RESEARCH ARTICLE

Tech strain: the musculoskeletal impact of electronic devices on young adults: A cross-sectional study

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Abstract

Objective: To determine the prevalence of upper extremity musculoskeletal disorders among young adults using handheld devices.

Method: The cross-sectional study was conducted from September 2022 to March 2023 at the Indus Hospital and Health Network, Karachi, and comprised young adults of either gender aged 18-25 years studying in the affiliated colleges of nursing, biomedicine and physiotherapy. Data was collected using the online RedCap questionnaire. Data was analysed using SPSS 26.

Results: Of the 412 participants, 242(58.7%) were females. The overall median age was 21 years (interquartile range: 20-23 years). A total of 280(68%) subjects had experienced upper musculoskeletal pain, and it was significantly associated with the frequency of using handheld devices (p=0.026), gender (p=0.001), frequently used hand (p=0.039) and purpose of mobile use (p=0.033).

Conclusion: Duration of cell phone or hand-held device usage caused symptoms of musculoskeletal disorders.

Keyword: Musculoskeletal impact, Handheld device use, Ergonomics, Young adults. (JPMA 75: 1086; 2025)

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Introductio

The modern era is marked by the use of electronic devices. The use of mobile phones, especially smart phones and other handheld devices, has increased over the past couple of decades. Because of its portability and ease in usage, the smartphone has had a large impact in everyone's daily life. According to a survey conducted in 2019, there were 2.7 billion smartphone users around the world, and about 77% of the American population owned a smartphone, and even though its use was popular among individuals from all age groups, 96% of the users were aged 18-29 years.[1] The survey also showed that on an average, American adults were spending 2 hours, 55 minutes on a smartphone in 2019, which was a 9-minute increase over 2018.

Depending on the duration of daily usage, individuals have reported various symptoms, mostly of the musculoskeletal system. A study reported that mobile and other handheld device users usually complain of pain, discomfort or muscle stiffness in at least one area of the upper extremities, including neck, upper back arm, and hand.[2] Other studies have also concluded that long-term use of smartphones causes continuous mechanical stress on the tendons, muscles and perimetric tissue of the neck and upper extremities which can induce musculoskeletal symptoms.[3] Majority of the users experienced pain and muscular stiffness in the upper extremities, especially cervical area and neck muscles. Numbness of the thumb due to excessive texting on mobile phone and handheld devices was also reported.[2,4] Neck pain in these individuals is due to continuous flexion of neck, and the degree of pain was also found to be directly correlated with the hours spent on surfing and usage.[5]

Apparently, the use of smartphones and mobile phones cannot be limited, but it is very important to know optimum time duration for their usage as to yield the maximum benefit and to prevent physical problems.[6] Evidence indicates that individuals using smartphones for 10 minutes or less per day showed less signs of muscle fatigue than those using it for >30 minutes.[7,8]

Muscular problems caused by handling of handheld devices and smartphones are usually curable through postural correction and basic training exercises, especially the recovery rate in young adults, like high school and university students, were found to be promising.[9]

Excessive texting is one of the major contributing factors for neck pain because of continuous neck flexion, while standing and using handheld devices contributes an additional threat.[10] A study in Hong Kong on adolescents (10-19 years) suggested that 35% of students using smartphones reported musculoskeletal symptoms.[11] A similar study conducted in India concluded that

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musculoskeletal problems in neck and hand (predominantly the thumb) were seen in smartphone-addicted students that could lead to long-term disability if not corrected early. Lee et al. did a comparison between single-handed and two-handed smartphone usage, and concluded that individuals who used a single hand reported more muscle stiffness and upper shoulder muscle pain compared to those using smartphone with two hands.[12] This pain is further exacerbated by the cervical flexion movement.[13]

These devices also have a direct and significant negative impact on sleep, with the potential to lead to inadequate sleep, poor sleep quality and excessive day-time somnolence[14] Interestingly, hand sizes and the difference between touch screen and keypad smartphone and other handheld devices also have an impact on musculoskeletal pain.[15]

According to a survey done in August 2024, there are about 193.3 million mobile phone users in Pakistan, and 77% of smartphone users are aged 21-30 years.[16] Pakistan is ranked 10th globally in hours spent on mobile (Android), with Pakistanis spending a total of 99 billion hours on their mobile phones in 2023.[17] According to the State of Apps report for Pakistan, Pakistan had 124 million broadband subscribers in 2023, and the average monthly data usage of a single user stood at 7.5 Giga Bytes GB.[18] According to Pakistan Telecommunication Authority (PTA) data, over 50% of Pakistan's population had access to smartphones in 2023. The country has seen a sharp rise in smartphone usage in the past few years. The highest adoption of smartphones is among young adults aged 18-34 years, with approximately 70% of individuals in this age group owning smartphones. This demographic is highly engaged with social media, mobile gaming, and entertainment apps.[19,20] These statistics highlight how deeply smartphones have integrated into the daily lives of Pakistanis, especially among the younger ones.

