Journal of Health, Wellness and Community Research
ISSN: 3007, 0570

OPEN ACCESS

JHWCR

Type: Original Article
Published: 05 February 2025
Volume: III, **Issue**: I
DOI: https://doi.org/10.61919/wg24bx41

Correspondence
✉ Ramiza khalid, drramizakhalid@gcuf.edu.pk

Received 07, 01, 25
Accepted 02, 02, 2025

Authors' Contributions
Concept: RK; Design: RK, SAA; Data Collection: RK, SAA; Analysis: AJK, MUK; Drafting: RK, MUK

Declarations
No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

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Postural and Musculoskeletal Effects of Smartphone Use on the Neck and Upper Extremities in University Students

Ramiza khalid[1], Syed Asadullah Arslan[2], Abdul Jalil khan[3], Muhammad Usman Khan[4]

[1] Government College University Faisalabad, Faisalabad, Pakistan
[2] The Superior University Lahore, Lahore, Pakistan
[3] NHS London, London, United Kingdom
[4] Ziauddin University Karachi, Karachi, Pakistan

ABSTRACT

Background: Smartphone use is highly prevalent among university students and commonly involves sustained neck flexion and unsupported upper-limb postures, which may be associated with musculoskeletal symptoms of the neck and upper extremities. Objective: To estimate the prevalence of neck and upper-extremity symptoms among university smartphone users and to evaluate associations between symptoms and self-reported smartphone-use posture (neck posture, back support, and arm support). Methods: A cross-sectional survey was conducted in 2018 among 180 university students (18–30 years) who used smartphones for at least four hours daily and reported at least one year of smartphone exposure. A structured questionnaire assessed demographics, smartphone-use patterns, postures during use (neck flexed vs neutral; back supported vs unsupported; arm raised with vs without support), and symptom presence and characteristics. Associations were tested using chi-square analyses with effect sizes summarized as odds ratios. Results: Overall, 171/180 participants reported at least one neck or upper-extremity symptom (95.0%). Pain was the most common symptom (53.9%), and the neck was the most frequently affected region (47.2%). Symptom prevalence was higher in participants reporting flexed neck posture (144/144; 100.0%) than neutral posture (27/36; 75.0%) ($p<0.001$), and in those using unsupported raised-arm posture (122/123; 99.2%) than supported posture (49/57; 86.0%) ($p<0.001$). Unsupported back posture was also associated with higher symptom prevalence (97/99; 98.0%) than supported back posture (74/81; 91.4%) ($p=0.043$). Conclusion: Neck and upper-extremity symptoms were highly prevalent and were associated with forward-flexed neck posture and unsupported raised-arm posture during smartphone use.

Keywords

smartphone use; neck pain; upper extremity; posture; musculoskeletal symptoms; university students

INTRODUCTION

Smartphone use has become a dominant mode of communication, information access, and entertainment among university students, with prolonged daily exposure increasingly recognized as an ergonomic and public health concern. Contemporary smartphones facilitate sustained visual attention and repetitive touch-screen interactions that often occur in constrained postures, and problematic or addictive patterns of use have been linked to functional consequences, including neck-related disability in young users (1). Alongside this behavioral shift, a growing body of occupational and applied ergonomics literature indicates that intensive handheld device use is associated with musculoskeletal complaints, particularly affecting the cervical region and upper extremities (2,3). Systematic evidence suggests that neck complaints are among the most frequently reported symptoms in handheld device users, with prevalence estimates varying widely across populations and settings, reflecting heterogeneity in exposure intensity, symptom definitions, and measurement approaches (4).

From a biomechanical perspective, smartphone tasks commonly encourage sustained neck flexion, reduced back support, and elevated or unsupported upper-limb postures, which can increase cervical loading and upper-limb muscular demand (5,6). Observational and laboratory studies have documented that users frequently hold phones below eye level, promoting forward head posture and measurable neck flexion during routine smartphone activities (7). Epidemiologic work in occupational settings has also demonstrated associations between repetitive work exposures and disorders of the neck and upper limbs, supporting the plausibility that cumulative loading and constrained postures contribute to symptom development (8). In parallel, modeling and clinical discussions have emphasized that increasing neck flexion can markedly amplify the effective load on cervical structures, potentially elevating tissue strain during sustained use (9). Repetitive thumb activity and prolonged touch-screen interaction may additionally contribute to localized hand and thumb symptoms through cumulative tendon and soft-tissue loading (10,11).

