Original Article

Severity and Functional Impact of Carpal Tunnel Symptoms in Relation to Mobile Device Usage

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Abstract

Background: Prolonged mobile device use may increase the risk of Carpal Tunnel Syndrome (CTS). This study explored the association between mobile usage patterns and CTS symptoms among college students.

Methods: Two hundred students (115 females, 85 males; mean age = 20.31 ± 1.53 years) participated. Mobile use was assessed via questionnaire, and CTS symptoms using the Boston Carpal Tunnel Questionnaire, Phalen's test, and Compression test.

Results: Most (94%) used smartphones for 4–6 hours daily; 12% showed CTS symptoms. CTS was significantly associated with device type (p = 0.021) and longer screen time.

Conclusion: Extended smartphone use was linked to higher CTS symptoms, emphasizing the need for awareness and preventive measures among students.

Keywords: Carpal Tunnel Syndrome, Mobile device use, Musculoskeletal health, College students, Phalen's test, Boston Carpal Tunnel Questionnaire

Introduction

Advances in information technology have made mobile devices essential to modern daily life.[1] Mobile deviceis defined as a hand-held portable device that has a display screen with touch input and a keyboard. At present, a wide range of mobile devices are available with varied application, including tablets, laptops, netbooks, and smartphones.[2] People are becoming increasingly dependent on these devices for many purposes such as E-learning, gaming, chatting, texting, internet browsing, watching videos and listening music.[3,4,5] Therefore, these devices have gained lot of popularity in all age groups especially among children and youth.[6] According to the available literature, India has become the second biggest smartphone market in terms of active users.[7]

Mobile devices are widely utilized by students to support their academic activities, offering immediate access to diverse educational resources. As a result, they have emerged as an essential learning tool, particularly for the younger

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generation.[8,9] The COVID-19 pandemic further accentuated this trend, as the shift to online learning significantly increased dependence on digital devices. Evidence indicates that average daily screen time among college students rose from 4.75 hours prior to the lockdown to 11.36 hours during the lockdown period.[10] The majority of students today possess and regularly use multiple mobile devices. One study reported that 87% of university students owned laptops, more than half possessed smartphones, and approximately 8% used iPads.[11] Therefore, addiction to these devices has increased substantially, specially of smartphone among students.[12] Excessive use of mobile devices has been associated with a deterioration in students' quality of life, manifesting as disrupted sleep patterns, poor eating habits, diminished energy levels, and compromised academic performance. Research further reveals that headaches, reduced concentration, memory impairment, hearing loss, and fatigue are attributable to smartphone usage.[13] Prolonged device interaction without adequate breaks can also result in repetitive strain injuries impacting the neck, shoulders, hands, and wrists.[14] Studies report that 50% of university students reported neck and shoulder pain[15], while29.2% of students noted thumb pain due to sustained smartphone use.[9] Prolonged improper hand positioning can impair microcirculation, reducing nutrient and oxygen supply to the muscles, which thus lead to decreased blood flow and early muscle fatigue.[14] Frequentuse of the devices, increases the risk of anatomical changes such as enlargement of the median nerve and subsequently impaired hand function and pinch strength.[16] These physiological alterations elevate the risk for carpal tunnel narrowing, predisposing individuals toCTS.[17,18,19] It is recognized as the most frequently reported entrapment neuropathy,[20] accounting for approximately 90% of all neuropathies,[21] and is estimated to affect 3–6% of the general population.[22] The syndrome is characterized by compression of the median nerve within the carpal tunnel at the wrist,[21] resulting in symptoms including numbness, tingling, pain, and weakness in the palmar aspects of the thumb, index, middle, and the radial side of the ring finger.[23]

Numerous studies have explored the impact of smartphone use on musculoskeletal pain and the incidence of CTS, with some also examining occupational risk factors. However, in India, research on the effects of excessive use of different mobile device on CTS especially among student population, remains limited. To the best of the current knowledge, no study has explored the relationship between the different types of mobile device use and the manifestation of CTS symptoms specifically in college students. Addressing this critical gap, the present study aims to provide foundational evidence to support early identificationenabling timely intervention strategies, thereby mitigating the risk of permanent nerve damage and functional impairment in this vulnerable group.

