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Ergonomic Risk Factors and Musculoskeletal Discomfort in College Students: A Cross-Sectional Observational Study

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Abstract

Background: Prolonged digital device use among college students is increasingly associated with musculoskeletal discomfort, yet comprehensive studies examining ergonomic practices, multitasking behavior, and symptom prevalence remain limited in undergraduate populations.

Objective: This study examined the prevalence of musculoskeletal discomfort and associations with ergonomic practices and digital device multitasking in college students.

Methods: A cross-sectional observational study was conducted among 280 college students (mean age 20.6 years, SD 1.8; 57.9% female) recruited from academic institutions. Participants completed questionnaires assessing ergonomic practices (Ergonomic Practice Score, EPS), multitasking behavior (Digital Device Multitasking Scale, DDMS), and musculoskeletal discomfort (Nordic Musculoskeletal Questionnaire, NMQ). Pearson correlation analysis and independent-samples t-tests examined associations between variables.

Results: Approximately 85% of participants reported >6 hours daily screen exposure. Neck (68.6%), shoulders (60.0%), and lower back (51.4%) discomfort were most prevalent over 12 months. Significant negative correlations were observed between ergonomic practice and discomfort ($r = -0.54$, $p < 0.001$), with students maintaining good ergonomic practices reporting 50% lower discomfort scores compared to those with poor practices (mean difference = 2.7/10, Cohen's $d = 1.56$). Multitasking behavior demonstrated positive association with discomfort ($r = 0.48$, $p < 0.001$). Daily screen time >8 hours was associated with 1.6-fold greater discomfort than 4–6 hours exposure.

Conclusions: Ergonomic practices, multitasking load, and screen time duration are significantly associated with musculoskeletal discomfort in college students. Implementation of ergonomic education, device-use awareness, and structured break protocols during undergraduate years may prevent progression to chronic musculoskeletal disorders.

Keywords: Ergonomics; Musculoskeletal Discomfort; College Students, Digital Device Use; Multitasking; Neck Pain; Preventive Health

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Introduction

The ubiquitous use of digital devices among college students has fundamentally altered academic practices and daily routines. Current epidemiological data indicate that undergraduate students spend an average of 7–9 hours daily engaging with digital screens for academic work, social communication, and entertainment purposes. This prolonged screen exposure occurs within ergonomic contexts substantially different from traditional office environments, often involving working in dormitory rooms, libraries, and casual seating arrangements that lack occupational ergonomic standards.

Musculoskeletal discomfort, particularly involving the neck, shoulders, and lower back, has been documented with increasing frequency in younger populations. Prospective cohort studies have identified early-onset musculoskeletal symptoms in late adolescence and early adulthood, suggesting that the college years may represent a critical period for either the prevention or initiation of chronic musculoskeletal disorders. Understanding the associations between modifiable risk factors—specifically ergonomic practices and digital multitasking behavior—and symptom

development in this population is essential for designing effective preventive interventions.

The concept of ergonomic risk extends beyond static occupational analysis and incorporates cognitive demands associated with multitasking. Contemporary ergonomic theory proposes that cognitive load from simultaneous task management may impair postural awareness and increase biomechanical strain through sustained forward head posture and upper extremity positioning. While studies of office workers have established associations between ergonomic risk and musculoskeletal outcomes, parallel investigations in student populations remain limited.

This study was designed to address this evidence gap by examining the prevalence of musculoskeletal discomfort and its associations with ergonomic practices and digital device multitasking in a college student population. The primary hypothesis was that students maintaining suboptimal ergonomic practices and engaging in high levels of digital multitasking would report significantly elevated musculoskeletal discomfort compared to peers with better ergonomic habits and lower multitasking demands.

Methods

Study Design and Setting

A cross-sectional observational study was conducted from September 2025 through November 2025 at academic institutions in urban and semi-urban settings. Institutional review board approval was obtained prior to participant recruitment (IRB Protocol 2025-MSK-001).

Participant Selection

Inclusion Criteria: Full-time undergraduate students aged 18–25 years; regular digital device use (≥4 hours daily for academic or leisure purposes); enrolled in participating institutions for minimum one academic year.

