RESEARCH ARTICLE

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Analysis of Correlation between Anthropometry of Hand and Smartphone Overuse on Musculoskeletal Pain in Thumb/Wrist in Medical Students: A Cross Sectional Study at Tertiary Care Center of Central India

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Resumen

Introducción: A medida que la tecnología móvil ha evolucionado y es ampliamente utilizada por la mayoría de la población, hay un aumento en la incidencia de dolor asociado con el uso excesivo de teléfonos móviles. El dolor asociado con el uso de teléfonos inteligentes se debe a los períodos prolongados de tiempo relacionados con los dispositivos digitales. El uso de teléfonos inteligentes puede causar varios tipos de molestias físicas, como dolor de cuello, hombro y pulgar, denominados colectivamente "trastornos musculoesqueléticos relacionados con teléfonos inteligentes" (SRMD). Estos problemas médicos surgen principalmente debido a malas posturas, movimientos repetitivos y uso prolongado de teléfonos inteligentes sin descanso. El impacto de los SRMD en la vida diaria de un individuo puede ser significativo, lo que resulta en una disminución de la productividad, una reducción de la calidad de vida y un aumento de los costos de atención médica. Es importante que las personas sean conscientes de los riesgos asociados con el uso de teléfonos inteligentes y tomen medidas para minimizar el riesgo de desarrollar SRMD. **Métodos:** El estudio propuesto fue un estudio observacional no invasivo basado en un cuestionario. El estudio se realizó en AIIMS Bhopal. El estudio se realizó en 130 hombres adultos y 70 mujeres adultas. Se registraron detalles personales y demográficos junto con medidas antropométricas como la longitud de la palma, el ancho de la palma y la longitud del dedo medio. También se documentó el nivel de adicción a los teléfonos inteligentes de las personas. **Resultados:** Se calcularon las correlaciones entre la longitud de la palma, el ancho de la palma, la longitud del dedo medio, el tamaño y la forma del teléfono inteligente, el nivel de adicción y el dolor musculoesquelético. **Conclusión:** El presente estudio propone algunos remedios importantes que pueden minimizar el dolor musculoesquelético asociado con el uso excesivo de teléfonos móviles.

Palabras Clave: Longitud de la palma, Anchura de la palma, Dolor musculoesquelético, Adicción a los teléfonos inteligentes

Abstract

Introduction: As mobile technology has evolved and is used extensively by most of the population, there is an increase in incidences of pain associated with the overuse of mobile phones. Pain associated with smartphone use is because of prolonged periods of time engaging with digital devices. The use of smartphones can cause various types of physical discomforts, such as neck pain, shoulder pain, and thumb pain, collectively referred to as “smartphone-related musculoskeletal disorders” (SRMDs). These medical issues arise mainly due to poor posture, repetitive movements, and prolonged use of smartphones without breaks. The impact of SRMDs on an individual’s daily life can be significant, resulting in decreased productivity, reduced quality of life, and increased healthcare costs. It is important for individuals to be aware of the risks associated with smartphone use and take steps to minimize their risk of developing SRMDs. Methods: The proposed study was an observational, questionnaire-based non-invasive study. The study was conducted in AIIMS Bhopal. The study was conducted on 130 adult males and 70

adult females. Personal and demographic details along with anthropometric measurements like Palm length, Palm breadth, and middle finger length were recorded. The level of smartphone addiction of individuals was also documented. **Results:** Correlations among palm length, palm breadth, length of the middle finger, smartphone size and shape, addiction level, and musculoskeletal pain were calculated. **Conclusion:** Present study proposes some important remedies which may minimize the musculoskeletal pain associated with the overuse of mobile phones.