Methodology

Study Design

This observational study was conducted on male and female college students recruited from various colleges in Chandigarh, Mohali, and Panchkula. Ethical approval was obtained from the Institutional Ethics Committee of Saket College of Physiotherapy (Approval No. SCP/2022-23/557). A total of 200 participants were enrolled in the study using convenience sampling.

Sample Size

For samplesize calculation: -[24]

$$n = Z_{1-\alpha/2}^{2} p (1-p)/ d^2$$

Where n = The minimum sample size

p = The presumed prevalence of the condition under the study (13.20%)[25]

$Z_{1-\alpha/2}$ = Is standard normal variate (at 5% type 1 error (P<0.05) it is 1.96.

d = Absolute error or precision and it is 5%

Thus, by using above formula the minimum sample size comes out to be 183. The sample used in the study was 200.

The study included undergraduate students aged 18–25 years of both genders who had been using mobile devices for at least 4 hours per day for more than one year and were willing to participate.[10,26-29] Participants were excluded if they had any inflammatory or neuromuscular conditions affecting the upper extremity, a history of hand or wrist fracture, previous hand or wrist surgery, congenital abnormalities, thoracic outlet syndrome, cervical radiculopathy, or diabetes mellitus.[5,16,26,30,31]

Procedure

Participants were informed about the purpose, procedure, and benefits of the study. Written informed consent was obtained from all participants prior to their enrolment in the study. Screening was conducted using an assessment proforma, and only those meeting the inclusion criteria were enrolled.

Self-Constructed Questionnaire for usage of Mobile Devices:

Data on mobile device usage were collected using a self-designed, interview-based questionnaire developed after a comprehensive literature review. It comprised two sections: demographic details and patterns of mobile device usage. The questionnaire underwent multiple rounds of pilot testing to refine content, grammar, and format based on participant's feedback. Following revisions, it was tested for validity and reliability before final implementation.[16,26,27,31]

For Validity and Reliability of The Questionnaire

The content validity of the self-constructed questionnaire was established through evaluation by a multidisciplinary panel of experts, including specialists in orthopaedics, physiotherapy, and engineering. Astudent representative was also included in the team, to ensure the instrument's clarity and relevance from the perspective of the target population. Recommendations from the panel were incorporated to develop the revised and finalized version of the questionnaire. To determine test-retest reliability, the finalized questionnaire was administered to the same 15 participants on two occasions spaced 10 days apart. The resulting reliability coefficient was high ($r = 0.911$, $p = 0.002$, $\alpha = 0.05$), demonstrating excellent reliability.

Screening for Carpal Tunnel Syndrome Symptoms

CTS screening was performed using the Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) along with Phalen's test and the Carpal Tunnel Compression test.

Boston Carpal Tunnel Syndrome Questionnaire

The BCTQ is a self-administered tool assessing symptom severity and functional status in CTS. It includes an 11-item Symptom Severity Scale (SSS) and an 8-item Functional Status Scale (FSS), each rated on a 5-point scale (1=no symptoms/difficulty, 5 = worst symptoms/inability). Symptom scores are classified as asymptomatic (11), mild (12–22), moderate (23–33), severe (34–44), and very severe (45–55); functional scores as asymptomatic (8), mild (9–16), moderate (17–24), severe (25–32), and very severe (33–40).[32-34]

Physical Examination

Two provocative tests, Phalen's test and Carpal Tunnel Compression test, were performed to assess current wrist status.

Phalen's Test Procedure

The participant's wrist was placed in full (but not forced) flexion for up to 60 seconds. The test was considered positive if paraesthesia or numbness occurred in the median nerve distribution.[35]

Carpal Tunnel Compression Test Procedure

Tingling or abnormal sensation in the median nerve distribution of the hand within 30 seconds after pressure was applied by the examiner's thumb over the median nerve at the carpal tunnel was considered positive for carpal tunnel syndrome.[35]

Results

Data were analysed using SPSS version 20, with statistical significance set at $p < 0.05$. Descriptive statistics were presented through tables and graphs. The Pearson Chi-square test assessed associations between CTS symptoms and mobile device usage. Based on combined BCTQ scores and clinical tests (Phalen's and Compression), 12% (n = 24) of participants showed CTS symptoms.

