Original Article

EFFECT OF SMARTPHONE USE ON MEDIAN NERVE MECHANOSENSITIVITY OF DOMINANT VERSUS NON-DOMINANT HAND IN UNIVERSITY STUDENTS

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Abstract

Objective: This study aimed to compare median nerve mechanosensitivity between dominant and non-dominant hand in university students.

Study Design: A cross-sectional comparative study was conducted.

Place and duration of study: : Data were collected from university students at ARID Agriculture University, and the Center of Advanced Studies in Health and Technology (CASHT) Rawalpindi, over a period of four months (Feb to May).

Material and Methods: Ethical approval was obtained from CASHT IRB, Rawalpindi (CASHT/IRB/2026/014). A total of 85 university students (57 males, 28 females) were recruited via non-probability purposive sampling. High smartphone use was confirmed using the SAS-SV (cut-off ≥32 males, ≥34 females). Participants with neurological, musculoskeletal, or systemic conditions affecting the upper limb were excluded. Bilateral median nerve mechanosensitivity was assessed using standardized ULNT-1 with an ordinal scale (0–3), and data were analyzed using paired-samples t-test (SPSS v.20).

Results: The dominant hand showed significantly higher mechanosensitivity (mean = 1.08, SD = 1.207) than the non-dominant hand (mean = 0.29, SD = 0.553); $t(84) = 6.403$, $p < 0.001$, mean difference 0.788 (95% CI: 0.543–1.033), Cohen's $d = 0.98$.

Conclusion: High smartphone usage was significantly associated with greater median nerve mechanosensitivity in the dominant hand compared to the non-dominant hand among university students, confirming the disproportionate mechanical burden imposed by device operation. ULNT-1 is recommended as a simple and effective early screening tool in high smartphone-using populations.

Keywords: Median nerve mechanosensitivity, smartphone use, ULNT-1, neurodynamic testing, hand dominance, university students, carpal tunnel syndrome.

1. Introduction

Smartphone use has grown exponentially across the globe, and university students represent one of the most intensive user groups. Pakistani university students spend five or more hours daily on their devices for academic, social, and entertainment purposes. The Pakistan Telecommunication Authority (2023) reports that 81.6% of the national population now uses cellular services, placing Pakistan among the most rapidly digitalizing societies worldwide. [1] This high-volume, sustained use has been linked to a growing burden of musculoskeletal and neural complaints in the upper limb. [2,10,11] The biomechanics of smartphone operation are inherently asymmetrical. Users typically employ one of two grip strategies: a one-handed grip in which the dominant hand both holds and operates the device using the thumb, or a two-handed grip in which the non-dominant hand supports the device while the dominant thumb executes the majority of screen interactions. In both cases, the dominant hand sustains repetitive and forceful thumb movements combined with non-neutral wrist postures, including wrist extension and ulnar deviation, for extended periods. [3,20] The median nerve is particularly vulnerable to these biomechanical stresses. It passes through the carpal tunnel at the wrist, a fibro-osseous canal shared with nine flexor tendons.[23,2] Non-neutral wrist positions sustained during smartphone use elevate intracarpal pressure, impairing nerve microcirculation and increasing mechanical loading on the nerve. Repeated flexor tendon excursion with each thumb tap adds compressive and frictional forces to the adjacent nerve. [4] Over time, these cumulative stresses may alter

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neural mechanosensitivity, the nerve's capacity to respond to mechanical stimuli, before any structural damage becomes clinically detectable. [5]

Neurodynamic testing, specifically the Upper Limb Neurodynamic Test 1 (ULNT-1), provides a validated, clinically feasible framework for assessing median nerve mechanosensitivity. The test applies to a standardized sequence of multi-joint movements that selectively loads the median nerve and detects changes in mobility or symptom provocation. The ULNT-1 demonstrates good to excellent intra and inter-rater reliability when performed by trained examiners. [6,12,13]

Previous research has documented smartphone-related upper limb functional compromise through grip strength measurements, nerve conduction studies, and ultrasonographic cross-sectional area assessment. However, these methods assess static structural or electrophysiological parameters and do not reflect dynamic neural behavior under mechanical loading. [2,8,18]

None captures how the nerve behaves mechanically under movement, which is precisely what mechanosensitivity testing directly measures. Furthermore, no published study has directly compared dominant versus non-dominant hand median nerve mechanosensitivity in relation to smartphone use, despite the clearly asymmetrical nature of device operation. The only Pakistani study identified — Latif et al. (2022) — assessed ULNT-1 positivity in smartphone users but did not perform a bilateral dominant versus non-dominant comparison. [7]

The present study addresses this specific gap. The objective was to compare median nerve mechanosensitivity between the dominant and non-dominant hands in university students classified as heavy smartphone users, using the ULNT-1 as a standardized outcome measure.