Keywords: Palm Length, Palm Breadth, Musculoskeletal pain, Smartphone addiction

Introduction

In this era of evolving technologies, smartphone devices upgraded in both design and functions. Smartphones have replaced mobile phones and become the new form of communication around the globe. Smartphones combine normal mobile phone features with other personal digital assistance functions, including internet browsing for learning, accessing email, global positioning system (GPS) navigation, desktop synchronization, capturing high-quality photos, and large displays even replacing computers (Choi et al.,2011). Today, it is estimated that more than 5 billion people have mobile devices, and over half of these communication devices are smartphones and became an integral part of their lifestyle. (Choi et al., 2011: Shim, 2012). A recent study showed that 79% of the population between the age 18-44 years have their smartphones with them almost all the time, with only two hours of their waking day spent without their smartphone in hand (Kim & Kim, 2015; Neupane et al.,2017). According to press release number 16/2021 of the Telecom Regulatory Authority of India published on March 17, 2021, there are a total of 1,163.41 million wireless subscribers in India (until January 2021), with a monthly growth rate of 0.84% (Jonsson et al., 2011). The habit of continuous checking and utilization of smartphone applications for long durations causes musculoskeletal pain due to operational stress over the thumbs, fingers, and wrist, along with stress, sleep disturbances, decreased physical activity, and poorer educational performance (Shim,2012; Kim & Kim, 2015; Neupane et al.,2017). The disorders are because smartphone use typically requires thumb and finger interactions with the small mobile screen (Neupane et al.,2017). There are very few studies reporting the relationship of continuous smartphone use in awkward wrist posture leading to collective trauma disorders of the wrist joint and hand particularly when the wrist, hands, and fingers are overused(Neupane et al.,2017; Jonsson et al., 2011).

The Smartphone Addiction Scale Short Version (SAS-SV) is an important tool to categorize smartphone addiction scientifically (Kwon et al.,2023). The repetitive static motion of the hands may also decrease blood supply and prevent nutrients from being delivered to muscles, thus leading to pain and muscle fatigue (Neupane et al.,2017; Jonsson et al., 2011). Chamy et al.,(2007) concluded that participants with short limb lengths developed more severe signs of thenar fatigue whereas participants with longer arms developed greater discomfort in the neck, shoulder, and back. They strongly recommended that the anthropometry of hand and phone design affected the development of discomfort and fatigue during phone use (Chamy et al., 2007). Nordic Musculoskeletal Questionnaire was clinically used to assess musculoskeletal pain due to the overuse of Smartphones (Young,1998; Kahraman et al.,2016).

Considering these applied aspects, the present study was conducted with the aim to evaluate the relationship between anthropometric measurements of the hand and intensity of musculoskeletal pain in the thumb or wrist due to overuse or addiction to smartphones in adults.

Material and Methods

The proposed observational, questionnaire-based non-invasive study was conducted in AIIMS Bhopal on adult subjects who have consented to the study. The permission from Institutional Ethics Committee was obtained before starting with the project. The study was conducted on 200 (130 male and 70 female) adult participants who volunteered for the study. The participants were explained about the details of the study. Participants were properly informed to record study parameters, and written consent was taken from the participants.

Individuals above 21 years of age using smartphones for more than 3 years and who volunteered to adhere to the study protocol and gave consent for participation were included in the study. Confidentiality was maintained in all aspects. Pediatric age groups and individuals who refused to volunteer were excluded from the research project. The observations of participants were recorded under the following aspects:

Personal and Demographics

Personal details such as name, age, sex, weight, and height were recorded. Body mass index (BMI) was calculated. The model of the smartphone, its usage time, duration of owning a smartphone, and the purposes of smartphone use in a typical day, including (i) talking (voice-to-voice), (ii) text messaging, (iii) listening to music, (iv)

watching videos, (v) social networking, (vi) gaming, and (vii) other uses was noted as in Fig 1 and Fig 2. The percentage of the population using various sizes of mobile was shown in Table 1.