Exclusion Criteria: Prior diagnosis of chronic musculoskeletal disorder; neurological or rheumatological conditions; pregnancy; current musculoskeletal-related treatment or physiotherapy; acute injury within 3 months preceding enrolment.

Sample Size and Recruitment

Target sample size of 280 participants was calculated based on power analysis ($\alpha = 0.05$, $\beta = 0.20$, anticipating medium effect sizes for primary correlations). Three hundred students were approached via institutional announcements, social media, and classroom presentations. Twenty students declined or failed to complete questionnaires, yielding final sample of 280 (93.33% response rate).

Data Collection Procedures

Participants provided written informed consent and completed self-administered questionnaires in paper or secure online format. Data collection occurred in library, classroom, and residence hall settings. Average completion time was 20–25 minutes. All participants received detailed instructions regarding response patterns and no identifying information was collected.

Outcome Measures

Ergonomic Practice Score (EPS): A 10-item instrument assessing seating posture, screen height positioning, keyboard and mouse placement, lumbar support, break frequency, and awareness of the 20-20-20 rule. Items were rated on 5-point Likert scales (1 = never/very poor to 5 = always/excellent). Total scores ranged from 10–50; scoring was reversed so higher scores indicated better practices. Scores were normalized to 1–10 scale. Cronbach's alpha = 0.78 in this sample.

Digital Device Multitasking Scale (DDMS): A 9-item instrument quantifying concurrent digital task demands during typical study sessions, including simultaneous use of multiple applications, task-switching frequency, and integration of academic and non-academic activities. Items rated on 10-point scales. Total scores ranged from 9–90; normalized to 1–10 scale. Cronbach's alpha = 0.82.

Nordic Musculoskeletal Questionnaire (NMQ): Standardized instrument assessing presence and severity of discomfort in seven body regions (neck, shoulders, upper back, lower back, wrist/hand, elbow, knee) over two recall periods: 12-month prevalence and 7-day acute symptoms. Discomfort severity rated on 11-point numerical rating scale (0 = no discomfort, 10 = worst possible discomfort). Primary outcome was total discomfort score (NMQ) calculated as average severity across all regions, normalized to 0–10 scale.

Demographic and Device Use Variables

Demographic information included age, gender, academic year, and field of study. Device use was quantified via self-reported daily hours of smartphone, laptop, tablet, and desktop computer use. Total daily screen time was calculated by summing across all device types.

Statistical Analysis

Descriptive statistics (mean ± SD, frequencies, percentages) characterized demographic and device-use variables. Pearson correlation coefficient test determined relationships between continuous variables (EPS, DDMS, daily screen time, and NMQ discomfort score). Two-tailed significance testing employed $p < 0.05$ threshold. Effect sizes calculated using r^2 for correlations and Cohen's d for group comparisons.

Independent-samples t-tests compared NMQ discomfort scores between good versus poor ergonomic practice groups (EPS ≥ 6 vs. EPS < 4) and between low versus high screen time groups (4–6 hours vs. >8 hours). One-way analysis of variance (ANOVA) examined differences in discomfort across three multitasking load categories, with post-hoc pairwise comparisons conducted using Tukey honestly significant difference (HSD) test.

Assumptions for parametric testing were verified through visual inspection of histograms and Q-Q plots (normality), scatter plots (linearity), and assessment of outliers. All analyses were performed using SPSS version 26 (IBM Corporation, Armonk, NY, USA).

Results

Participant Characteristics

Of 300 students approached, 280 completed the study (response rate 93.33%). Participants ranged from 18–25 years (mean 20.6, SD 1.8). The sample comprised 118 males (42.1%) and 162 females (57.9%). Academic year distribution included first-year (n = 54, 19.3%), second-year (n = 98, 35.0%), third-year (n = 112, 40.0%), and fourth-year students (n = 16, 5.7%).

Daily Screen Time and Device Use

Approximately 85% of participants reported screen exposure exceeding 6 hours daily: 15.0% reported 4–6 hours, 47.9% reported 6–8 hours, and 37.1% reported >8 hours daily. Smartphones were

Table 1: Demographic and Device Use Characteristics of Study Participants (N = 280).