2. Materials & Methods

A cross-sectional comparative study was conducted at ARID Agriculture University and the Center of Advanced Studies in Health and Technology (CASHT), Rawalpindi. Ethical approval was obtained from the Institutional Review Board of CASHT (Ref: CASHT/IRB/2026/014).

The sample size was calculated using G*Power 3.1.9.7 software based on effect sizes reported in prior literature. [8] A total of 85 participants was determined to be adequate to detect a statistically significant difference at an alpha level of 0.05 with a power of 0.80. A non-probability purposive sampling technique was used to recruit participants meeting the inclusion criteria.

Participants were included if they were university students aged 18–25 years, of either sex, and classified as high smartphone users via the Smartphone Addiction Scale – Short Version (SAS-SV), defined as a score ≥32 for males and ≥34 for females.[9] Participants were excluded if they had a history of neurological disorders affecting the upper limb (e.g., carpal tunnel syndrome, cervical radiculopathy), musculoskeletal injuries to the hand, wrist, or arm, or any systemic disease affecting peripheral nerves such as diabetes mellitus or hypothyroidism.

Mechanosensitivity was quantified using an ordinal scoring system applied during the sensitizing phase (elbow extension with wrist and finger extension maintained): Score 0 = full elbow extension achieved with no symptom provocation; Score 1 = mild stretch sensation, elbow extension at least 160°; Score 2 = moderate discomfort, elbow extension between 120° and 159°; Score 3 = severe pain or reproduction of familiar symptoms, test terminated before 120° elbow extension.[25] The dominant hand was tested first among all participants.

Data were analyzed using SPSS version 20. Descriptive statistics were calculated for demographic variables. A paired-samples t-test was used to compare mechanosensitivity scores between the dominant and non-dominant hands, with a significance threshold of $p < 0.05$. The use of a parametric test was justified by the sample size of 85, which satisfies the Central Limit Theorem for approximate normality of difference scores, consistent with prior neurodynamic studies employing ordinal ULNT scores with comparable sample sizes.[12,13]

3. Results

A total of 85 university students participated in the study. The sample comprised 57 males (67.1%) and 28 females (32.9%). The mean age of participants was 23.3 ± 1.35 years, consistent with the study's inclusion criteria of 18–25-year-old university students. All participants met the SAS-SV threshold for high smartphone use (≥32 for males; ≥34 for females).

Variable	Category / Measure	Value
Gender	Male	57
	Female	28
Age (years)	Mean ± SD	23.3 ± 1.35

Table 1: Demographic Profile of Participants (n = 85)

Table 2 presents the mean mechanosensitivity scores for the dominant and non-dominant hands, and the results of the paired-samples t-test comparison. The dominant hand demonstrated a significantly higher mechanosensitivity score (mean = 1.08, SD = 1.207) compared to the non-dominant hand (mean = 0.29, SD = 0.553). The paired t-test confirmed a statistically significant difference: t (84) = 6.403, p < 0.001. The mean difference was 0.788 (95% CI: 0.543–1.033), with a large effect size (Cohen's d = 0.98). These findings support rejection of the null hypothesis and confirm significantly greater dominant-hand median nerve mechanosensitivity among heavy-user university students.

Variable	Mean	SD	Mean Diff. (95% CI)	t (df)	p-value
Dominant Hand	1.08	1.207	0.788 (0.543–1.033)	6.403 (84)	**<0.001**
Non-Dominant Hand	0.29	0.553			

Table 2: Comparison of Median Nerve Mechanosensitivity Between Dominant and Non-Dominant Hands (Paired-Samples t-test)

SD = Standard Deviation; CI = Confidence Interval; df = Degrees of Freedom; p < 0.05 considered statistically significant.

4. Discussion

This study demonstrated a statistically significant and clinically meaningful difference in median nerve mechanosensitivity between the dominant and non-dominant hands of university students classified as heavy smartphone users. The dominant hand showed markedly higher ULNT-1 scores (M = 1.08, SD = 1.207) compared to the non-dominant hand (M = 0.29, SD = 0.553), with t (84) = 6.403, p < 0.001 and a large effect size (Cohen's d = 0.98). These findings are consistent with prior evidence linking intensive and asymmetric device use to disproportionate dominant-hand upper limb compromise.

Patel, Desai, and Shukla (2018) demonstrated that even two to four hours of daily mobile phone use produced measurable reductions in sensory nerve conduction velocity, with sensory fibers affected more than motor fibers, mirroring the pattern characteristic of early carpal tunnel syndrome.[2] Critically, the students in the present study consistently surpass this exposure threshold, suggesting they face substantially greater cumulative neural stress. Our findings extend this electrophysiological evidence by demonstrating functional neurodynamic changes detectable through the ULNT-1, a measure that captures how the nerve responds mechanically under load rather than assessing static axonal function.