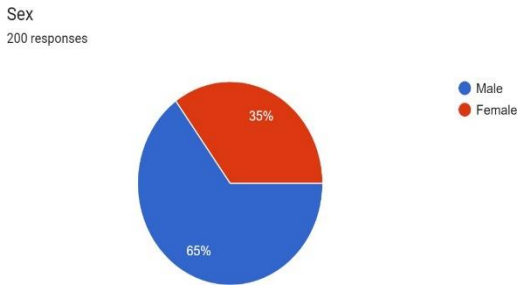

Figure1. Demographic characteristics of participants of the present study

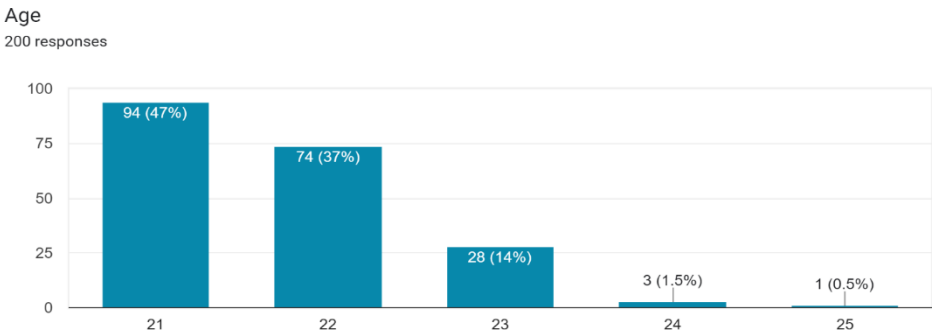

Figure 2. Age-wise number of participants participated in the study (n=200). Age groups were depicted in Figure 2, showing 94 (47%) of age group 21, 74 (37%) of age group 22, 28 (14%) of age group 23, 3 (1.5%) of age group 24, and 1(0.5%) of age 25.

Table 1. Groupings of Smartphone sizes

Groups	Smartphone size	Frequency
Small size	<6.01 inch	18
Medium size	6.01-6.69 inch	148
Large size	>6.69 inch	34

Anthropometric parameters

The anthropometric details of the palm of participants were recorded using a digital sliding caliper to the nearest millimeter.

Hand Length was measured by measuring the linear distance between the midstylion and dectylion sites.

Palm breadth (metacarpal) was measured from the straight distance between the base of the second metacarpal bone to the base of the fifth metacarpal bone.

The length of the middle finger was measured from the metacarpophalangeal joint to the tip of the middle digit.

All measurements were taken while the participants sat on a chair and their hands were kept on a horizontal platform. Fingers were kept close to each other.

Phone Model Groups

The groups of the smartphone were categorized according to the size of the touch screen which was measured in inches from one corner of the screen diagonally across to the opposite corner. 16 touch screen phones were used, 6 models from iPhone Apple, 4 Oppo, and 6 models from Samsung Galaxy. The screen sizes were measured using a Vernier caliper diagonally across the screen. Then, based on the screen size, mobile phones were grouped into small, medium, and large phone sizes as shown in Table 1, Figure 3, and Figure 4.

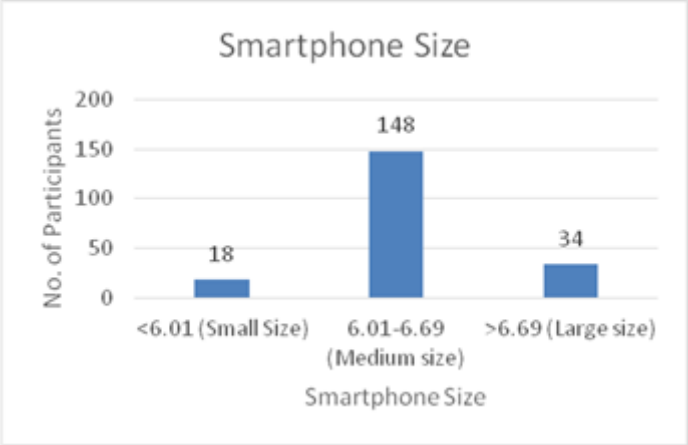

Figure 3. Different Sizes of the smartphones used by the participants

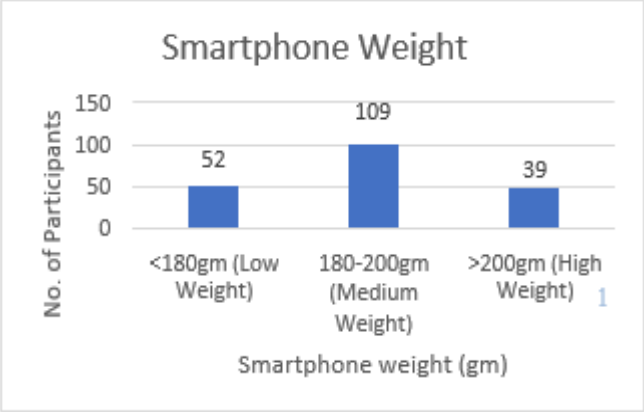

Figure 4. Weight of the Smartphones used by 200 participants

Smartphone Addiction Scale (SAS)

To study the level of smartphone addiction, the SAS carrying a 33-item scale in which responses to items were taken on a six-point Likert-type scale from 1 (*strongly disagree*) to 6 (*strongly agree*) (Young,1998). It was based on the Internet Addiction Test (Namwongsa et al., 2018) and comprised six factors: daily-life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationships, overuse, and tolerance. Higher scores indicate a higher risk of smartphone addiction. The total scores ranged from 33 to 198. A cut-off point for smartphone addiction was not reported in the original scale, with higher scores indicating a greater risk of being addicted to smartphones. A reliability and validity study of the Turkish version of the SAS was conducted by Demirci et al. (2014), and Cronbach's alpha was 0.94.

