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Original Article

Prevalence of Balance Impairment in University Students With Smartphone Associated Subclinical Neck Pain: A Cross-Sectional Study

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ABSTRACT

Background: Prolonged smartphone use among university students may coexist with cervical symptoms and altered postural control. Objective: To determine the prevalence and distribution of balance impairment among university students with smartphone-associated subclinical neck pain and examine associations of balance status with neck pain and smartphone addiction. Methods: This analytical cross-sectional study included 87 university students aged 18–25 years recruited by convenience sampling at Indus University, Karachi, Pakistan. Static balance was assessed using the Balance Error Scoring System, neck-related disability using the Neck Disability Index, pain intensity using a visual analogue scale, and smartphone-related behaviour using a smartphone addiction questionnaire. Descriptive statistics and chi-square tests were used for analysis. Results: Moderate balance impairment was the predominant BESS category, affecting 63 participants (72.4%), while 15 (17.2%) had mild impairment, one (1.1%) had severe impairment, and eight (9.2%) had normal balance. Moderate neck disability was present in 58 participants (66.7%), moderate pain in 38 (43.7%), and moderate-risk smartphone addiction in 61 (70.1%). Balance status was associated with sex (p=0.009), age group (p=0.028), smartphone addiction level (p=0.021), and neck-pain severity (p=0.001). Conclusion: Balance abnormalities frequently coexisted with neck-related symptoms and problematic smartphone-use behaviour in this university sample. Keywords: balance impairment; subclinical neck pain; smartphone addiction; university students; Balance Error Scoring System.

INTRODUCTION

Smartphones have become integral to communication, education, entertainment, and daily information management, particularly among university students, who frequently use these devices for both academic and recreational purposes. Although smartphones provide substantial practical benefits, prolonged and potentially problematic use has raised concerns regarding adverse physical and behavioural health outcomes (1). University students may be particularly susceptible because extended periods of smartphone use are often accompanied by sustained sitting, reduced physical activity, and prolonged cervical flexion (2). Previous research among undergraduate populations has identified neck pain as a common musculoskeletal complaint and has implicated prolonged smartphone use and other postural factors as potentially important correlates (3). Neck pain also

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represents a substantial contributor to disability globally, emphasizing the importance of identifying modifiable factors associated with its occurrence and functional consequences (4).

Subclinical neck pain refers to recurrent or persistent neck discomfort that may not be severe enough to prompt formal medical treatment but can nevertheless influence cervical function and sensorimotor control. The cervical region contains a high density of proprioceptive receptors that contribute information regarding head position and movement, which is integrated with visual and vestibular input to maintain postural orientation and balance. Evidence from individuals with recurrent subclinical neck pain suggests that altered interpretation of cervical proprioceptive information may occur even in the absence of major neurological or structural pathology (5). Sustained or repetitive cervical loading associated with prolonged smartphone viewing may therefore have implications beyond local pain by potentially disturbing cervical afferent input and the integration of sensory information required for postural control.

Emerging evidence supports a relationship between neck symptoms and alterations in balance performance. Differences in postural-control variability have been demonstrated between individuals with neck pain and asymptomatic participants, suggesting that cervical symptoms may be accompanied by measurable changes in postural stability (6). In university smartphone users with balance impairment, interventions directed toward cervical proprioception and craniocervical flexor function have also been investigated, further supporting a possible relationship between cervical sensorimotor function and static balance (7). These findings provide a plausible basis for examining balance disturbances among young adults who report recurrent neck symptoms associated with smartphone use.

More directly, previous cross-sectional research among university smartphone users with subclinical neck pain has demonstrated a substantial prevalence of static balance impairment and has identified smartphone-use characteristics and neck-related factors as relevant correlates (8). However, evidence remains limited regarding whether similar patterns are present among university students in Pakistan, where patterns of smartphone use, academic demands, lifestyle behaviours, and other contextual factors may differ. Moreover, although duration of smartphone use has received attention, problematic smartphone-use behaviour or smartphone addiction may represent an additional behavioural dimension associated with neck symptoms and balance performance. Examining neck pain severity, neck-related disability, smartphone addiction, and balance within the same university population may therefore provide a more comprehensive understanding of factors associated with postural impairment in young adults (9,10).

Accordingly, this analytical cross-sectional study aimed to determine the prevalence of balance impairment among university students with smartphone-associated subclinical neck pain and to examine the associations of balance impairment with neck pain severity, neck-related functional limitation, and smartphone addiction. The study specifically sought to determine whether greater neck-related symptoms and higher levels of problematic smartphone use were associated with poorer balance status in this population (11).