Despite converging evidence that posture and usage patterns may influence symptom occurrence, key uncertainties remain in student populations in low- and middle-income settings regarding the distribution of symptoms across the neck-to-hand kinetic chain and the extent to which common smartphone postures—particularly forward-flexed neck posture, unsupported back posture, and unsupported raised-arm posture—are associated with reported symptoms. Prior university-based work has documented substantial symptom prevalence among handheld device users and highlighted posture- and technique-related differences in muscle activity and kinematics during texting and smartphone use (12,13). Studies focusing on risk factors for neck disorders among university smartphone users also indicate that posture and exposure intensity are relevant correlates, but findings vary by setting and measurement methods (14). Accordingly, in university students who are daily smartphone users with prolonged exposure, the present cross-sectional study was designed to estimate the prevalence of neck and upper-extremity symptoms and to test whether forward-flexed neck posture with lack of back support and unsupported raised-arm posture are associated with the presence of symptoms in the neck and upper extremities. The research question was: among university students who use smartphones for at least four hours daily, are

DOI: https://doi.org/10.61919/wg24bx41

forward-flexed neck posture, lack of back support, and unsupported raised-arm posture during smartphone use associated with a higher prevalence of self-reported neck and upper-extremity musculoskeletal symptoms (15)?

MATERIALS AND METHODS

A cross-sectional observational survey was conducted among university students at Government College University Faisalabad, Pakistan, over a three-month period in 2018. The target population comprised enrolled students across multiple faculties, with the total university student population reported as approximately 20,000 at the time of the study. A probability-based approach described as simple random sampling was applied to recruit 180 participants from diverse academic faculties, including arts and social sciences, economics and management sciences, engineering, Islamic and oriental learning, life sciences, pharmaceutical sciences, and physical sciences, encompassing both main and new campuses. The final sample size was selected to provide stable prevalence estimates for symptoms and to support contingency-table analyses with adequate cell sizes for testing associations between posture categories and symptom presence (16).

Eligibility criteria were predefined to focus on prolonged smartphone exposure in young adults. Students were eligible if they were 18–30 years of age, currently enrolled at the university, used a smartphone daily, reported at least four hours of smartphone use per day, and had at least one year of smartphone exposure. Students using non-smartphone mobile devices and those reporting any pre-existing pathology affecting the neck or upper extremity were excluded to reduce outcome misclassification and confounding by prior disease. Participants were approached and informed about study purpose and procedures; written informed consent was obtained before data collection. To support confidentiality, personal identifiers were not disclosed in reporting, and responses were handled in aggregate form (17).

Data were collected using a structured questionnaire administered to capture demographics, smartphone exposure characteristics, posture-related exposures during smartphone use, and symptom outcomes affecting the neck and upper extremities. The instrument included an initial demographic section (e.g., age, sex, faculty/department, semester, and city of residence) followed by 17 structured items addressing: smartphone use status and daily use; handling pattern (one-handed vs two-handed); daily duration of smartphone use (4–6 hours, 6–8 hours, >8 hours); years of smartphone use (1 year, 2 years, >2 years); use of breaks during smartphone use (yes/no); primary purpose of smartphone use (texting, social media, calling); posture during smartphone use, including neck posture (flexed forward vs neutral), back support (supported vs unsupported), and arm posture (raised with support vs raised without support); and pre-existing pathology screening (18).

The primary outcome was the presence of any self-reported symptom in the neck or upper extremity during smartphone use, operationalized as a dichotomous variable (yes/no). Among symptomatic participants, secondary outcome descriptors included the dominant symptom type (pain, fatigue, stiffness, numbness), the anatomical region most affected (neck, shoulder, elbow, hand), symptom pattern (localized vs radiating), and symptom response to rest (disappears with rest vs persists). The primary exposures of interest were self-reported neck posture during smartphone use (flexed forward vs neutral), back support during smartphone use (unsupported vs supported), and arm posture during smartphone use (raised without support vs raised with support). Additional covariates collected for descriptive and analytical purposes included age category (18–23 vs 24–30 years), sex, daily duration of smartphone use, years of smartphone use, use of breaks, and handling pattern (one-handed vs two-handed), as these factors may be associated with both posture and symptom reporting (19,20).

To reduce information bias, the same questionnaire structure and response options were used for all participants, with standardized explanation of items at administration. Excluding participants with pre-existing neck or upper-limb pathology was used to mitigate confounding by established disorders and to improve interpretability of posture–symptom associations in relation to smartphone exposure. Because posture and symptoms were self-reported, the study design emphasized consistent operational categories (flexed vs neutral neck posture; supported vs unsupported back; supported vs unsupported raised-arm posture) to facilitate reproducible classification for analysis (21).