According to the BCTQ SSS, 50.5% were asymptomatic, 48.5% had mild, and 1% had moderate symptoms. On the FSS, 59.5% reported no functional difficulty, 39% mild, and 1.5% moderate difficulty (Figure 3). Among symptomatic participants, the most common complaints were daytime pain (58.3%), numbness/tingling (50%), and difficulty in writing or gripping (41.6%). Other symptoms included nocturnal pain (29%) and hand weakness (20%).

CTS was slightly more prevalent in females (7%) than males (5%), with no significant gender difference ($\chi^2 = 0.008$, $p = 0.930$, Table-1). A significant association was observed between CTS and academic year ($p = 0.007$), with second-year students showing the highest prevalence (7.5%) and frequent device use. CTS was significantly correlated with musculoskeletal discomfort in the neck, shoulder, wrist, and hand. However, no association was found with total duration of mobile use ($p = 0.732$) (Table-1 and 2).

Table 1. Summarizes the distribution of CTS Symptoms across demographic variables, with chi-square values and p-values indicating the statistical significance of associations.

Variable		CTS		Total Frequency	Chi-Square Value	p-value
		Present	**Not Present**			
Gender	Male	10	75	85		
	Female	14	101	115	.008	.930
Dominant Hand	Right	24	169	193		
	Left	0	07	07	.989	.320
Academic Year	1st	4	54	58		
	2nd	15	48	63	12.170	**.007****
	3rd	4	57	61		
	4th	1	17	18		
Academic Stream	**Medical**	**10**	**112**	**122**		
	Non-Medical	**03**	**20**	**23**	**20.71**	.023*
	Other Streams	**11**	**44**	**55**		

*Statistically significant at $p < 0.05$

**Highly significant at $p < 0.01$

Table 2. Association between CTS Symptoms and Mobile Device Usage Variable among College Students.

Variable		CTS		Chi-Square Value	p-value
		Present	Not Present		
Type of mobile devices used most of the time	SmartPhone Laptop Tablet Notebook Any Other	20 04 0 0 0	168 05 02 01 0	9.711	.021*
Hand used most while operating mobile device	Right Left Sometimes both	17 0 07	140 05 31	2.370	.306
Duration of device use	1- 3 years 3 years - 5 years 5 years - 7 years More than 7 years	10 07 05 02	66 69 25 16	1.289	.732
AverageScreen Time/day	4 hours - 6 hours 6 hours-8 hours 8 hours - 10 hours More than 10 hours	09 08 05 02	114 40 12 10	8.672	.032*
Purpose for which mobile device usedmost of the time	Reading Texting Playing games Others	24 42 10 17	173 158 190 183	8.589	.198
Experience any pain while using mobile devices.	None Rarely Occasionally Frequently Always	01 15 03 04 01	70 87 13 05 01	20.646	.000**
Region of pain	Neck Shoulder Elbow Wrist Hand Other	04 05 01 14 07 01	57 13 06 13 16 13	2.462 4.663 0.036 46.94 8.364 0.336	0.117 0.031* 0.850 0.000** 0.004** 0.562

*Statistically significant at $p < 0.05$

**Highly significant at $p < 0.01$

Significant relationships were noted between CTS and average daily screen time ($p = 0.034$), duration of reading on mobile devices ($\chi^2 = 18.893$, $p = 0.0002$**), and the type of device used ($p = 0.021$), indicating that prolonged screen exposure and device ergonomics may contribute to symptom development (Table2 and 3).

Table 3. Association of CTS Symptoms with Duration of Reading, Texting, Gaming, and Leisure Activities among College Students.

