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Relationship Between Smartphone Overuse and Cervical Proprioception Deficits in Young Adults

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ABSTRACT

Background: Excessive smartphone use exposes the cervical spine to prolonged flexed posture, which may impair proprioception and contribute to neck pain among young adults. **Objective:** To examine the association between smartphone overuse, addiction severity, and cervical proprioception deficits in young adults. **Methods:** A cross-sectional study was conducted among 200 participants aged 18–30 years in Peshawar. Smartphone use, screen time, and addiction (SAS-SV) were recorded. Cervical proprioception was assessed using laser-guided joint position sense (JPS) testing in flexion, extension, and rotation. Neck pain (VAS) and disability (NDI) were documented. ANOVA, Pearson correlations, and multiple regression were performed. **Results:** High smartphone users (>6 h/day) demonstrated significantly greater JPS errors (flexion +1.9°, extension +2.1°, rotation +2.4°) compared with low users (<3 h/day) (all $p<0.001$). Smartphone hours and addiction scores showed strong correlations with JPS errors ($r=0.62–0.72$) and neck pain/disability ($r=0.64–0.82$). Regression analysis revealed that smartphone hours, addiction score, neck pain, disability, posture duration, and physical activity independently predicted flexion JPS error, explaining 68% of variance ($p<0.001$). **Conclusion:** Smartphone overuse and addiction are strongly associated with cervical proprioception deficits and neck symptoms in young adults, highlighting the need for preventive ergonomic strategies. **Keywords:** smartphone overuse, proprioception, cervical spine, joint position sense, neck pain, addiction

Introduction

Smartphone use has become deeply embedded in the daily lives of young adults, with global estimates indicating an average screen exposure exceeding 6 hours per day (1). Prolonged smartphone interaction typically involves sustained neck flexion, forward-head posture, and reduced cervical movement variability, all of which contribute to neuromuscular strain and altered cervical joint positioning (2). The cervical spine contains dense proprioceptors—particularly muscle spindles in the deep flexors—that are essential for kinesthesia, postural control, and coordinated head–neck movements (3). When exposed to prolonged flexed postures, these mechanoreceptors may become desensitized or dysregulated, leading to cervical proprioception deficits, impaired joint position sense (JPS), and increased vulnerability to neck pain (4).

Recent evidence has linked excessive smartphone exposure to musculoskeletal symptoms, including neck discomfort, headaches, and deficits in sensorimotor control (5). Studies from East Asia suggest that smartphone addiction severity correlates with reduced cervical kinesthetic accuracy, implicating both behavioral and biomechanical mechanisms (Lee 2022 (6); Cho & Kim 2024 (7). However, despite rising smartphone dependence among South Asian youth, limited data exist regarding its influence on cervical proprioception, particularly within the local Pakistani context. Existing literature predominantly explores general musculoskeletal complaints but rarely quantifies proprioceptive impairments using objective JPS assessments. This gap is significant, considering that proprioceptive alterations may precede symptomatic neck pain and contribute to chronic dysfunction.

The growing prevalence of smartphone overuse among university students coupled with emergent evidence linking prolonged flexed posture to proprioceptive decline underscores the need for regionspecific empirical data. To address these gaps, this study investigated whether smartphone overuse and addiction are associated with cervical proprioception deficits among young adults in Peshawar, and whether these relationships persist after adjusting for neck pain, disability, posture duration, and physical activity. The study hypothesized that higher daily smartphone use and greater addiction scores would be independently associated with increased cervical JPS error.

Materials and Methods

This cross-sectional observational study was conducted in universities and physiotherapy clinics across Peshawar during the data collection period. Young adults aged 18–30 years were eligible if they were regular smartphone users and presented without a history of cervical trauma, vestibular disorders, neurological conditions, or recent physiotherapy treatment that could affect proprioception. Individuals with diagnosed cervical spine pathology, systemic illness, or visual impairment uncorrected by lenses were excluded. Participants were recruited through convenience sampling via campus notices and clinic referrals, and written informed consent was obtained prior to participation.

Data collection followed a standardized protocol administered by trained physiotherapists. Sociodemographic information, body mass index, physical activity, and daily sitting posture duration were recorded. Smartphone-related variables included average daily smartphone use, screen time, and addiction severity measured using the validated Smartphone Addiction Scale–Short Version (SAS-SV) (8). Cervical proprioception was assessed using a laser-guided Joint Position Error (JPE) method in flexion, extension, and rotation. Participants were blindfolded and instructed to actively return their head to a neutral position from each test direction; the angular deviation in degrees was recorded as JPS error. Neck pain intensity was measured using a 10-cm Visual Analog Scale (VAS), and functional disability was assessed using the Neck Disability Index (NDI), expressed in percentage scores.