Modified Nordic Musculoskeletal Questionnaire (mNMQ)

In the present study, the mNMQ was used (Kahraman et al., 2016; Choi, 2018). The mNMQ consists of items relating to six body regions (neck, shoulders, upper back, lower back, elbow, and wrists-hands) from the original NMQ, and assesses upper body musculoskeletal symptoms related to any pain or numbness in the previous 12 months and last seven days. The mNMQ investigates pain and numbness in the body regions that are used most frequently during smartphone use, enabling participants to answer "yes" or "no" by using a simple body image. The participants were asked whether the pain that had developed within the past year prevented them from doing normal work (at home or outside the home) or whether hospitalization was required due to this pain. The Turkish version of NMQ was used in the present study (Choi, 2018).

Smartphone addiction was analyzed based on the SAS-SV score (Fig 5, Fig 6, Fig 7 & Fig 8).

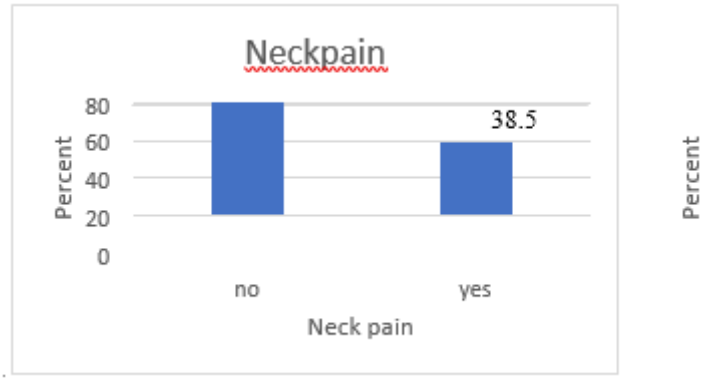

Figure 5. Presence of Neck pain in 200 Smartphone Users

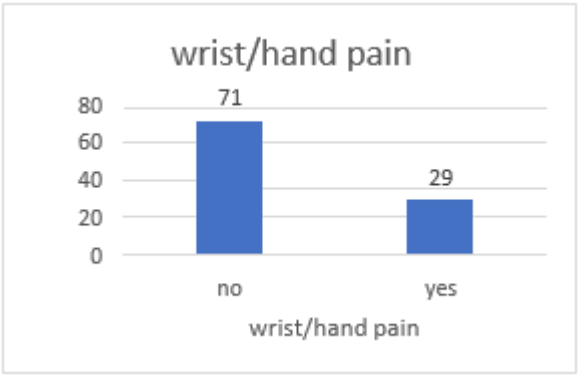

Figure 6. Presence of Wrist or Hand pain in 200 Smartphone Users

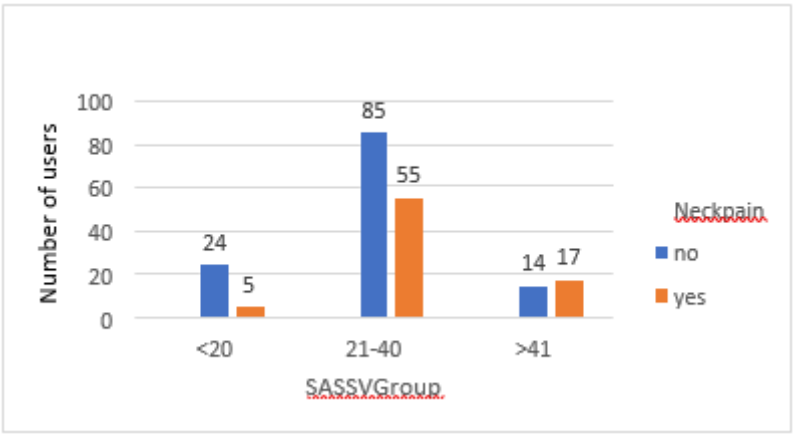

Figure 7. Presence and absence of Neck pain in 200 Smartphone Users

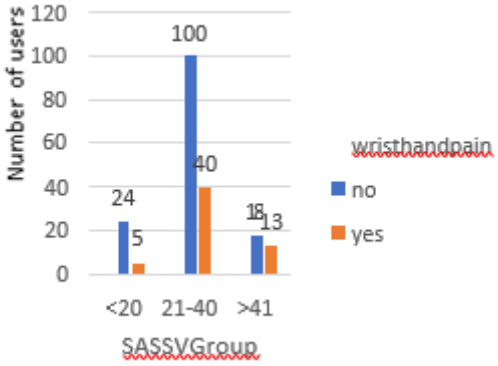

Figure 8. Presence and absence of Wrist/ Hand pain in 200 Smartphone Users

Results

The Demographic characteristics of the subjects are presented in Figures 1, 2, 3, and 4. The present study included 130 (65%) males and 70 (35%) females. It was shown that 190 (95%) were right-handed and 10 (5%) were left-handed.

Discussion

The present study observed addiction to smartphones among medical graduates which was 35.5% (Table 1 & Table 4). Young-Soon Choi from Korea reported a degree of addiction to smartphones in 32.1 % of college students. Choi (2018) also observed that participants who experienced physical pain because of smartphone use were 39.1%. Wrist, finger pain, and neck pain were in the order of joints (Choi,2018). The findings were still higher in Turkish university students as 43%. (Kim & Kim, 2015). This overuse of smartphones was affecting the health as well as academic performances of students.

The most frequent musculoskeletal pain due to smartphone usage was in the neck region which was 38.5%, followed by wrist/hand pain observed in 29.0% of participants (Table 5, Table 6 & Table 7). In a study from Egypt, the most frequent pain experienced by the physical therapy students was in the neck, eyes, and back region (AlAbdulwahab et al., 2017) while in Turkey, the incidence of musculoskeletal pain was also identified in the neck, shoulder, and upper back (Kim & Kim, 2015). Yang and colleagues (Yang et al., 2016), reported neck and elbow areas as the most frequent body pain suffered by adolescent students whereas in Korea, the most common musculoskeletal pain endured by the students was in neck and shoulder. (Choi,2018; Karki et al.,2020; Kwon et al., 2013; Shan et al., 2013). Musculoskeletal pain in the neck was found to be associated with the overuse of smartphones ($r = 0.011$, $p \leq 0.05$), but the present study did not find any significant correlation between overuse of smartphones and wrist/hand pain (Table 7 and Table 10, $r = 0.107$, $p \geq 0.05$), which was similar to the study performed by AlAbdulwahab et al. (2017). The hand and neck might move continuously toward the screen throughout the day if smartphones were used excessively. Such motions increase the likelihood of chronic neck pain.