Variable	Duration/day	CTS		Chi Square Value	p-value
		Present	Not Present		
Reading	0-1 hour 1-2 hours 3-4 hours 5-6 hours >6 hours No reading	08 08 03 03 0 02	28 83 53 07 04 01	18.893	.0002**
Texting	0-1 hour 1-2 hours 3-4 hours 5-6 hours >6 hours No texting	08 10 03 19 01 01	75 52 16 03 02 10	3.204	.669
Gaming	0-1 hour 1-2 hours 3-4 hours 5-6 hours >6 hours Not playing game	06 04 0 0 0 14	74 13 05 01 05 78	6.076	.299
Leisure Activities	0-1 hour 1-2 hours 3-4 hours 5-6 hours >6 hours No leisure time spent	4 10 6 3 0 1	62 65 31 5 3 10	8.377	0.137

***Statistically significant at p < 0.05**

****Highly significant at p < 0.01**

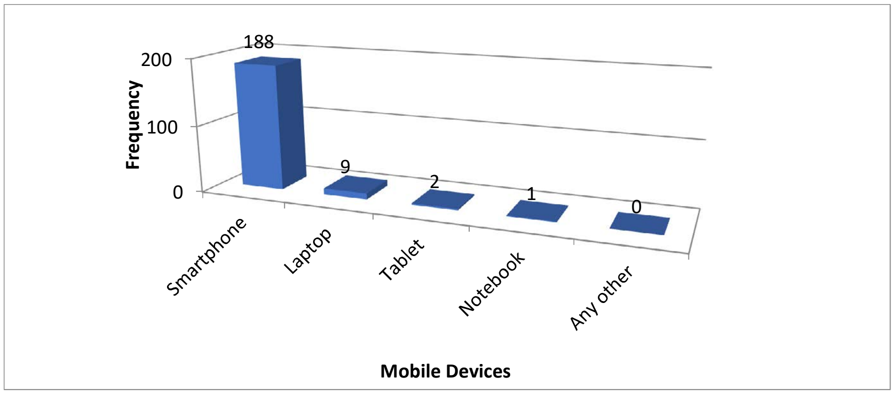

Figure 1: Represents the frequency of different mobile devices used most often by the participants.

