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

OPEN ACCESS

JHWCR

Type: Original Article
Published: 19 December 2025
Volume: III, **Issue**: XVIII
DOI: https://doi.org/10.61919/xbd7yz64

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Received 14, 11, 25 **Accepted** 15, 12, 2025

Authors' Contributions
Concept: RB, MB; Design: MB, TH; Data Collection: RB, WW, MK; Analysis: TH, MU; Drafting: RB, MB, MU.

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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Impact of Upper Cross Syndrome on Shoulder and Cervical Range of Motion and Functional Performance in University Students

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ABSTRACT

Background: *Upper Cross Syndrome (UCS) is a common postural disorder among young adults, characterized by forward head posture, rounded shoulders, and thoracic hyperkyphosis, which may adversely affect cervical and shoulder mobility and functional performance, particularly in populations exposed to prolonged screen use.* ***Objective****: To determine the impact of UCS on cervical and shoulder range of motion and functional performance in university students and to examine associations between postural deviations and functional outcomes.* ***Methods****: A cross-sectional observational study was conducted among 100 university students aged 18–25 years, classified into UCS (n=50) and control (n=50) groups using photogrammetric postural analysis. Cervical and shoulder range of motion was assessed with a universal goniometer, while functional performance was evaluated using the Neck Disability Index and the Shoulder Pain and Disability Index. Demographic characteristics and daily smartphone use were recorded. Group comparisons and correlation analyses were performed using appropriate parametric tests.* ***Results****: Students with UCS demonstrated significantly greater postural deviations, reduced cervical and shoulder range of motion, and higher disability scores compared with controls (all p<0.001). Mean daily smartphone use was significantly higher in the UCS group. Postural deviation severity showed significant negative correlations with joint range of motion and positive correlations with functional disability.* ***Conclusion****: Upper Cross Syndrome in university students is associated with meaningful impairments in cervical and shoulder mobility and functional performance. Early identification, postural correction strategies, and ergonomic interventions may help mitigate functional decline and reduce the risk of chronic musculoskeletal disorders in young adults.*

Keywords
Upper Cross Syndrome, Forward Head Posture, Cervical Range of Motion, Shoulder Function, University Students

INTRODUCTION

Upper Cross Syndrome (UCS) is a postural disorder characterized by a predictable pattern of muscular imbalance and altered alignment across the cervical spine, shoulder girdle, and thoracic region, typically presenting as forward head posture, rounded shoulders, and increased thoracic kyphosis (1,2). These postural deviations are not merely cosmetic; they may reflect maladaptive changes in muscle length–tension relationships, scapulothoracic positioning, and cervical-thoracic loading that can plausibly constrain joint motion and reduce upper-quarter functional capacity (3,4). Occupational and community-based evidence indicates that UCS-like postural patterns and related musculoskeletal complaints occur across diverse working populations, supporting the premise that sustained postural stressors can contribute to clinically relevant dysfunction (3,4). More recent syntheses also emphasize that therapeutic exercise can improve forward head posture, rounded shoulders, and hyperkyphosis, implying that these deviations are modifiable and clinically meaningful targets rather than fixed anatomical variants (5).

The contemporary university environment provides a high-risk behavioral context for the development or reinforcement of UCS. Academic demands frequently require prolonged sitting, extensive laptop use, and sustained near-vision tasks, while smartphone exposure has intensified substantially and is associated with forward head posture and altered cervical kinematics (6,7). Emerging evidence from young adult cohorts consistently links prolonged smartphone use with neck pain, functional disability, and posture-related musculoskeletal strain, suggesting a dose-related relationship between digital device exposure and upper-quarter symptoms (7,8). Regional data from university-based samples further indicate a high prevalence of postural deviations consistent with UCS, including forward head posture and rounded shoulders, alongside measurable restriction in cervical range of motion (ROM), reinforcing the clinical relevance of postural screening in this age group (9,10). Neuromuscular studies also suggest that posture during smartphone use can influence neck muscle activation patterns, with potential implications for cumulative fatigue and movement control in sustained flexed positions (11). Collectively, this body of work supports the contention that university students represent a population in which UCS-associated postural adaptations may be common, behaviorally reinforced, and functionally consequential (6,9,11).