MATERIAL AND METHODS

An analytical cross-sectional study was conducted at Indus University, Karachi, Pakistan, to determine the prevalence of static balance impairment and examine its association with neck-related symptoms and smartphone-use characteristics among university students with smartphone-associated subclinical neck pain. Data collection was undertaken over a six-month period. The target population comprised university students aged 18–25 years who regularly used smartphones and reported recurrent neck discomfort associated with smartphone use.

Participants were eligible if they were university students aged 18–25 years, reported smartphone use for more than two hours per day, and experienced mild-to-moderate subclinical neck pain associated with smartphone use. Subclinical neck pain was operationally defined as self-reported neck discomfort without a previous formal diagnosis or treatment, accompanied by low-to-moderate pain intensity on the visual analogue scale and mild neck-related functional limitation.

Eligibility was based on a Neck Disability Index (NDI) score below 14 and a visual analogue scale (VAS) score below 6, consistent with the study's predefined screening criteria and the approach used in previous research on university smartphone users with subclinical neck pain (8). Students were excluded if they reported visual, auditory,

vestibular, or neurological disorders; medical conditions known to affect balance; chronic musculoskeletal disease; lower-limb fracture or injury; traumatic injury or surgical intervention involving the spine or lower limbs during the preceding year; or participation in a neck-muscle strengthening or balance-training programme during the previous 12 months. Eligibility and exclusion criteria were assessed through participant self-report and a structured health-screening questionnaire before enrolment.

A non-probability convenience sampling technique was used to recruit eligible participants. The required sample size was estimated using OpenEpi version 3.0 with an anticipated frequency of 6% and a 5% margin of error, yielding a final sample of 87 participants. All eligible participants were informed about the study procedures and provided written informed consent before data collection.

Data were collected using a structured questionnaire and standardized clinical outcome measures. The questionnaire was used to record demographic information and smartphone-use characteristics. Static balance was assessed using the Balance Error Scoring System (BESS), which evaluates postural stability across six testing conditions comprising double-leg, single-leg, and tandem stances performed on firm and foam surfaces. Balance errors occurring during the standardized stance conditions were recorded to quantify static postural-control performance. The BESS has previously been used to identify static balance impairment among university smartphone users with subclinical neck pain (12).

Neck-related functional limitation was assessed using the Neck Disability Index. The NDI provides a quantitative measure of the functional effect of neck symptoms on activities of daily living, with higher scores indicating greater neck-related disability. For participant screening, an NDI score below 14 was used to represent the mild level of disability specified in the study eligibility criteria. Neck-pain intensity was assessed using the visual analogue scale, a commonly used measure of subjective pain intensity (9). For study eligibility, VAS scores below 6 were considered compatible with the predefined low-to-moderate pain criterion.

Smartphone-related behavioural dependence was evaluated using the smartphone addiction questionnaire employed in the study. Participants were subsequently classified according to the instrument's low-, moderate-, and high-risk categories. Smartphone addiction level was treated as a categorical exposure variable in analyses examining its relationship with balance status. Neck-pain severity and demographic characteristics, including age and gender, were also evaluated as potential factors associated with balance impairment.

All assessments were conducted after completion of eligibility screening and informed consent procedures. The primary outcome was static balance status measured using BESS. Secondary variables included neck-related disability measured by the NDI, pain intensity measured by the VAS, smartphone addiction level, and demographic characteristics. Standardized eligibility criteria and the same assessment instruments were applied across the study sample to maintain consistency in participant evaluation. Individuals reporting conditions likely to independently influence balance were excluded to reduce potential clinical confounding arising from neurological, vestibular, visual, auditory, musculoskeletal, or recent traumatic disorders.

Data were entered and analysed using IBM SPSS Statistics version 26.0. Descriptive statistics were used to summarize participant characteristics and study variables. Categorical data were presented as frequencies and percentages, while quantitative variables were summarized using appropriate measures of central tendency. The prevalence of balance impairment, neck disability categories, pain-severity categories, and smartphone-addiction categories was described for the complete study sample.

Chi-square tests were used to examine associations between categorical balance status and participant characteristics, including age, gender, neck-pain severity, and smartphone-addiction level. Correlation analysis was additionally conducted in the complete sample of 87 participants to examine relationships among balance performance, neck disability, and smartphone-addiction scores. Statistical significance was defined as a two-sided p-value <0.05.