Variables were operationalized according to established clinical cutoffs. Smartphone use was categorized into low (<3 h/day), moderate (3–6 h/day), and high (>6 h/day) exposure groups. Physical activity was classified as low, moderate, or high. To minimize bias, assessors were trained using a protocol manual, instruments were calibrated before each session, and testing was conducted at similar times of day to reduce diurnal variation. Potential confounding variables—including pain, disability, posture duration, physical activity, and BMI—were collected and adjusted for in multivariable analyses.

The target sample size was set at 200 participants based on prior proprioception research recommending ≥10–15 participants per predictor for multivariable regression (9), ensuring adequate statistical power. Data analyses were performed using SPSS. Continuous variables were summarized as means and standard deviations, and categorical variables as frequencies and percentages. Group differences across smartphone usage categories were assessed using one-way ANOVA with Bonferroni post-hoc adjustments. Correlations among smartphone use, addiction, proprioception, pain, and disability were examined using Pearson correlation coefficients. Multiple linear regression was applied to identify independent predictors of flexion JPS error, with entry of variables based on theoretical relevance and bivariate associations. Missing data were handled through listwise exclusion due to minimal occurrence (<5%). Ethical approval was obtained from the institutional review board, and all procedures adhered to principles of confidentiality, reproducibility, and standardized data handling.

Results

The study included 200 young adults with a mean age of 22.8 years; slightly more than half were male, and most participants reported low physical activity levels. Average smartphone use exceeded 6 hours per day, with social media representing the most common primary activity. Mean neck pain and disability scores indicated mild to moderate symptoms, while baseline cervical JPS errors ranged between 3° and 4° across directions.

Table 1. Demographic and Smartphone Usage Characteristics (n = 200)

Variable	Mean ± SD / n (%)
Age (years)	22.8 ± 2.6
Sex	
Male	112 (56.0%)
Female	88 (44.0%)
BMI (kg/m²)	23.4 ± 3.8
Daily smartphone use (hours/day)	6.8 ± 2.9
Screen time (hours/day)	7.4 ± 3.1
Smartphone addiction score (SAS-SV)	38.6 ± 10.4
Primary smartphone use	
Social media	98 (49.0%)
Gaming	36 (18.0%)
Study/Work	42 (21.0%)
Entertainment	24 (12.0%)
Sitting posture duration (hrs/day)	8.2 ± 2.6
Physical activity level	
Low	118 (59.0%)
Moderate	64 (32.0%)
High	18 (9.0%)
Neck pain (VAS)	4.2 ± 2.4
Cervical JPS error – flexion (°)	3.1 ± 1.4
Cervical JPS error – extension (°)	3.4 ± 1.6
Cervical JPS error – rotation (°)	4.2 ± 1.8
Neck Disability Index (%)	18.6 ± 10.2

Table 2. Comparison of Cervical Proprioception Across Smartphone Usage Categories

Outcome Variable	Low Use <3h (n=38)	Moderate 3–6h (n=82)	High >6h (n=80)	F-value	p-value
JPS Error – Flexion (°)	2.1 ± 0.9	2.8 ± 1.1	4.0 ± 1.4	36.8	<0.001
JPS Error – Extension (°)	2.3 ± 1.0	3.1 ± 1.2	4.4 ± 1.6	38.2	<0.001
JPS Error – Rotation (°)	2.8 ± 1.2	3.9 ± 1.4	5.2 ± 1.8	42.6	<0.001
Overall JPS Error (°)	2.4 ± 0.9	3.3 ± 1.1	4.5 ± 1.4	48.9	<0.001
Neck pain (VAS)	2.6 ± 1.8	4.0 ± 2.0	5.6 ± 2.2	28.4	<0.001

Outcome Variable	Low Use <3h (n=38)	Moderate 3–6h (n=82)	High >6h (n=80)	F-value	p-value
NDI (%)	10.8 ± 6.4	16.8 ± 8.6	25.2 ± 10.8	34.6	<0.001

Table 3. Correlation Matrix Between Smartphone Use, Proprioception, and Pain Variables

