International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/26-2-45*

PROSPECTIVE ASSOCIATION BETWEEN OBJECTIVELY MEASURED SMARTPHONE SCREEN TIME AND THUMB JOINT POSITION SENSE ERROR IN FIRST-YEAR MBBS STUDENTS

Dr. Indu K. Pisharody[1], Dr. R. Naveen[2], Dr. Sobha Kumari T[3]

[1]*Postgraduate Dept. of Physiology, Sree Mookambika Institute of Medical Sciences, Kulasekharam, India*

[2]*Professor, Dept. of Physiology, Sree Mookambika Institute of Medical Sciences, Kulasekharam*

[3]*Professor & HOD Department of Physiology Sree Mookambika Institute of Medical Sciences, Kulasekharam.*

Correspondence:
Dr. R. Naveen

Received: **January 20, 2026**
Revised: **January 30, 2026**
Accepted: **February 04, 2026**
Published: **February 20, 2026**

Abstract

Background: Smartphone use is ubiquitous among undergraduate medical students, yet the neuromuscular consequences of prolonged, repetitive thumb interaction with touchscreen devices remain incompletely characterized. This study aimed to determine whether objectively measured daily smartphone screen time is associated with deterioration in thumb joint position sense (JPS) accuracy over an 8-week observation period. ***Methods:*** A prospective observational cohort study was conducted among 120 first-year MBBS students aged 18–23 years. Daily smartphone screen time was objectively recorded using built-in digital wellbeing tools (iOS/Android) over 7 consecutive days at baseline and at Week 8. Thumb JPS was assessed using an active repositioning task at predefined target angles (20°, 40°, and 60° of flexion/abduction) using a validated digital inclinometer. Secondary outcomes included smartphone addiction risk assessed using the Smartphone Addiction Scale–Short Version (SAS-SV) and thumb/wrist discomfort measured using a Visual Analog Scale (VAS). ***Results:*** The mean objective daily screen time was 6.8 ± 1.4 hours. A significant positive correlation was observed between average daily screen time and mean absolute thumb JPS error at Week 8 ($r = 0.42$, $p < 0.001$). Participants in the highest screen-time tertile (>7 hours/day) demonstrated significantly greater JPS error compared with the lowest tertile (7.8° ± 1.9° vs. 4.3° ± 1.2°, $p < 0.001$). Smartphone addiction risk was identified in 58.3% of participants. ***Conclusions:*** Higher smartphone screen exposure is associated with a measurable decline in thumb proprioceptive accuracy in first-year MBBS students. These findings suggest that excessive screen use may induce early sensorimotor alterations before overt musculoskeletal symptoms develop.

Keywords: Joint position sense, Medical students, Proprioception, Smartphone screen time, Thumb biomechanics.

INTRODUCTION

The widespread integration of smartphones into medical education has substantially altered the ergonomic and neuromuscular demands placed on undergraduate students. Smartphone ownership among young adults has reached near saturation, with medical students representing a particularly high-intensity user group.1,2 Medical students increasingly rely on smartphones for academic resources, communication, and recreational activities, resulting in prolonged periods of repetitive thumb-dominant interaction with touchscreen interfaces.

Although smartphones enhance accessibility to educational and clinical information, sustained use imposes repetitive low-load mechanical stress on the thumb, a structure evolutionarily optimized for opposition and grasping rather than high-frequency precision movements.3 This biomechanical mismatch has been implicated in a spectrum of musculoskeletal conditions commonly described as “text thumb” or smartphone-related thumb disorders, including tendinopathies, reduced pinch strength, and wrist pain.3,4,6 Systematic reviews have reported a high prevalence of musculoskeletal complaints associated with smartphone use, with hand and wrist involvement affecting up to one-third of users.4

Beyond overt pain and structural pathology, the potential subclinical neurological consequences of excessive smartphone use remain insufficiently explored. Proprioception, derived from afferent input from muscle spindles, joint mechanoreceptors, and cutaneous receptors, is fundamental for fine motor control and joint stability.7 Alterations in joint position sense (JPS) may precede pain and functional impairment, serving as an early indicator of sensorimotor maladaptation. Continuous static loading and repetitive thumb movements during prolonged screen interaction may induce changes in mechanoreceptor sensitivity and

afferent signaling, resulting in subtle proprioceptive deficits.7,8

Existing studies examining the relationship between smartphone use and thumb proprioception are limited predominantly to cross-sectional designs and rely heavily on self-reported screen-time estimates, which are prone to recall bias and systematic underestimation.9,10 Furthermore, objective quantification of screen exposure and standardized proprioceptive testing protocols remain inconsistently applied. The present study addresses these limitations by employing a prospective design with objectively logged smartphone screen-time data and validated digital inclinometry to evaluate the association between smartphone use and thumb joint position sense accuracy in first-year MBBS students.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational cohort study was conducted over an 8-week period in the Department of Physiology at a tertiary-care medical college. The study aimed to evaluate the association between objectively measured smartphone screen time and thumb joint position sense (JPS) accuracy. Ethical approval was obtained from the Institutional Ethics Committee.