Statistical analysis was performed using SPSS version 17. Descriptive statistics were used to summarize demographic characteristics, smartphone exposure patterns, posture categories, and symptom distributions, reporting frequencies and percentages for categorical variables. Associations between symptom presence (yes/no) and posture exposures (neck posture, back support, arm posture) were assessed using chi-square tests of independence with a two-sided significance threshold of 0.05. In addition to hypothesis testing, effect size estimation was planned by computing odds ratios with 95% confidence intervals for each posture exposure contrasted against its reference category to quantify the magnitude of association in clinically interpretable terms. Where data completeness permitted, multivariable binary logistic regression was specified to estimate adjusted odds ratios for symptom presence while controlling for plausible confounders (sex, age category, daily duration of smartphone use, years of use, use of breaks, and handling pattern), recognizing that exposure intensity and technique may influence both posture and symptom reporting (22,23). Analyses were conducted on complete cases for variables included in each model, with denominators reported for transparency in each results table (24).

Ethical safeguards included voluntary participation, informed consent, explanation of study purpose and procedures, and protection of participant confidentiality through restricted access to survey responses and reporting of aggregate findings only (17).

RESULTS

A total of 180 university students participated, with a higher proportion of females (62.2%) than males (37.8%). Most participants were aged 18–23 years (74.4%), were in semesters 1–5 (78.3%), and resided in Faisalabad (77.8%) (Table 1). Nearly all participants reported daily smartphone use (97.2%), and one-handed handling predominated (65.6%). Daily exposure was substantial, with 30.6% using smartphones for more than eight hours/day and 42.2% reporting more than two years of smartphone use. Forward-flexed neck posture was reported by 80.0% of respondents, while 68.3% reported holding the arm raised without support during use, and 46.7% reported using the phone without back support (Table 2).

Table 1. Participant Demographics (N = 180)

Variable	Category	n	%
Sex	Male	68	37.8
	Female	112	62.2
Age (years)	18–23	134	74.4
	24–30	46	25.6

Variable	Category	n	%
Semester	1–5	141	78.3
	6–10	39	21.7
City	Faisalabad	140	77.8
	Non-Faisalabad	40	22.2

Table 2. Smartphone-Use Pattern and Posture Characteristics (N = 180)

Variable	Category	n	%
Daily smartphone user	Yes	175	97.2
	No	5	2.8
Handling pattern	One-handed	118	65.6
	Two-handed	62	34.4
Daily duration	4–6 hours	72	40.0
	6–8 hours	53	29.4
	>8 hours	55	30.6
Years of use	1 year	40	22.2
	2 years	64	35.6
	>2 years	76	42.2
Breaks during use	Yes	105	58.3
	No	75	41.7
Neck posture during use	Flexed forward	144	80.0
	Neutral	36	20.0
Back support during use	Supported	96	53.3
	Unsupported	84	46.7
Arm posture during use	Raised with support	57	31.7
	Raised without support	123	68.3
Main purpose	Social media	107	59.4
	Texting	54	30.0
	Calling	19	10.6
Pre-existing neck/UE pathology	No	180	100.0

Table 3. Symptom Prevalence and Characteristics (N = 180)

Outcome	Category	n	%
Any neck/upper-extremity symptom	Yes	171	95.0
	No	9	5.0
Dominant symptom type	Pain	97	53.9
	Fatigue	38	21.1
	Stiffness	22	12.2
	Numbness	14	7.8
	None	9	5.0
Most affected region	Neck	85	47.2
	Shoulder	46	25.6
	Elbow	8	4.4
	Hand	32	17.8
	None	9	5.0
Pain distribution	Localized	143	79.4
	Radiating	28	15.6
	None	9	5.0
Symptoms disappear with rest	Yes	155	86.1
	No	16	8.9
	No symptoms	9	5.0

Table 4. Associations Between Smartphone-Use Posture and Symptom Presence (N = 180)

Exposure	Category	Symptoms Yes n/N (%)	Symptoms No n/N (%)	χ^2 (df=1)	p-value	OR (95% CI)
Neck posture	Flexed forward	144/144 (100.0)	0/144 (0.0)	37.895	<0.001	99.84 (5.64–1766.02)
	Neutral (ref)	27/36 (75.0)	9/36 (25.0)			Ref
Arm posture	Raised without support	122/123 (99.2)	1/123 (0.8)	14.336	<0.001	14.02 (2.40–82.08)
	Raised with support (ref)	49/57 (86.0)	8/57 (14.0)			Ref
Back support	Unsupported	97/99 (98.0)	2/99 (2.0)	4.112	0.043	3.93 (0.91–16.95)
	Supported (ref)	74/81 (91.4)	7/81 (8.6)			Ref

Overall, 171/180 participants reported at least one neck or upper-extremity symptom, yielding a prevalence of 95.0% (Table 3). Pain was the most frequently reported dominant symptom (53.9%), followed by fatigue (21.1%), stiffness (12.2%), and numbness (7.8%). Symptoms were most often localized to the neck (47.2%), followed by the shoulder (25.6%), hand (17.8%), and elbow (4.4%). Most symptomatic participants described localized symptoms (79.4%), and symptom resolution with rest was common (86.1%), although 8.9% reported persistence despite rest (Table 3).