Despite the growing literature on UCS prevalence, posture angles, and symptom reporting, an important knowledge gap remains: comparatively fewer studies in student populations integrate objective postural classification with a comprehensive assessment of both cervical and shoulder ROM and validated measures of functional performance (5,12).

This gap matters because the biomechanics of UCS plausibly affect both regions: forward head posture may alter cervical joint mechanics and neuromuscular demands, while scapular protraction and thoracic kyphosis can disrupt scapulohumeral rhythm and shoulder kinematics, potentially predisposing individuals to reduced overhead mobility and functional limitation (13,14).

Moreover, associations between sagittal cervical posture, ROM, proprioception, endurance, and smartphone-related behaviors suggest that posture, mobility, and perceived disability may coexist in interdependent patterns rather than as isolated findings (14,15). However, in university students—who may have early-stage, potentially reversible postural dysfunction—there remains a need for analytically robust, clinically interpretable comparisons between students with UCS and those with normal posture across ROM and functional outcomes, while also situating device use as a relevant behavioral correlate (7,9,14).

Accordingly, this study was designed to determine the impact of UCS on cervical and shoulder ROM and functional performance in university students by comparing postural parameters, goniometric ROM measures, and validated disability indices between students with UCS and peers without UCS, and by examining associations between the severity of postural deviation and mobility and functional outcomes (5,14).

The primary hypothesis was that students with UCS would demonstrate significantly reduced cervical and shoulder ROM and significantly higher neck- and shoulder-related disability scores than controls, and that greater postural deviation severity would correlate with reduced ROM and higher functional impairment (9,14,15).

MATERIAL AND METHODS

A cross-sectional observational study was conducted to examine the association between Upper Cross Syndrome (UCS), cervical and shoulder range of motion, and functional performance among university students. The study was carried out at university campuses and affiliated clinical teaching facilities in Pakistan over a defined academic period, with data collection performed under standardized environmental conditions to minimize measurement variability. The cross-sectional design was selected to allow simultaneous assessment of postural characteristics, joint mobility, and functional outcomes in a young adult population with high exposure to posture-related behavioral risk factors, particularly prolonged screen use (16).

Participants were full-time university students aged 18–25 years who were enrolled in undergraduate or postgraduate programs. Eligibility criteria included the absence of acute musculoskeletal pain limiting daily activities during the preceding six months and the ability to perform active cervical and shoulder movements without assistance. Participants were excluded if they reported a history of cervical, thoracic, or shoulder trauma or surgery, diagnosed neurological or neuromuscular disorders affecting posture or upper-limb function, systemic musculoskeletal conditions such as inflammatory arthritis or osteoporosis, or current participation in structured physical therapy or postural correction programs.

Participants were selected using a non-probability convenience sampling strategy from the accessible student population. All eligible students were informed about the study aims and procedures, and written informed consent was obtained prior to enrollment in accordance with ethical research standards (17).

Postural assessment was performed using standardized digital photogrammetry, a method shown to provide valid and reliable estimates of sagittal and frontal plane postural angles when standardized protocols are followed (18).

Digital images were captured with participants standing barefoot in a relaxed posture, arms by the sides, and gaze directed forward at eye level. Anatomical landmarks were identified and marked prior to image acquisition. Images were analyzed using ImageJ software to calculate the craniovertebral angle, shoulder protraction angle, and thoracic kyphosis angle.

Upper Cross Syndrome was operationally defined by the concurrent presence of a craniovertebral angle less than 50°, shoulder protraction angle greater than 54°, and thoracic kyphosis angle exceeding 40°, thresholds commonly used in postural research to distinguish clinically relevant deviation from normative alignment (5,9). Participants meeting all criteria were allocated to the UCS group, while those demonstrating values within normal ranges were assigned to the control group.