The current study was planned to determine the prevalence of upper extremity musculoskeletal disorders among young adults using handheld devices in an urban setting.

Subjects and Methods

The descriptive, cross-sectional study was conducted from September 2022 to March 2023 at the Indus Hospital and Health Network (IHHT), Karachi, and comprised those studying in the affiliated colleges of nursing, biomedicine and physiotherapy. After approval from the institutional ethics review committee (ERC), the sample size was calculated using WHO sample size calculator,[21] while taking the proportion of musculoskeletal disorder to be 35% in the population with 95% confidence level and maximum error of estimate 5%.[11] The sample was inflated by 18%) to account for attrition. The sample was raised using nonprobability consecutive sampling technique. Those included were adult students of either gender aged 18-25 years who owned a smartphone or other handheld devices. Those with any injury in the preceding six months to the hand or upper extremity, having any deformity, having any degenerative, inflammatory, musculoskeletal or neuromuscular conditions of the upper extremity or hand affecting the use of the extremity in the activities of the daily living were excluded.

Before data-collection, permission was obtained from the principals of the colleges who were requested for a list of the students at their institutions. Informed consent was also taken from each subject.

Data was collected through the online RedCap questionnaire whose link[22] was disseminated among the students. Data was collected on password-protected tablets by ERC-approved personnel, and was uploaded directly onto the secure IHHT servers. After data-collection, all the participants were given half-an-hour session on health awareness regarding the need to limit unnecessary use of handheld devices. They were also guided about muscle strengthening exercises, with special focus on neck and upper limb.

Data was analysed using SPSS 26. Data related to age, height, weight, use of handheld device for hours per day), and use of handheld device for days per week was non-normally distributed, and was reported as median and interquartile range (IQR). Frequencies and percentages were calculated for categorical variables. Mann Whitney U test was used to compare non-normal continuous variables. $P<0.05$ was considered statistically significant.

Results

Of the 413 individuals approached, 1(0.24%) did not volunteer to participate, and the study was completed by 412(99.75%) students; more than half being females 242(58.7%). The overall median age was 21 years (IQR: 20-23 years), height was 160cm (IQR: 153-167.6cm) and weight was 55kg (IQR: 48-64.8kg). The majority 397(96.4%) used smartphones. Right-hand dominance was found in 384(93.2%) participants. Use of both hands for typing was observed in 199(48.3%) cases. Median time spent on using handheld device was 6 hours (IQR: 5-10 hours). Most frequent positions found were sitting (with leaning forward) 139(33.7%), and supine position 127(30.8%). Overall, 189(67.5%) participants agreed that pain occurred after the usage of mobile phone and 226(80.7%) used pain-killers for the resulting pain. Studying was the most

Table-1: Characteristics of the participants (n=412).