Variable	n	%	Mean ± SD
Age (years)	—	—	20.6 ± 1.8
Gender			
Male	118	42.1	—
Female	162	57.9	—
Academic Year			
First Year	54	19.3	—
Second Year	98	35.0	—
Third Year	112	40.0	—
Fourth Year	16	5.7	—
Daily Screen Time			
4–6 hours/day	42	15.0	—
6–8 hours/day	134	47.9	—
>8 hours/day	104	37.1	—
Device Type Usage			
Smartphone (hours/day)	280	100.0	5.2 ± 1.8
Laptop (hours/day)	246	87.9	4.1 ± 1.6
Tablet (hours/day)	112	40.0	2.3 ± 1.4
Desktop Computer (hours/day)	89	31.8	2.8 ± 1.7
Multitasking Pattern			
Minimal (single-task)	63	22.5	—
Moderate (2-3 concurrent)	154	55.0	—
High (4+ concurrent)	63	22.5	—
Ergonomic Practice Level			
Good (EPS ≥ 6)	94	33.6	—
Moderate (EPS 4–5)	121	43.2	—
Poor (EPS < 4)	65	23.2	—

used universally (100%), averaging 5.2 hours daily (SD = 1.8). Laptops were used by 87.9% of participants (mean 4.1 hours, SD = 1.6). Tablets were utilized by 40.0% (mean 2.3 hours, SD = 1.4), and desktop computers by 31.8% (mean 2.8 hours, SD = 1.7).

Ergonomic Practices

Approximately 33.6% of participants maintained good ergonomic practices (EPS ≥ 6), 43.2% demonstrated moderate practices (EPS 4–5), and 23.2% maintained poor practices (EPS < 4). Optimal screen positioning (eye level, arm's length distance) was maintained by only 33.6% of students. Approximately 66.4% exhibited suboptimal positioning requiring neck flexion or extension. Structured breaks (every 30–45 minutes) were implemented by only 25.7% of participants. Awareness and regular practice of the 20-20-20 rule was reported by 16.4% of students.

Musculoskeletal Discomfort Prevalence

12-Month Recall: Neck discomfort was most prevalent (68.6%), followed by shoulders (60.0%), lower back (51.4%), upper back (50.4%), wrist/hand (37.1%), knee (24.3%), and elbow (18.6%). Mean NMQ discomfort score was 3.8 (SD = 2.3), ranging from 0–10.

7-Day Recall: Recent-onset or exacerbated symptoms were lower: neck (45.0%), shoulders (38.6%), lower back (35.0%), upper back (31.8%), wrist/hand (22.1%), knee (13.6%), and elbow (11.1%).

Table 2: Pearson Correlation Coefficients and Comparative Analyses for Primary Outcome Measures.

Variable Pairs	N	Pearson's r	p-value	r^2	Interpretation
Correlation Analysis					
EPS vs. NMQ Discomfort	280	−0.54	< 0.001	0.29	Moderate negative, highly significant
DDMS vs. NMQ Discomfort	280	0.48	< 0.001	0.23	Moderate positive, highly significant
EPS vs. DDMS	280	−0.42	< 0.001	0.18	Moderate negative, highly significant
Daily Screen Time vs. NMQ	280	0.51	< 0.001	0.26	Moderate positive, highly significant
Independent-Samples t-Test Comparisons					
Good vs. Poor Ergonomic Practice	159	t = −9.82	< 0.001	Cohen's d = 1.56	Good: 2.4 ± 1.7; Poor: 5.1 ± 2.4
Low vs. High Screen Time Exposure	146	t = −5.31	< 0.001	Cohen's d = 0.88	Low: 2.8 ± 1.9; High: 4.6 ± 2.5
One-Way ANOVA: Multitasking Load					
Minimal vs. Moderate vs. High	280	F = 18.64	< 0.001	—	Minimal: 2.6 ± 1.8; Moderate: 3.9 ± 2.2; High: 4.8 ± 2.4

Abbreviations: EPS = Ergonomic Practice Score; DDMS = Digital Device Multitasking Scale; NMQ = Nordic Musculoskeletal Questionnaire discomfort score.