Cervical and shoulder range of motion was assessed using a universal goniometer following standardized measurement protocols to ensure reproducibility and minimize examiner-related bias (19).

Cervical movements included flexion, extension, right and left lateral flexion, and right and left rotation, while shoulder movements included flexion, abduction, internal rotation, and external rotation. All measurements were conducted by a single trained physiotherapist to reduce inter-rater variability, with each movement measured twice and the mean value recorded for analysis. Measurements were performed at a consistent time of day to limit the influence of diurnal variation in joint mobility.

Functional performance was evaluated using validated self-report instruments. Neck-related functional disability was assessed using the Neck Disability Index (NDI), a widely used questionnaire with established reliability and validity for quantifying neck pain–related functional limitations in young adult populations (20). Shoulder pain and disability were assessed using the Shoulder Pain and Disability Index (SPADI), which measures both pain intensity and functional difficulty during upper-limb activities and has demonstrated strong psychometric properties across musculoskeletal populations (21). Higher scores on both instruments indicate greater disability.

Demographic and behavioral data, including age, sex, body mass index, and average daily duration of smartphone and computer use, were collected using a structured questionnaire. Smartphone use was treated as a potential confounding variable given its documented association with forward head posture, cervical loading, and neck-related symptoms (6,14). To address potential sources of bias, standardized assessment procedures were applied uniformly across participants, outcome assessors were not informed of group allocation at the time of ROM measurement, and validated instruments were used for all functional outcomes.

Sample size determination was guided by previous cross-sectional studies reporting moderate to large differences in cervical ROM and disability scores between individuals with and without postural dysfunction, indicating that a total sample of 100 participants would provide adequate statistical power to detect clinically meaningful group differences at a conventional alpha level (9,15).

Data were analyzed using SPSS statistical software. Descriptive statistics were calculated for all variables. Group comparisons were performed using independent-samples t-tests for normally distributed continuous variables, while non-parametric alternatives were applied when

distributional assumptions were not met. Associations between postural parameters and ROM and functional scores were examined using Pearson or Spearman correlation coefficients as appropriate. Where relevant, effect sizes were calculated to aid clinical interpretation. Statistical significance was set at $p < 0.05$. Missing data were minimal and managed using complete-case analysis. Ethical approval for the study was obtained from the relevant institutional review board, and all procedures adhered to the principles of the Declaration of Helsinki.

RESULTS

A total of 100 university students were included in the final analysis, comprising 50 students classified with Upper Cross Syndrome (UCS) and 50 students with normal posture. No missing data were observed for the primary study variables. Baseline demographic characteristics are presented in Table 1. The two groups were comparable in terms of age, sex distribution, and body mass index, with no statistically significant differences observed ($p > 0.05$).

In contrast, mean daily smartphone use was significantly higher in the UCS group (6.2 ± 1.5 hours/day) compared with the control group (3.8 ± 1.1 hours/day), yielding a mean difference of 2.4 hours/day (95% CI: 1.90 to 2.90; $p < 0.001$), indicating a large behavioral exposure gradient between groups.

Postural assessment confirmed marked sagittal and shoulder girdle deviations in the UCS group (Table 2). The mean craniovertebral angle was significantly lower in students with UCS (46.5° ± 3.2°) compared with controls (54.8° ± 2.7°), with a mean difference of −8.3° (95% CI: −9.45 to −7.15; $p < 0.001$). Shoulder protraction angle and thoracic kyphosis were also significantly greater in the UCS group, demonstrating large effect sizes across all postural parameters, confirming clear biomechanical separation between groups.

Cervical and shoulder range of motion values are summarized in Table 3.