The structural basis for dominant-hand susceptibility is supported by İnal et al. (2015), who found significantly larger median nerve cross-sectional areas in the dominant hands of high smartphone users compared to their non-dominant hands on ultrasonography.[8] The present results are functionally consistent with this morphological finding: the dominant hand, which performs the vast majority of screen interactions, accumulates greater asymmetric mechanical loading. Mousa et al. (2019) further confirmed experimentally that unilateral smartphone typing produces a significantly greater acute increase in nerve cross-sectional area than bilateral operation, directly evidencing the disproportionate mechanical demand placed on the operating hand.[14]

Hasib et al. (2025) introduced the concept of the 'smartphonopathic hand' to describe lateralised neural enlargement in smartphone users, documenting significantly larger dominant-hand nerve cross-sectional areas even in low users.[15] This suggests that hand dominance itself, independent of overall usage level, contributes to neural asymmetry.[21,22] Our finding of a large effect size in mechanosensitivity differences between hands, even within a population of uniformly high users, supports this concept and indicates that functional neurodynamic asymmetry is detectable before structural adaptation becomes clinically manifest.

The most directly relevant Pakistani study, Latif et al. (2022), identified median nerve tightness via ULNT-1 in 44% of right-sided and 40.8% of left-sided smartphone users, with positive neurodynamic findings significantly associated with poorer upper limb function and reduced grip and pinch strength.[7] The present study advances this work by providing the first bilateral dominant-versus-non-dominant ULNT-1 comparison in a Pakistani university student population. Our findings confirm that the asymmetry of mechanosensitivity, which mirrors the asymmetry of phone operation itself, is both statistically robust and functionally significant.

Ergün Keşli et al. (2023) observed that progressive smartphone addiction was associated with reduced grip strength and upper limb function, while self-reported pain showed comparatively modest changes.[16,17,18] This dissociation between objective functional compromise and subjective pain reporting is consistent with the subclinical status of the elevated ULNT-1 scores observed in the present study. The dominant-hand neurodynamic changes documented here represent a functional deficit detectable before resting pain symptoms emerge, supporting the value of objective neurodynamic screening in high-exposure populations.

Hernandez-Secorun et al. (2024) demonstrated that elevated ULNT-1 mechanosensitivity in pre-surgical carpal tunnel syndrome patients was significantly correlated with poorer functional outcomes and reduced quality of life. [6] Placed in this clinical context, the subclinical mechanosensitivity changes documented in the present student sample may represent an early point on the same pathological continuum. Without ergonomic intervention or usage modification, it is hypothesized that these changes could progress toward the clinical severity documented in overt nerve entrapment; however, future longitudinal studies should examine whether the functional neural changes identified here advance to clinically significant pathology.[19,20]

Collectively, the present findings support incorporating bilateral ULNT-1 assessment into routine physiotherapy screening for university students with high smartphone exposure. This approach, combined with usage counselling and ergonomic guidance on grip patterns and device posture, represents a practical and evidence-based strategy for mitigating the neural consequences of intensive smartphone use.

Conclusion

Heavy smartphone use is significantly associated with markedly elevated dominant-hand median nerve mechanosensitivity in university students, as demonstrated by a statistically significant and large-effect-size difference between dominant and non-dominant hands on the ULNT-1 ($t\ (84) = 6.403$, $p < 0.001$; Cohen's $d = 0.98$). This asymmetry reflects the disproportionate biomechanical loading of the dominant hand during device operation and likely represents a subclinical neural change that may precede overt peripheral nerve entrapment conditions such as carpal tunnel syndrome.

Limitations

Limitations of the study include its cross-sectional design, which precludes causal inference; reliance on self-reported smartphone usage via the SAS-SV; absence of detailed grip-pattern and usage-pattern characterisation; and the lack of structural assessment to determine whether mechanosensitivity changes correspond to morphological neural alterations. Additionally, the fixed testing order (dominant hand tested first among all participants) may have introduced a potential order effect on ULNT-1 scores. The absence of a control group of low or non-smartphone users limits direct comparability of findings. Furthermore, the non-blinded nature of ULNT-1 administration introduces the possibility of examiner bias in score assignment.

Future Recommendations

Future research should employ longitudinal designs, larger and more diverse samples, and multimodal assessments combining ULNT-1 with ultrasonographic and electrophysiological measures to determine whether the functional neural changes identified here progress to clinically significant pathology.

Disclosure /Conflict of interest:

Authors declare no conflict of interest.

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