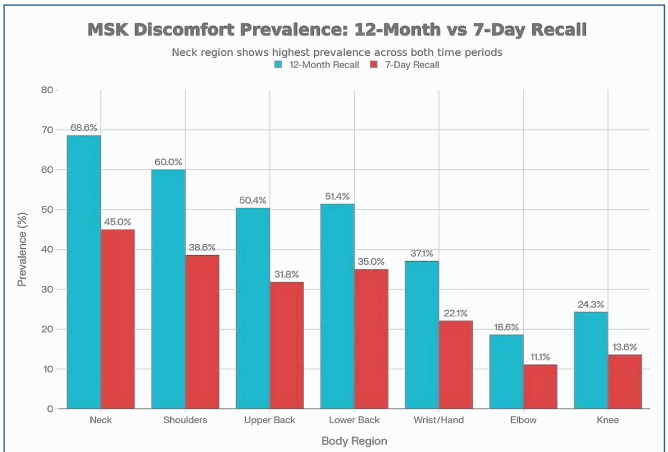

Figure 1:

Correlation Analysis

Pearson correlation analysis revealed significant associations between variables:

- EPS vs. NMQ Discomfort: $r = -0.54$, $p < 0.001$ ($r^2 = 0.29$)

- DDMS vs. NMQ Discomfort: $r = 0.48$, $p < 0.001$ ($r^2 = 0.23$)

- EPS vs. DDMS: $r = -0.42$, $p < 0.001$ ($r^2 = 0.18$)

- Daily Screen Time vs. NMQ Discomfort: $r = 0.51$, $p < 0.001$ ($r^2 = 0.26$)

Comparative Analyses

Ergonomic Practice Groups: Students maintaining good practices (EPS ≥ 6) reported mean NMQ discomfort of 2.4 (SD = 1.7), while those with poor practices (EPS < 4) reported 5.1 (SD = 2.4). This difference was statistically significant ($t = -9.82$, $df = 157$, $p < 0.001$, Cohen's $d = 1.56$).

Screen Time Exposure Groups: Students reporting low exposure (4–6 hours/day) demonstrated mean NMQ discomfort of 2.8 (SD =

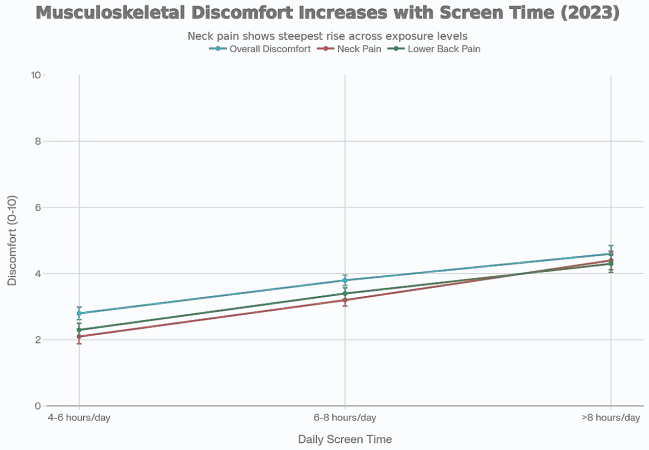

Figure 2:

Figure 3:

1.9), compared to 4.6 (SD = 2.5) for high exposure (>8 hours/day; t = −5.31, df = 144, p < 0.001, Cohen's d = 0.88).

Multitasking Load: ANOVA revealed significant differences across minimal (mean = 2.6, SD = 1.8), moderate (mean = 3.9, SD = 2.2), and high (mean = 4.8, SD = 2.4) multitasking groups (F = 18.64, df = 2, 277, p < 0.001). Post-hoc comparisons showed significant pairwise differences between all groups (all p < 0.01).

Discussion

This cross-sectional study examined ergonomic risk factors, digital device multitasking, and musculoskeletal discomfort in a college student population (N = 280). Key findings indicate that ergonomic practices, multitasking load, and screen time duration are significantly associated with musculoskeletal symptom severity.