Ethical approval for the study was obtained from the Institutional Review Board of the Foundation of Medical Research and Laboratories under approval number FMRL-IRB/2025/012. Participation was voluntary, and written informed consent was obtained from all participants before enrolment and data collection.



RESULTS

A total of 87 university students were included in the analysis. Females constituted 82.0% (n=71) of the sample, while males accounted for 18.0% (n=16). Most participants were aged 21–23 years (n=56, 64.4%), followed by those aged 18–20 years (n=21, 24.1%) and 24–25 years (n=10, 11.5%). Regarding smartphone addiction, 61 participants (70.1%) were classified as having moderate-risk smartphone addiction, whereas 14 (16.1%) were classified as high risk and 12 (13.8%) as low risk.

Neck-related disability was common in the study population. Moderate disability represented the largest NDI category, affecting 58 participants (66.7%), while 20 (23.0%) had mild disability, eight (9.2%) had no disability, and one (1.1%) had severe disability. On assessment of static balance using the BESS, moderate balance impairment was the predominant category, occurring in 63 participants (72.4%). Mild impairment was observed in 15 participants (17.2%), severe balance deficit in one participant (1.1%), and normal balance in eight participants (9.2%). When all categories labelled as balance impairment were combined, 79 of 87 participants (90.8%) had some degree of balance impairment.

Table 1. Participant Characteristics and Smartphone Addiction Levels (n=87)

Variable	Category	n (%)
Sex	Female	71 (82.0)
	Male	16 (18.0)
Age, years	18–20	21 (24.1)
	21–23	56 (64.4)
	24–25	10 (11.5)
Smartphone addiction level	Low risk	12 (13.8)
	Moderate risk	61 (70.1)
	High risk	14 (16.1)

Table 2. Distribution of Neck Disability, Static Balance, and Neck-Pain Severity (n=87)

Measure	Category	n (%)
Neck Disability Index	No disability	8 (9.2)
	Mild disability	20 (23.0)
	Moderate disability	58 (66.7)
	Severe disability	1 (1.1)
Balance Error Scoring System	Normal balance	8 (9.2)
	Mild balance impairment	15 (17.2)
	Moderate balance impairment	63 (72.4)
	Severe balance deficit	1 (1.1)
Visual analogue scale	No pain	21 (24.1)
	Mild pain	27 (31.0)
	Moderate pain	38 (43.7)
	Severe pain	1 (1.1)

Abbreviations: BESS, Balance Error Scoring System; NDI, Neck Disability Index; VAS, visual analogue scale.

Table 3. Bivariate Associations Between Balance Status and Participant Characteristics (n=87)

Association	χ^2	df	p-value
Balance status × sex	15.241	5	0.009
Balance status × age group	20.096	10	0.028
Balance status × smartphone addiction level	14.851	6	0.021
Balance status × neck-pain severity	16.658	3	0.001

Statistical test: Pearson chi-square test as reported in the study analysis. Statistical significance was defined as $p<0.05$. Pain severity showed a broader distribution. Moderate neck pain was reported by 38 participants (43.7%), mild pain by 27 (31.0%), no pain by 21 (24.1%), and severe pain by one participant (1.1%). Bivariate analyses reported statistically significant associations between balance status and sex (χ^2=15.241, p=0.009), age group (χ^2=20.096, p=0.028), smartphone addiction level (χ^2=14.851, p=0.021), and neck-pain severity (χ^2=16.658, p=0.001). Among the behavioural variables examined, smartphone addiction level was therefore associated with balance status in the study sample, while neck-pain severity also demonstrated an association with balance classification.

DISCUSSION

The present study identified a substantial burden of balance abnormalities, neck-related disability, pain, and problematic smartphone use among university students with smartphone-associated subclinical neck pain. Moderate balance impairment represented the largest BESS category, while only a small proportion of participants were classified as having normal balance. Balance status was also associated in the reported bivariate analyses with neck-pain severity and smartphone addiction level, as well as with age and sex. Collectively, these findings suggest that balance disturbances in young smartphone users with neck symptoms may coexist with both cervical symptoms and behavioural patterns of smartphone use, although the cross-sectional design does not establish the temporal direction or causality of these relationships (13).