The overuse of large size of smartphones was related to the degree of musculoskeletal pain (Table 8, Table 9, Table 11). The smartphone brands were grouped based on their diagonal screen size measurements. The results showed that 18 out of 200 participants used small-sized phones, 148 participants used medium-sized phones, and 34 used large-sized phones. So, the majority of participants tend to use small to medium size mobile phones. This can be related to the less reported hand pain as well as the awareness of the subjects to pick the mobile size that matches their hand size (Table 12, Table 13, Table 14).

Pain in the neck was the most common symptom observed in the participants and was due to regular posture adopted by smartphone users (Alhazmi et al., 2018; Elsertyet al.,2018; Kamel et al.,2020; Tonga et al.,2017; Walankar et al.,2021). They remain in this posture while looking at their devices for long time. The length of time devoted to smartphone usage and adopting flexed neck postures resulted in pain and discomfort in the neck region in the long term (Namwongsa et al.,2018). Furthermore, smaller smartphone screen sizes might indirectly influence the adoption of different neck positions to enhance looking at the screen. Smaller screens might cause more forward bending of the neck, reducing the distance between the screen and the user's eyes (Ning, et al.,2015). A compensatory forward neck bending might be occasioned by increased neck muscle activity, which might have affected DNF endurance in the smartphone-addicted groups. Previous studies supported that the mechanical steadiness in the cervical region was the main function of the deep muscles of the neck namely the longus capitis, longus colli which provided longitudinal spine stability in the cervical region (Domenech et al., 2012 ; Ning et al., 2015). Alshahrani and colleagues (2021) in their extensive study on neck and hand muscle endurance in smartphone users reported that excessive use of a smartphone and the posture of keeping the cervical spine flexed for long durations were associated with high addiction, which led to long-term health issues. They emphasized the fact that students should be made aware of the long-term ill effects of smartphone addiction (Alshahrani et al.,2021). Hence, during the present study, all the participants were advised regarding precautions during the use of smartphones for longer durations for academic purposes. Taking a rest for a few minutes in between the sessions and exercises to increase the endurance of muscles of the neck and wrist/ hand would surely help in reducing the symptoms of smartphone over usage.