In association analyses, forward-flexed neck posture demonstrated a strong relationship with symptom presence: 144/144 (100.0%) of those reporting flexed neck posture reported symptoms, compared with 27/36 (75.0%) of those reporting neutral neck posture (χ^2=37.895, p<0.001). Using continuity-corrected estimation due to a zero cell, flexed neck posture was associated with markedly higher odds of symptoms (OR=99.84,

95% CI 5.64–1766.02) (Table 4). Arm posture also showed a robust association: symptoms were present in 122/123 (99.2%) participants using a raised arm without support compared with 49/57 (86.0%) using arm support (χ^2=14.336, p<0.001), corresponding to substantially higher odds of symptoms when using the arm without support (OR=14.02, 95% CI 2.40–82.08) (Table 4). Back support demonstrated a smaller but statistically significant association: symptoms were reported in 97/99 (98.0%) participants using the phone without back support versus 74/81 (91.4%) using back support (χ^2=4.112, p=0.043), yielding an elevated but imprecise odds estimate (OR=3.93, 95% CI 0.91–16.95) (Table 4).

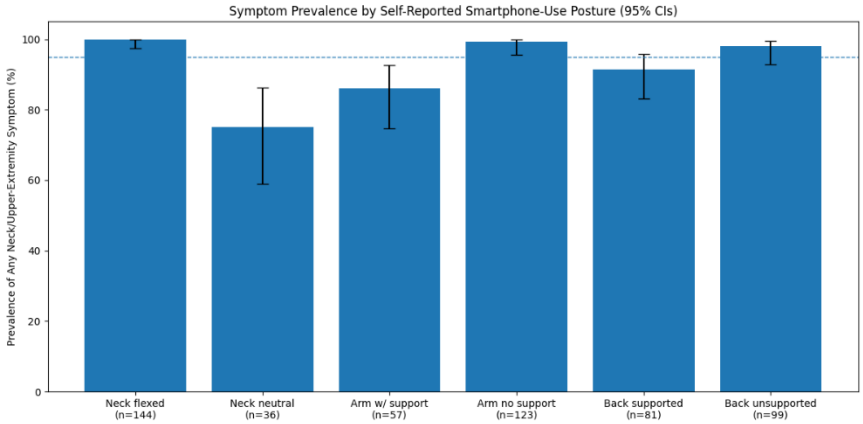

Figure 1. Symptom Prevalence by Self-Reported Smartphone-Use Posture (95% CIs)

Symptom prevalence was highest in participants reporting flexed neck posture (100.0%) and raised arm posture without support (99.2%), both exceeding the prevalence observed in their respective reference categories, including neutral neck posture (75.0%) and raised arm posture with support (86.0%). Participants reporting unsupported back posture also demonstrated a higher symptom prevalence (98.0%) than those reporting supported back posture (91.4%). Confidence intervals indicate the widest uncertainty for the neutral neck category due to smaller subgroup size (n=36), whereas estimates for the largest subgroups (e.g., unsupported arm posture, n=123; flexed neck posture, n=144) were comparatively tighter, reinforcing the pattern of consistently higher symptom prevalence in unsupported/flexed postures across domains.

DISCUSSION

In this cross-sectional sample of university students with substantial smartphone exposure, self-reported neck and upper-extremity symptoms were highly prevalent (95.0%), with the neck being the most frequently affected region (47.2%), followed by shoulder (25.6%) and hand (17.8%). This distribution is broadly consistent with the pattern reported in prior work in young adult and university populations, where cervical and shoulder complaints commonly dominate symptom reports in association with prolonged device use and constrained postures (4,12,13). The predominance of pain (53.9%) and fatigue (21.1%) also aligns with earlier mobile-device symptom profiles, although direct comparisons across studies should be made cautiously because symptom recall windows, case definitions, and instruments vary materially between investigations (12). Importantly, the very high overall symptom prevalence observed here underscores the likelihood that symptom definition and measurement characteristics—particularly the absence of an explicit time anchor in symptom reporting—may inflate point estimates, a limitation that has been recognized as a source of heterogeneity across handheld-device studies (4,20).