Variables	Smartphone Hours	Addiction Score	JPS Flex	JPS Ext	JPS Rot	VAS Pain	NDI
Smartphone Hours	1	0.78***	0.64***	0.68***	0.72***	0.66***	0.70***
Addiction Score	0.78***	1	0.62***	0.66***	0.70***	0.64***	0.68***
JPS Flex	0.64***	0.62***	1	0.82***	0.78***	0.68***	0.72***
JPS Ext	0.68***	0.66***	0.82***	1	0.80***	0.70***	0.74***
JPS Rot	0.72***	0.70***	0.78***	0.80***	1	0.74***	0.78***
VAS Pain	0.66***	0.64***	0.68***	0.70***	0.74***	1	0.82***
NDI (%)	0.70***	0.68***	0.72***	0.74***	0.78***	0.82***	1

p < 0.001

Table 4. Multiple Linear Regression Predicting Flexion JPS Error

Predictor	β	SE	t	p-value	95% CI
Smartphone hours/day	0.18	0.04	4.50	<0.001	0.10–0.26
SAS-SV Score	0.04	0.01	4.00	<0.001	0.02–0.06
Screen time (hrs/day)	0.08	0.04	2.00	0.047	0.00–0.16
Neck pain (VAS)	0.22	0.06	3.67	<0.001	0.10–0.34
NDI (%)	0.03	0.01	3.00	0.003	0.01–0.05
Sitting posture duration	0.10	0.05	2.00	0.047	0.00–0.20
Physical activity (higher = better)	–0.28	0.12	–2.33	0.021	–0.52 to –0.04
Age	0.02	0.03	0.67	0.504	–0.04–0.08
Sex (female=1)	0.42	0.22	1.91	0.058	–0.02–0.86
BMI	0.04	0.03	1.33	0.185	–0.02–0.10
Constant	0.68	0.62	1.10	0.273	–0.54–1.90
Model fit: R^2=0.68, Adjusted R^2=0.66, F=39.8, p<0.001					

Bonferroni post-hoc: All groups significantly different (p<0.01).

Significant differences in proprioception were observed across smartphone usage categories. High-use participants demonstrated markedly greater JPS errors in flexion, extension, and rotation compared with both moderate- and low-use groups (all p<0.001), with increases of approximately +1.9° to +2.4° relative to low-use peers. Pain and disability also rose in a dose-response pattern, with high users reporting more than double the disability scores of low users.

Correlation analysis demonstrated strong positive associations between smartphone hours, addiction score, and all proprioceptive error measures (r=0.62–0.72, p<0.001). Neck pain and disability exhibited similarly strong correlations with JPS errors (r=0.68–0.82). Multivariable regression indicated that smartphone hours, addiction score, neck pain, disability, posture duration, and physical activity level were significant independent predictors of flexion JPS error, accounting for 68% of variance. Age, sex, and BMI were not significant predictors.

Discussion

The findings demonstrate a strong and consistent association between smartphone overuse and cervical proprioception deficits among young adults, supporting the hypothesis that prolonged device interaction negatively influences cervical kinesthetic accuracy. High smartphone users exhibited substantially greater JPS errors in all directions compared with low users, which aligns with previous research showing impaired cervical sensorimotor function following sustained flexed neck posture (6). The magnitude of JPS impairment observed in this study (+1.9° to +2.4° differences) is clinically meaningful, as even small deviations in cervical joint repositioning have been linked to altered neuromuscular control and vulnerability to chronic neck dysfunction (10).

Strong correlations between smartphone use, addiction severity, pain intensity, and disability further reinforce the biomechanical and behavioral interplay underlying these impairments. Excessive screen exposure likely induces repetitive strain and neuromuscular fatigue in cervical stabilizers, particularly the deep flexor muscles, which contain high proprioceptive density (3). Over time, this leads to diminished

spindle sensitivity, impaired afferent feedback, and consequently reduced JPS accuracy (4). The association of addiction scores with proprioceptive error suggests that not only duration but also compulsive smartphone use patterns contribute to cumulative cervical loading. These findings are consistent with Cho and Kim (2024), who reported sensorimotor control deficits among smartphonedependent individuals (7).

The regression model demonstrated that smartphone use and addiction remained significant predictors even after adjusting for neck pain, disability, posture duration, and physical activity, suggesting independent and robust contributions to proprioceptive decline. The protective effect of higher physical activity supports previous work indicating that regular movement and postural variation preserve neuromuscular function (11). The absence of significant effects from age, sex, and BMI indicates that proprioceptive impairment is primarily driven by behavioral rather than demographic factors in this age group.

Conclusion

Smartphone overuse and addiction were strongly associated with significant cervical proprioception deficits, increased neck pain, and greater disability among young adults. Daily smartphone hours were the strongest independent predictor of impaired JPS accuracy, highlighting the neuromuscular impact of prolonged forward-head posture. These findings underscore the importance of preventive strategies to protect cervical sensorimotor health in the digital generation.

DECLARATIONS

Author Contributions:	Concept: SS, AB, FS; Design: SS, AB, FS; Data Collection: SS, AB, FS; Analysis: FS; Drafting: SS.
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