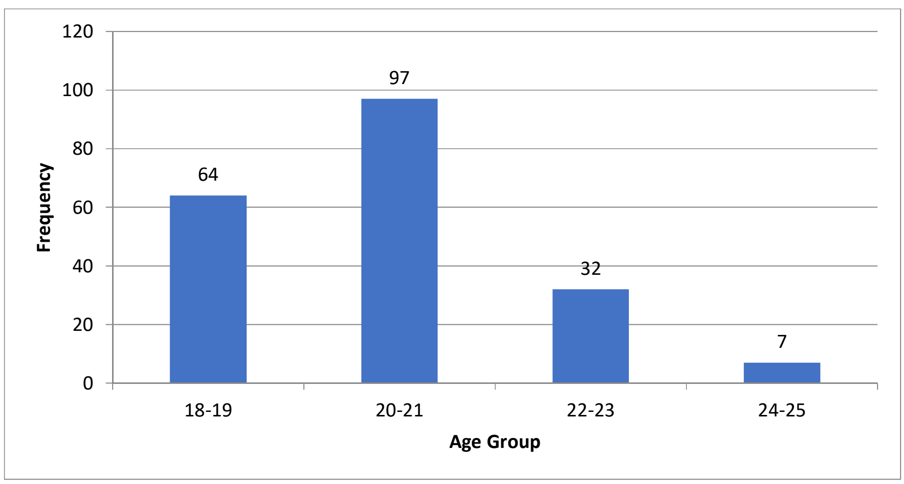

Figure 2: Distribution of Study Participants According to Age Group

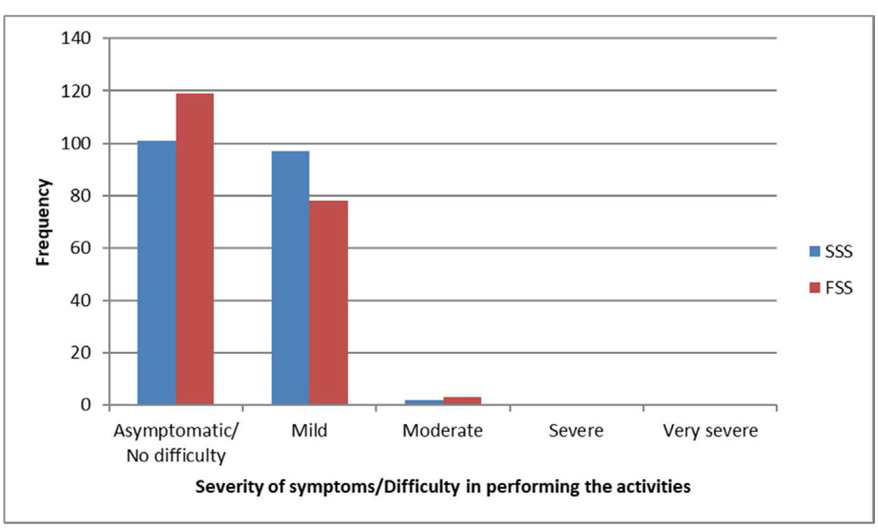

Figure 3: Represents the frequency of the participants based on the SSS and FSS.

Discussion

In this study12% of the participants demonstrated the symptoms suggestive of CTS. The prevalence was higher among females, which aligns with existing literature indicating that women are more predisposed to CTS due to anatomical characteristics, hormonal influences, and smaller carpal tunnel dimension.[36] Male and female smartphone users have different purposefor using their devices. Males use smartphones for more diverse range of activities, such as playing games and watching videos, females more likely use them for communication and social networking purpose.[37]Although most participants belonged to the younger age group (below 22 years), no significant association between age and CTS symptoms was found, consistent with earlier evidence showing CTS typically affects older adults. Previous studies found that CTS more commonly affects the older adults[38,39]. Age-related changes in the flexor retinaculum may have a role in the etiology of CTS.[39] If more samples with older age group were included in this study, then we would have found more comparable results in context to age.

Among the 24 participants (12%), slight daytime pain (58.3%) and slight numbness or tingling (50%) were the most common symptoms. A smaller proportion experienced medium pain (16.6%), severe tingling (12.5%), or weakness (8.3%). Functionally, mild to moderate difficulty was most frequently noted while writing, gripping a phone, performing household chores, and carrying a grocery basket. These findings correspond with previous research. Studies on dental students reported similar rates of pain and numbness,[40] while Feng et al. documented over 50% pain and 60% numbness among clinically diagnosed CTS cases, along with functional limitations in fine-motor tasks.[41] Andersen et al. also reported hand tingling among computer users.[42] In the present study, 14.5% had a positive Phalen's test and 12% had a positive compression test, supporting the presence of early CTS symptoms despite low severity on BCTQ.

Few studies globally have examined CTS prevalence among students. Behee et al. reported median nerve compression signs in 17% of college students,[43] while the general population shows CTS-related incidence ranging from 14.4% to 16.6%.[44] Correlation between CTS symptoms and the region of pain (shoulder, wrist and hand)waspresent in the current study. Our results were consistent with a survey study which found that daily use of a key board for more than 4 hours is associated with shoulder and wrist/hand pain[45]. Woo et al. revealed that 49.9% of respondents reported of having musculoskeletal complaints in one or more body regions and 84.9% reported of having symptoms at multiplesitesandreported that prevalence of wrist/hand pain in intensive electronic device users were significantly higher than non-intensive users.[14,15]

In the present study a significant association was found between CTS symptoms and academic year ($p = 0.007$), with the highest proportion of symptomatic individuals (7.5%) observed in the second year. They also reported the highest use of mobile devices for texting (9%) and watching videos (9%). Prolonged wrist extension, ulnar deviation, and repetitive movements such as typing or mouse use are known to increase median nerve strain across the carpal tunnel,[46] and maintaining the wrist in non-neutral positions has been shown to elevate CTS risk.[47] However, evidence regarding the influence of academic year on CTS remains limited. One study comparing first-year and fourth-year architecture students reported greater computer use among senior students due to drawing-related tasks,[48] contrasting with our findings. Therefore, while the current study suggests a possible association between academic year and CTS symptoms, this relationship cannot be conclusively established due to insufficient literature support. Further studies across diverse student populations are needed to clarify this pattern.