A key finding was the strong association between forward-flexed neck posture and symptom presence, where all participants reporting flexed neck posture also reported symptoms. This directionality is biomechanically plausible because forward head posture and increased cervical flexion are expected to increase cervical extensor demand and gravitational moment, thereby increasing strain in cervical structures during sustained viewing and interaction tasks (9,19). Laboratory and modeling studies have similarly emphasized that changes in head/neck posture meaningfully alter cervical loading, supporting the inference that persistent flexion could plausibly contribute to discomfort and symptom development (9,19). However, the cross-sectional design precludes causal inference and cannot exclude reverse causation, whereby individuals with existing symptoms adopt altered postures to compensate. Moreover, the observed “zero cell” in the flexed-neck/no-symptom category suggests either near-universal symptom reporting in that subgroup or potential misclassification/measurement artifact, which should be interpreted with caution despite statistical significance.

The association between unsupported raised-arm posture and symptoms was also substantial, with nearly all participants using an unsupported raised-arm posture reporting symptoms and markedly higher odds of symptoms compared with those using arm support. This finding is consistent with ergonomic and kinematic evidence indicating that handheld texting and touch-screen tasks can increase upper-limb and trapezius muscle activity and alter cervical posture, particularly when the forearms are unsupported and the device is held away from the body (5,7). Prior work has demonstrated technique- and posture-related differences in muscle activity and kinematics during texting, supporting the interpretation that unsupported postures may increase cumulative loading across the shoulder–neck complex and hand–thumb structures during repetitive smartphone interactions (13). In parallel, studies focusing on mobile input device characteristics and texting style have documented meaningful differences in muscle activity and posture, reinforcing the plausibility that support strategies can modulate exposure (5).

Back support showed a smaller association with symptom presence, with higher symptom prevalence among those without back support. Although statistically significant on chi-square testing, the confidence interval around the odds ratio was wide and included the null, suggesting imprecision and possible residual confounding. This pattern may reflect the influence of correlated behaviors such as longer daily use, fewer breaks, or more intense social-media use among those using unsupported postures, which are plausible confounders in student populations (14,20). The results therefore support the hypothesis that unsupported postures co-occur with higher symptom reporting, but they do not isolate back support as an independent determinant. Future analyses using multivariable modeling with prespecified covariates (e.g., sex, age group, duration, years of use, breaks, and handling technique) would be more informative for estimating adjusted associations and distinguishing posture effects from exposure intensity.

Several methodological considerations should temper interpretation. First, posture exposure and symptoms were self-reported and categorized into broad groups (flexed vs neutral; supported vs unsupported), which may introduce non-differential misclassification and inflate or attenuate

DOI: https://doi.org/10.61919/wg24bx41

associations. Second, the symptom outcome lacked an explicit recall period, limiting comparability with studies that use standardized time windows and validated instruments (4,12). Third, while the sampling approach was described as random, the absence of a documented sampling frame and response rate restricts assessment of selection bias. Finally, the study assessed multiple posture–symptom associations; although findings were directionally coherent, a prespecified multiple-comparison approach and reporting of effect sizes alongside p-values are important to reduce overemphasis on statistical significance and improve clinical interpretability (20).

Within these constraints, the findings remain clinically meaningful for student health promotion because the pattern of results consistently points to higher symptom reporting in postures characterized by forward neck flexion, unsupported arms, and lack of back support. These exposures are modifiable through ergonomic strategies—raising the device toward eye level, using forearm/back support, and taking breaks—which are consistent with general ergonomic principles and the broader evidence base linking device technique and posture to musculoskeletal complaints (2,3,4). Future research should adopt validated symptom measures, specify symptom recall windows, directly quantify posture (e.g., goniometry or app-based angle measures), and use analytical models that adjust for exposure duration, task type, and psychosocial factors to clarify independent associations and support stronger preventive recommendations (14,20,23).

CONCLUSION

Among university students with prolonged daily smartphone use, neck and upper-extremity symptoms were highly prevalent, with the neck most frequently affected and pain as the dominant symptom. Self-reported forward-flexed neck posture and unsupported raised-arm posture showed strong associations with symptom presence, while unsupported back posture demonstrated a smaller association with less precise effect estimation. Although the cross-sectional design and self-reported measures limit causal inference, the consistent direction of findings supports targeted ergonomic awareness emphasizing posture support, reducing sustained neck flexion, and incorporating breaks during smartphone use to potentially reduce symptom burden in this population.

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