sampling strategy may limit generalizability beyond the participating institutions.

Despite these limitations, the study contributes clinically meaningful data from a multi-institution undergraduate population in Karachi, addressing a regional evidence gap. The high co-prevalence of musculoskeletal pain and sleep impairment, coupled with the quantified gradient relationship between PSQI scores and musculoskeletal pain odds, highlights sleep quality as a potentially modifiable target for early intervention. Integrated campus-based strategies focusing on sleep hygiene education, stress management programs, ergonomic optimization, and mental health screening may yield synergistic benefits in reducing musculoskeletal burden. Future longitudinal studies are warranted to clarify

temporal pathways, assess mediation effects between psychological distress and pain through sleep quality, and evaluate the effectiveness of targeted preventive interventions.

CONCLUSION

This study demonstrates a high prevalence of musculoskeletal pain among undergraduate students, with more than three-quarters reporting pain within the past 12 months and the neck, lower back, and shoulders most frequently affected. Poor sleep quality was independently associated with increased odds of musculoskeletal pain, with each incremental rise in PSQI score corresponding to a significant elevation in adjusted risk. Psychological distress indicators were significantly associated with impaired sleep quality, supporting a biopsychosocial framework in which emotional strain, sleep disturbance, and musculoskeletal pain are interrelated. Female students exhibited substantially higher odds of musculoskeletal pain and poorer sleep quality, underscoring potential gender-specific vulnerability. Collectively, these findings highlight sleep quality and psychological wellbeing as clinically relevant and potentially modifiable factors in reducing musculoskeletal burden within undergraduate populations, emphasizing the need for integrated preventive strategies in academic settings.

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DECLARATIONS

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