Study Population

First-year MBBS students aged 18–23 years were recruited. Inclusion criteria included right-hand dominance, regular smartphone use for at least one year, and willingness to provide objective smartphone screen-time data. Students with a history of hand or wrist surgery, inflammatory arthritis, diabetes mellitus, peripheral neuropathy, or neurological disorders affecting sensory or motor function were excluded.

Sample Size Estimation

Sample size was calculated assuming an anticipated correlation coefficient of 0.30 between daily smartphone screen time and thumb JPS error, with 80% power and a two-tailed alpha of 0.05. The minimum required sample size was 84 participants. To account for potential attrition and enable subgroup analysis, 120 participants were enrolled.

Exposure Assessment: Smartphone Screen Time

Daily smartphone screen time was objectively recorded using built-in tracking tools (iOS "Screen Time" and Android "Digital Wellbeing"). Participants submitted screenshots of their "Last 7 Days" screen-time summaries at baseline and at Week 8. Average daily screen time (hours/day) was calculated and used as the primary exposure variable.

Outcome Assessment: Thumb Joint Position Sense

Thumb JPS was assessed using a validated digital inclinometer application secured over the proximal phalanx of the dominant thumb. Testing was conducted in a quiet, temperature-controlled environment. Participants were blindfolded to eliminate visual input. Target angles of 20°, 40°, and 60° were used. An active repositioning protocol was employed, with three trials performed at each angle. Mean absolute JPS error, expressed in degrees, was calculated as the average angular deviation across all trials.

Secondary Outcome Measures

Smartphone addiction risk was assessed using the Smartphone Addiction Scale–Short Version (SAS-SV). Subjective thumb and wrist discomfort were evaluated using a 10-cm Visual Analog Scale.

Statistical Analysis

Data were analyzed using SPSS version 28.0. Normality was assessed using the Shapiro–Wilk test. Continuous variables are presented as mean ± standard deviation. Pearson's correlation coefficient was used to assess the relationship between screen time and thumb JPS error. Participants were categorized into tertiles based on screen-time exposure, and intergroup differences were analyzed using one-way ANOVA. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 120 first-year MBBS students were enrolled at baseline, of whom 114 (95.0%) completed the study and were included in the final analysis. Six participants were excluded due to incomplete follow-up data.

The mean age of participants was 20.4 ± 1.6 years. The cohort consisted of 58 males (50.9%) and 56 females (49.1%), with all participants being right-hand dominant. The mean objectively measured daily smartphone screen time was 6.8 ± 1.4 hours.

Characteristic	Value (Mean ± SD / n (%))
Age (years)	20.4 ± 1.6
Gender	Male: 58 (50.9%); Female: 56 (49.1%)
Hand dominance	Right: 114 (100%)
Objective screen time (hours/day)	6.8 ± 1.4
SAS-SV score	38.4 ± 9.2
Baseline JPS error (degrees)	4.8 ± 1.3
VAS pain score	2.8 ± 1.9

Table 1: Baseline Characteristics and Smartphone Usage Profile:
Based on established SAS-SV cut-off scores, 58.3% of participants were classified as being at high risk for smartphone addiction. (Fig 1) Participants classified as high-risk demonstrated significantly higher average daily screen time compared with those in the low-risk group ($p < 0.001$).

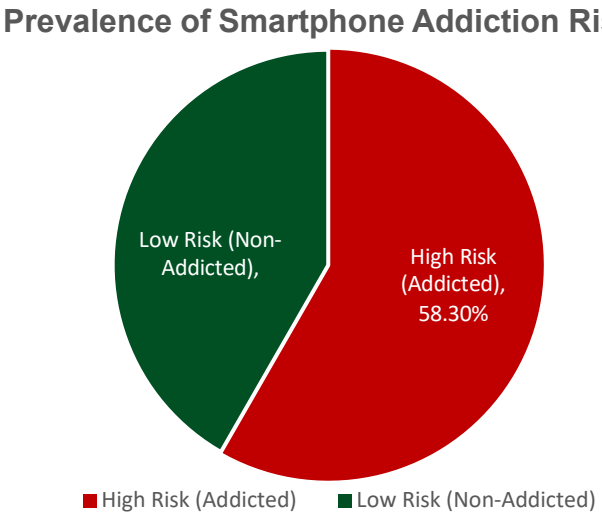

Fig 1: Pie diagram showing prevalence of Smart phone addiction
At Week 8, a statistically significant positive correlation was observed between average daily smartphone screen time and mean absolute thumb JPS error ($r = 0.42$, $p < 0.001$). Higher screen exposure was associated with progressively greater proprioceptive error across all tested angles.