Characteristics of study participants	n%
Gender	
Male	170(41.3)
Female	242(58.7)
Age (years) -- Median(IQR)	21(20-23)
Height (cm) -- Median(IQR)	160(153-167.6)
Weight (cm) -- Median(IQR)	55(48-64.8)
Which is your dominant hand?	
Right	384(93.2)
Left	28(6.8)
Which hand do you use for typing/ writing?	
Left	15(3.6)
Right	198(48.1)
Both	199(48.3)
What type of handheld devices (HHD) do you use?	
Smartphone (Android or IOS)	397(96.4)
Mobile tablet	11(2.7)
Ordinary phone (with numerical key pad)	4(0.9)
What is the average frequency for your use of your handheld devices (HHD) (in days per week)?	
Median(IQR)	7(7-7)
What is the average time (in hours per day) that you spend using your handheld devices (HHD)?	
Median(IQR)	6(5-10)
What is your most frequent position when you use your mobile device (more than one option)	
Sitting position (With leaning forward)	139(33.7)
Sitting position (Sitting upright)	102(24.8)
Standing position	4(1)
Walking position	5(1.2)
Supine position (Lying down)	127(30.8)
Lateral recumbent position (Lying on the side)	35(8.5)
Time of pain	
Morning	44(14.9)
Afternoon	34(11.5)
Night	181(61.1)
Throughout the day	37(12.5)
Severity of pain	
Mild (1-3)	213(76.1)
Moderate to severe pain (4-6)	54(19.3)
Very severe (7-9)	8(2.9)
Worst pain (10)	5(1.8)
Do you think that this pain was related to the use of your mobile device?	
Yes	189(67.5)
I do not believe that this type of pain is related to mobile phones use.	37(13.2)
I believe that this type of pain is related to mobile phones use	54(19.3)
Have you ever used pain killer to decrease this pain?	
No	226(80.7)
Yes	52(18.6)
-Once per week	24(46.2)
-Twice per week	19(36.5)
-Thrice per week	3(5.8)
-Four time in a week	2(3.8)
-Six to eight time in a week	3(5.8)
-Nine to Ten time in a week	3(2.6)
Did you Decrease the use of your mobile device after experiencing this pain?	
No	108(38.6)
Yes	172(61.4)
What is your purpose of using mobile?	
Studying	354(88.3)
Texting	263(65.6)
Working	137(34.2)
Social Media	279(69.6)
Watching Videos	205(51.1)
Internet surfing	96(23.9)
Email	95(23.7)
Streaming TV show	73(18.2)
Playing games	82(20.4)

IQR: Interquartile range.

common reported cause of pain 354(88.3%) (Table 1).

The most common region affected by the pain was neck 202(24.1%), followed by right shoulder 132(15.7%). The time of the pain was predominantly in the night 181(61.1%). The severity of pain was reported to be mild in 213(76.1%) cases, while 5(1.8%) graded their pain as 'worst' (Figure).

A total of 280(68%) subjects had experienced upper musculoskeletal pain (Table 2). The use of mobile phones at night was significantly associated with neck pain (p<0.001), shoulder pain (p<0.05), right arm and forearm (p<0.05), and right wrist (p<0.05). The bedtime use of handheld devices was significantly associated with the presence of musculoskeletal pain (p<0.001).

Musculoskeletal pain was significantly associated with the frequency of using handheld devices (p=0.026), gender

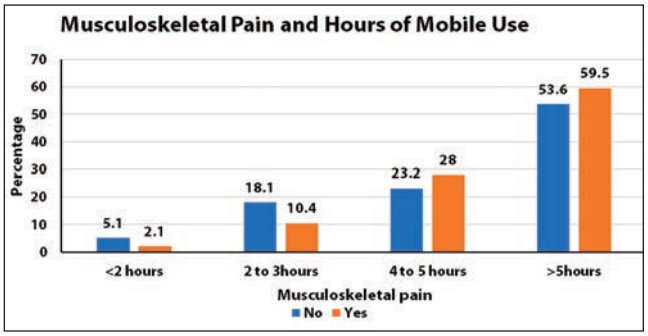

Figure: Severity of musculoskeletal pain.

Table-2: Median difference in the frequency of handheld device usage and its association with musculoskeletal pain.

	Musculoskeletal pain		*p*-value
	No	Yes	
Use of handheld device (in hours per day)			
n	128	280	0.026*ǂ
Median(IQR)	6(4-9)	7(5-10)	
Min-Max	1-18	1-19	
Use of handheld device (in days per week)			
n	127	278	0.976ǂ
Median(IQR)	7(7-7)	7(7-7)	
Min-Max	2-7	1-7	
Age (years)			
n	122	276	0.566ǂ
Median(IQR)	21(20-23)	21(20-23)	
Min-Max	18-42	18-38	
Height (cm)			
n	127	271	0.442ǂ
Median(IQR)	160(155.4-167)	160(152.4-168)	
Min-Max	127-193	124.3-225.5	
Weight (kg)			
n	131	277	0.034*ǂ
Median(IQR)	57(50-64)	54(46.5-65)	
Min-Max	30-175	33-88	

*p<0.05, ǂ Mann whitney test U test

Table-3: Association of musculoskeletal pain with the characteristics of the participants.