In this study, 94% of participants primarily used smartphones, consistent with findings from Karnataka where 90.5% of undergraduates reported smartphone use.[49] A significant association was found between CTS symptoms and the type of mobile device used ($p = 0.021$). Previous research similarly reported that using a smartphone for more than two hours daily was significantly linked to CTS development.[5] One study found no association between device type and CTS symptoms based on FSS scores,[50] suggesting that factors such as posture and duration of use may be more influential. Studies have shown that mobile devices often require users to maintain non-neutral wrist positions.[51] Differences in device size and weight further alter wrist angles,[14] and such sustained deviation increase carpal tunnel pressure, contributing to CTS risk.[52] These findings highlight the ergonomic impact of device characteristics on median nerve stress.

In the current study, correlation analysis showed no significant association between CTS symptoms and years of mobile device use (p = 0.732), possibly due to the relatively small number of long-term users in the sample. These findings align with a study which similarly reported no association between duration of device use and CTS incidence.[5] On the other hand, one study found a strong association between owning a smartphone for more than nine years and higher prevalence of wrist/hand and neck pain.[53] Another study reported that computer workers with over eight years of experience had a significantly greater risk of CTS compared to those with less than four years of experience.[47] Moreover, long-term electronic device use may contribute to enlargement of the median nerve cross-sectional area and thickening of flexor tendons within the carpal tunnel,[54,55] potentially increasing susceptibility to CTS.

In this study, a significant association was found between CTS symptoms and average daily screen time on mobile devices (p = 0.034). This is consistent with earlier findings showing that prolonged use of electronic devices is linked to increased wrist and hand discomfort and structural changes in the carpal tunnel that may predispose individuals to CTS. Studies have also reported that using a smartphone for four or more hours per day increases the likelihood of developing CTS, as repetitive thumb movements and sustained wrist flexion can irritate the median nerve.[54,55]

Among the participants, the most common mobile activities were watching videos (37%) and browsing the internet (23%). No correlation was observed between CTS symptoms and the primary purpose of mobile use (p = 1.98). However, time spent on reading showed a significant association with CTS symptoms (p = 0.002). This may be because fewer participants used their devices extensively for texting, gaming, or music. Existing research supports these findings, indicating that various smartphone activitiessuch as chatting, gaming, reading, or prolonged typingcan contribute to musculoskeletal strain[5]. Even short durations of smartphone use in a fixed posture have been shown to cause wrist fatigue. Repetitive thumb motions and prolonged flexed wrist positions may increase pressure within the carpal tunnel, tighten soft tissues, and place stress on the median nerve, thereby elevating the risk of CTS.[54,55]

Research has shown that prolonged use of mobile devices can negatively impact wrist and hand function. When individuals without symptoms are exposed to repetitive or sustained risk factors, they become more vulnerable to developing CTS symptoms over time.This may reduce students' study efficiency and overall quality of life. Increasing reliance on mobile devices and sedentary behaviour further compromises health, contributing to sleep disturbances, musculoskeletal disorders, and other related health problems. These issues can promote weight gain and obesity, which are additional risk factors for CTS.

Conclusion

The study revealed early CTS symptoms among college students, with smartphone use, device type, and extended daily screen time as key risk factors. Although symptoms were mild, they reflect early repetitive strain and median nerve stress. Ergonomic awareness, posture correction, and limiting screen exposure are vital preventive strategies to mitigate CTS risk in young users.

Limitations

Self-reported data may have introduced bias, and variations in device dimensions were not considered, which could affect hand posture and wrist strain. The cross-sectional design also limits causal interpretation.

Future Suggestions

Longitudinal studies with larger samples and electrophysiological confirmation are recommended to establish causality and guide evidence-based ergonomic interventions for preventing CTS.

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Conflicts of Interest Statement: NONE

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