The observed pattern is broadly consistent with previous research in university smartphone users with subclinical neck pain. Wah et al. reported a 74.07% prevalence of static balance impairment in a comparable population and found that prolonged daily smartphone use, longer duration of smartphone exposure, and higher NDI scores were associated with impaired balance (8). Direct numerical comparison with the present study should nevertheless be made cautiously because the previous study used a defined BESS threshold for binary classification of static balance impairment, whereas the present data were reported across normal, mild, moderate, and severe balance categories. Despite these methodological differences, both studies indicate that abnormalities of static postural control may be common among young smartphone users experiencing neck-related symptoms (14).

The association between neck-pain severity and balance status is biologically plausible because cervical proprioceptive information contributes to the integration of head, neck, and body orientation during postural control. Paulus and Brumagne demonstrated altered interpretation of cervical proprioceptive signals in individuals with recurrent subclinical neck pain, supporting the possibility that cervical symptoms may be accompanied by disturbances in sensorimotor processing (15). More recent observations among students with and without neck pain have likewise indicated differences in patterns of postural-control variability, suggesting that cervical symptoms may coexist with altered strategies for maintaining upright stability (16). These findings provide a plausible physiological context for the association observed in the present study but do not establish that neck pain itself caused the balance abnormalities.

Smartphone-related behaviour may further contribute to this relationship. Prolonged smartphone use commonly involves sustained cervical flexion and repetitive loading of neck structures, and undergraduate populations with prolonged smartphone exposure have previously demonstrated an increased occurrence of neck complaints (17). Smartphone addiction has also been associated with a range of adverse health and behavioural outcomes in adults (18). In the present study, most participants were classified in the moderate smartphone-addiction category, and balance status was significantly associated with smartphone-addiction level. This finding suggests that problematic smartphone-use behaviour may represent a relevant factor when evaluating young adults presenting with concurrent neck symptoms and balance abnormalities. Nevertheless, smartphone addiction and duration of smartphone use represent different constructs, and the current findings should not be interpreted as evidence that smartphone addiction independently causes balance impairment.

The predominance of moderate neck-related disability is also clinically relevant because it indicates that cervical symptoms within this study population were accompanied by functional limitations rather than representing pain

intensity alone. Previous research among undergraduate students has demonstrated that neck pain is common and is associated with several physical and behavioural factors, including prolonged smartphone use (19). At the broader population level, neck pain contributes substantially to years lived with disability worldwide (4). Identification of neck symptoms and functional limitation in younger adults may therefore have relevance for early musculoskeletal-health awareness, particularly in populations with intensive use of handheld digital devices.

The present findings may have practical implications for university health and rehabilitation services. Assessment of young adults reporting recurrent smartphone-associated neck symptoms may benefit from considering functional neck disability and postural-control performance alongside pain intensity and patterns of smartphone use. Previous intervention research has shown that cervical proprioceptive and craniometrical flexor training can be investigated in university smartphone users with balance impairment, supporting continued research into potentially modifiable cervical sensorimotor factors (20). However, because the present study did not evaluate an intervention, its findings cannot establish the effectiveness of posture education, exercise, smartphone-use modification, or any other preventive or therapeutic strategy.

Several features of the study should be considered when interpreting the findings. The use of multiple clinical and behavioral measures enabled simultaneous characterization of balance, neck-related disability, pain, and smartphone addiction in a defined university population. Nevertheless, the analytical cross-sectional design precludes determination of temporal sequence and causal relationships. Convenience sampling from a single university limits generalizability and introduces potential selection bias, while the predominance of female participants may further limit applicability to populations with different sex distributions. Smartphone-related behavior and several clinical characteristics relied on participant report and may therefore be affected by recall or classification bias. Physical activity and other potentially relevant determinants of balance were not incorporated into the reported analyses, leaving the possibility of residual confounding. In addition, several outcome categories contained small numbers of participants, which may affect the stability of categorical association testing. Future investigations using larger and more representative samples, clearly defined balance thresholds, detailed smartphone-exposure measures, and multivariable analyses would help clarify the independent relationships among smartphone use, cervical symptoms, neck-related disability, and postural control.

CONCLUSION

Balance abnormalities were common among the university students with smartphone-associated subclinical neck pain included in this cross-sectional study, with moderate balance impairment representing the predominant BESS category. Balance status was associated with neck-pain severity and smartphone-addiction level and was also related to age and sex in the reported bivariate analyses. These findings indicate that cervical symptoms, problematic smartphone-use behaviour, and static balance characteristics coexist within this population and support consideration of balance and neck-related function when evaluating young adults reporting smartphone-associated neck symptoms.

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