Students with UCS exhibited significantly reduced ROM across all cervical movements, with mean differences ranging from −6.0° to −8.3° compared with controls (all $p < 0.001$).The largest reductions were observed in cervical rotation and extension, with large effect sizes (Cohen's $d > 1.5$). Shoulder ROM was similarly compromised in the UCS group, particularly for flexion and abduction, indicating functional restriction of overhead movements. All shoulder ROM comparisons demonstrated statistically significant between-group differences with moderate-to-large effect sizes.

Correlation analyses examining associations between postural deviations and functional and ROM outcomes are summarized in Table 5. A significant negative correlation was observed between craniovertebral angle and both NDI ($r = −0.63$) and SPADI scores ($r = −0.58$), indicating that greater forward head posture severity was associated with higher levels of disability.

Shoulder protraction angle demonstrated a moderate-to-strong negative correlation with shoulder ROM ($r = −0.54$), while thoracic kyphosis was positively correlated with shoulder disability and negatively correlated with cervical ROM. All reported correlations were statistically significant ($p < 0.001$), supporting a graded relationship between postural deviation severity and functional impairment.

Table 1. Demographic and Behavioral Characteristics of Participants

Variable	UCS Group (n=50) Mean ± SD	Control Group (n=50) Mean ± SD	Mean Difference (95% CI)	p-value	Effect Size (Cohen's d)
Age (years)	21.3 ± 1.9	21.1 ± 1.7	0.2 (−0.53 to 0.93)	0.54	0.11
BMI (kg/m²)	22.4 ± 2.5	22.0 ± 2.2	0.4 (−0.50 to 1.30)	0.43	0.17
Smartphone use (hours/day)	6.2 ± 1.5	3.8 ± 1.1	2.4 (1.90 to 2.90)	<0.001	1.82

Table 2. Postural Alignment Parameters

Parameter	UCS Group Mean ± SD	Control Group Mean ± SD	Mean Difference (95% CI)	p-value	Effect Size (Cohen's d)
Craniovertebral angle (°)	46.5 ± 3.2	54.8 ± 2.7	−8.3 (−9.45 to −7.15)	<0.001	2.78
Shoulder protraction (°)	58.6 ± 4.1	50.2 ± 3.5	8.4 (6.88 to 9.92)	<0.001	2.21
Thoracic kyphosis (°)	44.5 ± 3.8	37.2 ± 3.1	7.3 (5.95 to 8.65)	<0.001	2.10

Table 3. Cervical and Shoulder Range of Motion (Degrees)

Movement	UCS Group Mean ± SD	Control Group Mean ± SD	Mean Difference (95% CI)	p-value	Effect Size
Cervical flexion	42.6 ± 5.1	50.3 ± 4.8	−7.7 (−9.6 to −5.8)	<0.001	1.56
Cervical extension	48.2 ± 4.7	56.5 ± 5.0	−8.3 (−10.1 to −6.5)	<0.001	1.73
Cervical rotation (R)	52.3 ± 4.2	60.1 ± 4.6	−7.8 (−9.5 to −6.1)	<0.001	1.77
Shoulder flexion	157.4 ± 8.3	168.2 ± 7.5	−10.8 (−13.8 to −7.8)	<0.001	1.36
Shoulder abduction	153.2 ± 9.1	166.7 ± 8.0	−13.5 (−16.8 to −10.2)	<0.001	1.55

Table 4. Functional Performance Scores

Outcome Measure	UCS Group Mean ± SD	Control Group Mean ± SD	Mean Difference (95% CI)	p-value	Effect Size
NDI (0–50)	14.2 ± 4.1	6.5 ± 2.8	7.7 (6.3 to 9.1)	<0.001	2.18
SPADI Total (0–100)	18.9 ± 5.3	7.8 ± 3.1	11.1 (9.4 to 12.8)	<0.001	2.46