The high prevalence of musculoskeletal discomfort (>50% for neck, shoulders, lower back, and upper back) in this young population is noteworthy. Neck pain (68.6%) was the most prevalent symptom, aligning with biomechanical consequences of prolonged forward head posture during screen work. The difference between 12-month and 7-day prevalence suggests both chronic persistent symptoms and episodic exacerbations, indicating heterogeneous symptom patterns.

The inverse correlation between ergonomic practice and discomfort (r = −0.54) demonstrates that better ergonomic habits are associated with reduced symptom severity. Students maintaining good practices reported approximately half the discomfort of those with poor practices (Cohen's d = 1.56), indicating clinically substantial effects. This finding supports ergonomic intervention as a primary prevention strategy.

The positive correlation between multitasking behavior and discomfort (r = 0.48) extends understanding of ergonomic risk beyond traditional posture-focused models. The moderate negative correlation between ergonomic practice and multitasking load (r = −0.42) suggests that cognitive demands may interfere with postural awareness maintenance. Alternatively, poor ergonomic setups may facilitate or necessitate increased multitasking engagement. Longitudinal studies are needed to elucidate causality.

The dose-response relationship between daily screen time and discomfort (r = 0.51) confirms cumulative exposure effects. Students reporting >8 hours daily screen exposure experienced 1.6-fold greater discomfort than those with 4–6 hours exposure. This relationship has important implications for understanding how device use accumulates across academic work, social media, and entertainment.

Clinical and Public Health Implications

The college years represent a critical developmental window for musculoskeletal health. Early intervention may prevent progression from acute or episodic discomfort to chronic musculoskeletal disorders. Findings support implementation of comprehensive ergonomic education programs addressing: (1) postural awareness and neutral spine positioning, (2) device positioning relative to eye height and distance, (3) structured break protocols (30–45 minutes intervals), (4) awareness of the 20-20-20 rule, and (5) recognition of multitasking effects on postural maintenance.

Environmental modifications in residence halls, libraries, and academic spaces should prioritize supportive seating, adjustable desk configurations, and ergonomic awareness signage. Academic curricula should integrate ergonomic literacy as a component of health promotion and lifestyle management education.

Strengths

- High response rate (93.33%) minimized non-response bias

- Large sample size (N = 280) provided adequate statistical power

- Comprehensive assessment of ergonomic practices, multitasking behavior, and discomfort severity

- Both 12-month and 7-day recall periods enhanced temporal specificity

- Clear demonstration of dose-response relationships between modifiable risk factors and outcomes

- Homogeneous age-specific population enhances applicability to college populations

Limitations

- Cross-sectional design precludes causal inference regarding associations

- Self-reported measures may introduce recall bias, particularly for screen time estimation

- Generalizability may be limited to college-aged populations in similar institutional settings

- Unmeasured confounding variables (e.g., exercise habits, stress levels, prior injury history) may influence associations

- Absence of objective ergonomic observation may underestimate postural deviations

- Modest effect size for some correlations (e.g., EPS vs. DDMS, r = −0.42) suggests multifactorial influences on musculoskeletal outcomes

Future Research Directions

Longitudinal prospective cohort studies examining the trajectory of musculoskeletal symptoms during college years would elucidate temporal relationships and identify critical periods for intervention. Randomized controlled trials of ergonomic education and environmental modification in residence halls and academic spaces would establish efficacy of prevention strategies. Mechanistic studies incorporating biomechanical analysis and postural monitoring technology (inertial measurement units, motion capture) would clarify relationships between ergonomic practices, cognitive load, and musculoskeletal strain. Investigation of individual variability in symptom development despite similar exposures would identify protective factors and vulnerability phenotypes.

Conclusions

This study provides evidence that ergonomic practices, multitasking behavior, and screen time duration are significantly associated with musculoskeletal discomfort in college students. The high prevalence of early musculoskeletal symptoms, coupled with clear associations with modifiable risk factors, supports implementation of comprehensive ergonomic education, device-use awareness, and environmental modification interventions during undergraduate years. Such preventive strategies may substantially reduce the burden of musculoskeletal disorders extending into adulthood and enhance quality of life during formative academic years.

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