	Musculoskeletal pain		*p*-value
	No	Yes	
	n (%)	n(%)	
Male	70(53)	100(35.7)b	0.001*t
Female	62(47)	180(64.3)b	
Right	121(91.7)	263(93.9)	0.395t
Left	11(8.3)	17(6.1)	
Left	7(5.3)	8(2.9)	0.039*t
Right	52(39.4)	146(52.1)b	
Both	73(55.3)	126(45)	
Smartphone (Android or IOS)	128(97.7)	269(96.1)	0.784[1]
Mobile tablet	2(1.5)	9(3.2)	
Ordinary phone (with numerical key pad)	1(0.8)	2(0.7)	
What is the average duration of using mobile per day?			
< 2hours	7(5.1)	6(2.1)	0.037*t
2 to 3 hours	25(18.1)	30(10.4)	
4 to 5 hours	32(23.2)	81(28)	
>5 hours	74(53.6)	172(59.5)	
Studying	102(82.9)	252(90.6)a	0.033*t
Texting	77(62.6)	186(66.9)	
Working	43(35)	94(33.8)	
Social Media	80(65)	199(71.6)	
Watching Videos	68(55.3)	137(49.3)	
Internet surfing	36(29.3)	60(21.6)	
Email	33(26.8)	62(22.3)	
Streaming TV show	31(25.2)b	42(15.1)	
Playing games	25(20.3)	57(20.5)	
Sitting position (With leaning forward)	42(32.1)	97(34.6)	0.546[1]
Sitting position (Sitting upright)	29(22.1)	73(26.1)	
Standing position	1(0.8)	3(1.1)	
Walking position	1(0.8)	4(1.4)	
Supine position (Lying down)	49(37.4)	78(27.9)	
Lateral recumbent position (Lying on the side)	10(7.0)	25(8.9)	

(*p*=0.001), frequently used hand (*p*=0.039) and purpose of mobile use (*p*=0.033) (Table 3).

Discussion

The study revealed that a significant proportion of females were affected with musculoskeletal pain (*p*=0.001). This was in contrast to a study which reported an equal frequency of musculoskeletal pain in males and females.[23] Another study reported a higher frequency of musculoskeletal problems in females compared to males, but the difference was not significant.[24] The current association may have been due to the fact that the study sample comprised predominantly of females (58.7%).

In the current study, the most common sites of pain were neck (24.1%), followed by shoulder (15.7%). An earlier study reported 48.44% and 16.3% prevalence of pain in neck and shoulder, respectively.[24] In another study, 71.2% subjects reported to have cervical pain, which was almost three times higher than the current frequency.[8]

Most of these individuals experienced pain predominantly at night (61.1%). The use of mobile phones at night was significantly associated with neck pain (*p*<0.001), shoulder pain (*p*<0.05), right arm and forearm (*p*<0.05) and right wrist (*p*<0.05). The results reflected that 1.8% of the participants experienced severe pain. This frequency was much less than the 10.3% reported by an earlier study.[25] The current study showed a strong association between the bedtime use of handheld devices and the presence of musculoskeletal pain. Similar association was reported from Saudi Arabia (*p*<0.02) among nursing students.[26]

The duration of mobile usage had a significant positive association with the pain in upper extremities (*p*<0.05). The finding was in contrast to a study in which the duration of mobile use had not been identified as a predictor of musculoskeletal pain.[26] Interestingly, a substantial proportion (67.5%) of the current subjects linked their pain directly to the usage of mobile phones.

Furthermore, the current study identified behavioural adaptations in response to pain, with a significant number of participants opting to reduce mobile phone usage (60%). A study reported that among those who experienced musculoskeletal pain while using mobile phones, 62% reported reducing their mobile phone usage as a coping mechanism.[27] These results were similar to the current findings.

Approximately 90% of the current participants used mobile phones for studying, followed by social media use 69.6%. According to a study, 95% of college students reported using mobile phones for studying, and 91% reported using mobile phones for social media use.[26]

The current study has limitations. The participants' physical activity levels or ergonomic habits beyond handheld device use were not assessed, therefore the effect of posture on musculoskeletal pain other than device use could not be analysed. The descriptive, cross-sectional design of the study was itself a limitation in terms of establishing an association. Also, the online questionnaire could have been affected by recall bias and self-reporting inaccuracies.

Despite the limitations, however, the study identified the association of musculoskeletal disorder with the use of smartphones and other handheld devices.

On the basis of the findings, the provision of ergonomically -designed workstations, including adjustable desks and chairs, is recommended. Guidelines regarding acceptable use of handheld devices and health consequences of overuse should be developed.

Conclusion

Duration of cell phone or hand-held device usage caused symptoms of musculoskeletal disorders.

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Author Contribution:

MM & SRK: Literature search, study design, concept, questionnaire design, data collection, basic data analysis and drafting.

AI: Literature search, study design, concept, questionnaire design, advanced data analysis, interpretation, writing and final approval.

RT & GH: Literature search, study design, concept, data collection and basic data analysis.