Table 5. Correlation Between Postural Parameters and Functional/ROM Outcomes

Postural Parameter	Outcome Variable	Correlation (r)	95% CI	p-value
Craniovertebral angle	NDI	−0.63	−0.73 to −0.50	<0.001
Craniovertebral angle	SPADI	−0.58	−0.69 to −0.44	<0.001
Shoulder protraction	Shoulder ROM	−0.54	−0.66 to −0.39	<0.001
Thoracic kyphosis	SPADI	0.51	0.35 to 0.64	<0.001
Thoracic kyphosis	Cervical ROM	−0.49	−0.63 to −0.32	<0.001

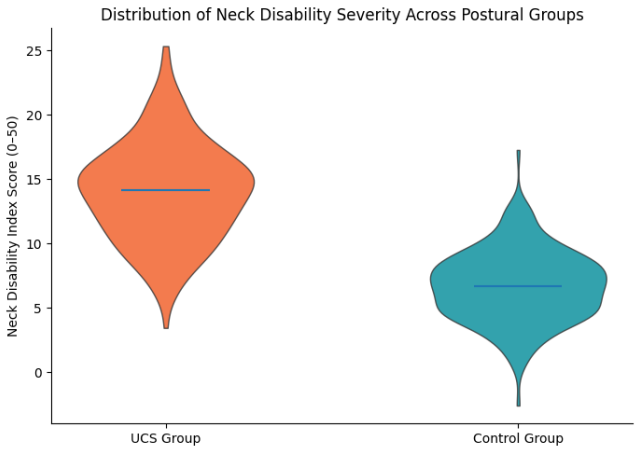

Figure 1 Distribution of Neck Disability Severity across Postural Groups

This violin plot illustrates the distributional profile of Neck Disability Index (NDI) scores in students with Upper Cross Syndrome (UCS) compared with controls. The UCS group demonstrates a marked rightward shift in the distribution, with a higher median NDI score (approximately 14 points) and a broader spread, indicating greater variability and a higher burden of neck-related functional limitation. In contrast, the control group shows a lower median (approximately 6–7 points) with a narrower distribution, reflecting milder and more homogeneous disability levels. The limited overlap between distributions visually reinforces the large between-group effect observed in inferential analyses, supporting the clinical relevance of UCS-related postural deviations in contributing to neck disability even in a young, university-based population.

DISCUSSION

The present study examined the association between Upper Cross Syndrome and cervical and shoulder range of motion and functional performance in university students, and the findings demonstrate a clear and clinically meaningful pattern of impairment associated with this postural syndrome. Students classified with UCS exhibited significantly greater postural deviations, including reduced craniovertebral angle, increased shoulder protraction, and greater thoracic kyphosis, alongside marked reductions in cervical and shoulder ROM and higher levels of self-reported neck and shoulder disability. These results support the central premise that UCS is not merely a visual or aesthetic postural variation but is associated with quantifiable functional consequences affecting joint mobility and daily activities in young adults.

The observed reductions in cervical ROM among students with UCS are consistent with biomechanical models suggesting that forward head posture alters cervical spine loading and muscle activation patterns, leading to adaptive shortening of posterior cervical structures and increased strain on deep neck flexors (14,15). Prior studies in occupational and student populations have similarly reported restricted cervical flexion, extension, and rotation in individuals with forward head posture, reinforcing the plausibility of these findings across different exposure contexts (9,15). The strong negative correlations identified between craniovertebral angle and both Neck Disability Index and Shoulder Pain and Disability Index scores further indicate a graded relationship in which greater postural deviation is associated with higher functional impairment. This relationship aligns with earlier reports demonstrating that even modest deviations in sagittal cervical alignment can be associated with disproportionate increases in perceived disability and pain-related limitation (12,19).