Participants were stratified into tertiles based on average daily screen time:

- **Low usage:** <4.5 hours/day
- **Moderate usage:** 4.5–7.0 hours/day
- **High usage:** >7.0 hours/day

Usage group	20°	40°	60°	Mean JPS error
Low	3.2 ± 1.1	4.5 ± 1.4	5.1 ± 1.6	4.3 ± 1.2
Moderate	4.1 ± 1.3	5.9 ± 1.8	6.5 ± 1.9	5.5 ± 1.5
High	5.8 ± 1.6	8.2 ± 2.1	9.4 ± 2.4	7.8 ± 1.9*

Table 2: Thumb joint position sense error (degrees) by screen-time tertile
Participants in the high-usage group demonstrated nearly double the mean proprioceptive error compared with the low-usage group, with the largest differences observed at 60° of thumb flexion/abduction. (Table 2)

Mean SAS-SV scores showed a strong positive correlation with objective screen time ($r = 0.68$, $p < 0.001$) and a moderate correlation with thumb JPS error ($r = 0.28$, $p = 0.003$).

VAS pain scores demonstrated a modest positive correlation with mean JPS error ($r = 0.35$, $p = 0.001$), indicating that greater proprioceptive impairment was associated with higher subjective discomfort, although pain levels remained low overall.

DISCUSSION

This prospective observational study demonstrates a significant association between objectively measured smartphone screen time and impaired thumb joint position sense (JPS) accuracy among first-year MBBS students. Participants with higher daily screen exposure exhibited greater proprioceptive error, suggesting that excessive smartphone use may induce early sensorimotor alterations even before the development of overt musculoskeletal symptoms.

Most previous research on smartphone-related morbidity has focused on clinically apparent outcomes such as pain syndromes, grip strength reduction, tendon pathology, and peripheral nerve involvement. In contrast, the

present findings suggest that proprioceptive dysfunction may represent an earlier, subclinical manifestation of excessive smartphone use. Given that proprioception is essential for fine motor coordination and joint stability, even subtle deterioration in JPS may have functional implications for precision-dependent tasks.

The observed association is biologically plausible and may be explained by sustained low-load static contractions and repetitive thumb movements during prolonged smartphone interaction. Continuous activation of intrinsic and extrinsic thumb muscles may result in mechanoreceptor desensitization, altered muscle spindle firing, and impaired afferent feedback to the central nervous system. Similar mechanisms have been described in repetitive-use occupational activities, supporting the plausibility of early proprioceptive compromise.

The present findings are consistent with the broader literature reporting adverse health effects associated with prolonged smartphone use. Deglomine G et al.11 systematically reviewed 41 studies involving over 17,000 participants and reported a strong overall association between smartphone use and negative health outcomes, particularly musculoskeletal complaints and functional impairments, though most studies were cross-sectional. Peripheral nerve involvement has also been documented. Patel J et al.12 demonstrated significant reductions in median nerve conduction velocity and grip strength with increasing smartphone use, while Samuel PS et al.13 reported structural changes in the median nerve and flexor pollicis longus tendon among high-addiction users.

Muscle performance impairments have likewise been described. Osailan A et al.14 found an inverse relationship between smartphone usage duration and hand-grip and pinch-grip strength, while Hundekari JC et al.15 reported progressively reduced median motor nerve conduction velocity with longer duration of smartphone use among medical students. Additionally, Alshahrani A et al.16 observed reduced neck flexor endurance in smartphone-addicted individuals, highlighting the broader neuromusculoskeletal impact of prolonged device use.

Notably, JPS error in the present study was most pronounced at larger thumb angles, particularly at 60° of flexion/abduction. This is clinically relevant, as wide thumb excursions are commonly required during one-handed smartphone operation, especially for scrolling and corner-screen interactions. Increased mechanical and neuromuscular demand at these positions may further exacerbate proprioceptive inaccuracies.

The strengths of this study include its prospective design, use of objectively logged screen-time data, and standardized assessment of thumb JPS using a validated digital inclinometer, addressing key limitations of earlier studies that relied predominantly on cross-sectional designs and self-reported exposure measures. However, the single-center setting and relatively short follow-up period may limit generalizability and preclude assessment of long-term adaptations or recovery. Minor measurement variability related to device placement cannot be entirely excluded.

The findings of the current study suggest that excessive smartphone use may adversely affect thumb proprioception at an early stage, underscoring the need for preventive strategies and ergonomic awareness, particularly among young adults and medical students with high digital exposure.

CONCLUSION

This prospective study demonstrates that higher objectively measured smartphone screen time is associated with a measurable decline in thumb joint position sense accuracy in first-year MBBS students. These findings suggest that excessive smartphone use may contribute to early proprioceptive alterations preceding clinically apparent musculoskeletal disorders. Early identification of such changes may inform preventive ergonomic strategies and targeted educational interventions aimed at preserving hand function in medical trainees.

Acknowledgments

The authors acknowledge the cooperation of the participating students and the support provided by the Department of Physiology during data collection and testing.

Conflicts of Interest

The authors declare that there are no conflicts of interest related to this study.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author Contributions

Conceptualization, study design, data collection, statistical analysis, and manuscript preparation were performed by the authors. All authors reviewed and approved the final manuscript.

Informed Consent

Written informed consent was obtained from all participants prior to enrolment in the study

Abbreviations

JPS – Joint Position Sense

SAS-SV – Smartphone Addiction Scale–Short Version

VAS – Visual Analog Scale

ICC – Intraclass Correlation Coefficient

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