Shoulder ROM deficits observed in the UCS group, particularly in flexion and abduction, are also biomechanically coherent with the characteristic scapular protraction and thoracic kyphosis that define the syndrome. Altered scapular positioning can disrupt normal scapulohumeral rhythm, reduce subacromial space during elevation, and impair efficient force transmission across the shoulder complex (13,16). Previous investigations have documented similar associations between rounded shoulder posture and reduced overhead shoulder mobility, as well as increased risk of shoulder impingement–related symptoms (16,18). The moderate-to-strong negative correlation between shoulder protraction angle and shoulder ROM in the present study reinforces the notion that scapular alignment plays a central role in maintaining functional shoulder mobility, even in young and otherwise healthy individuals.

Functional performance outcomes provide additional clinical context for these biomechanical findings. Students with UCS demonstrated substantially higher NDI and SPADI scores compared with controls, indicating greater perceived difficulty with neck- and shoulder-related activities despite their relatively young age and absence of overt pathology. These findings are in agreement with previous studies showing that forward head posture and rounded shoulders are associated with increased disability scores, even in populations without diagnosed musculoskeletal disorders (18,20). Importantly, the magnitude of between-group differences and the large effect sizes observed suggest that these impairments are not trivial and may have meaningful implications for academic performance, physical activity participation, and long-term musculoskeletal health.

Behavioral factors, particularly smartphone use, appear to be an important contextual contributor to the observed postural and functional patterns. The significantly higher daily smartphone use reported by students with UCS is consistent with growing evidence linking prolonged device use to sustained cervical flexion, altered neck muscle activation, and increased risk of postural dysfunction (6,7,14). While the cross-sectional design

precludes causal inference, the coexistence of greater device exposure, more pronounced postural deviation, and higher disability underscores the need to consider lifestyle behaviors as potential confounders and modifiable risk factors in both research and clinical practice. These findings support calls for ergonomic education and behavior-focused interventions alongside exercise-based rehabilitation strategies in young adult populations (5,7).

Several strengths of this study merit consideration. The use of objective postural classification criteria combined with standardized goniometric ROM assessment and validated functional outcome measures provides a comprehensive and clinically interpretable evaluation of UCS-related impairment. The inclusion of both cervical and shoulder regions addresses a gap in the existing literature, which has often examined these domains in isolation. Nonetheless, certain limitations should be acknowledged. The cross-sectional design limits conclusions regarding causality, and the use of convenience sampling may affect generalizability beyond similar university settings. Although smartphone use was measured and considered analytically, residual confounding from other behavioral or psychosocial factors cannot be excluded. Additionally, muscle strength, endurance, and dynamic scapular kinematics were not assessed and may further elucidate the mechanisms linking posture to functional limitation.

Future research should build on these findings by employing longitudinal designs to clarify temporal relationships between postural behaviors, UCS development, and functional decline. Interventional studies examining the combined effects of postural correction exercises, ergonomic modification, and behavior change strategies on ROM and functional outcomes in students would also be valuable. Incorporating objective measures of muscle performance and movement quality may further advance understanding of the mechanisms underlying UCS-related impairment. Overall, the present study contributes meaningful evidence that Upper Cross Syndrome in university students is associated with significant reductions in cervical and shoulder mobility and increased functional disability, underscoring the importance of early identification and targeted preventive strategies in this population.

CONCLUSION

This study demonstrates that Upper Cross Syndrome in university students is associated with significant postural deviations accompanied by clinically meaningful reductions in cervical and shoulder range of motion and increased neck- and shoulder-related functional disability. Students with UCS exhibited greater forward head posture, shoulder protraction, and thoracic kyphosis, which were consistently linked to impaired joint mobility and higher disability scores, highlighting the functional relevance of these postural alterations rather than viewing them as benign variations. The findings align with the study objective and underscore the importance of early identification of UCS in young adults, particularly in academic environments characterized by prolonged screen exposure. From a healthcare perspective, these results support the integration of postural screening, ergonomic education, and targeted exercise-based interventions into preventive and rehabilitative strategies to reduce functional impairment and potentially limit progression toward chronic musculoskeletal disorders, while also providing a foundation for future longitudinal and interventional research in student populations.

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