Table 2. Categories of Smartphones according to smartphone's weight

Groups	Smartphone Size	Frequency
Low Weight	<180 g	52
Medium Weight	180-200 g	109
Heavy Weight	>200 g	39

Table 3. Handbreadth, Middle finger length, and Palm length

	Handbreadth (mm)	Middle finger length (mm)	Palm length (mm)
Mean	79.8	78.9	102.2
Number	200	200	200
Mean	32.7	21.9	33.0
Std. Deviation	6.7	4.7	6.8
Minimum	64.7	67.3	88.1
Maximum	97.4	89.1	121.1

Table 4. Groupings Smartphone addiction based on SAS-SV score

Groups	SAS-SV score	Frequency
Less addicted	<20	23
Medium addicted	21-40	146
Highly addicted	>41	31

Table 5. Analysis of SAS-SV score

Smartphone addiction scale					
Mean	Number of participants	Mean	Std. Deviation	Minimum	Maximum
29.7	200	46.0	9.2	10.0	56.0

Table 6. Neck pain analysis in 200 smartphone users with different sizes

Presence of Neck pain		Frequency (n)	Percent (%)	Valid Percent	Cumulative Percent
Valid	No	123	61.5 %	61.5 %	61.5 %
	Yes	77	38.5 %	38.5 %	100 %

Table 7. Wrist/Hand pain analysis in 200 smartphone users with different sizes

Presence of Wrist/Hand pain		Frequency (n)	Percent (%)	Valid Percent	Cumulative Percent
Valid	No	142	71.0 %	71.0	71.0
	yes	58	29.0 %	29.0	100.0

Table 8. Correlations between SAS-SV score and Neck pain in 200 participants

SAS-SV Groups	Counts	Neck pain		Total
		No	Yes	
<20 (Less addicted)	Count	24	5	29
	Expected Count	17.8	11.2	29.0
21-40 (Moderately addicted)	Count	85	55	140
	Expected Count	86.1	53.9	140.0
>41 (Strongly addicted)	Count	14	17	31
	Expected Count	19.1	11.9	31.0

Table 9. Chi-Square Tests for Correlation between SAS-SV Groups and Neck Pain.*a 0 cells (0.0%) have an expected count of less than 5. The minimum expected count is 11.17

	Value	df	Asymptotic Significance level (2-sided)
Pearson Chi-Square	9.067[a]	2	0.011
Likelihood Ratio	9.635	2	0.008
Linear-by-Linear Association	8.836	1	0.003
Number of Valid Cases	200		

Table 10. Correlation between SAS-SV score and Wrist/Hand Pain

Groups		Wrist/Hand pain		Total
		No	Yes	
SAS-SV ≤20 (Less addicted)	Count	24	5	29
	Expected Count	20.6	8.4	29.0
21-40 (Moderately addicted)	Count	100	40	140
	Expected Count	99.4	40.6	140.0
≥41 (Strongly Addicted)	Count	18	13	31
	Expected Count	22.0	9.0	31.0
Total (n=200)	Count	142	58	200
	Expected Count	142.0	58.0	200.0

Table 11. Chi-Square Tests between SAS- SV score and Wrist/hand pain

	Value		Asymptotic Significance (2-sided)
Pearson Chi-Square	4.479[a]		0.107
Likelihood Ratio	4.518		0.104
Linear-by-Linear Association	4.436		0.035
No of Valid Cases	200		
[a] 0 cells (0.0%) have an expected count of less than 5.The minimum expected count is 8.41			

Table 12. Correlations between wrist/hand pain and Middle finger length

		Wrist/hand pain	Middle finger length
Wrist/hand pain	Pearson Correlation	1	–0.076
	Sig. (2-tailed)		0.286
	N	200	200
Middle finger length	Pearson Correlation	–0.076	1
	Sig. (2-tailed)	0.286	
	N	200	200

Table 13. Correlations in between Wrist/ Hand pain Hand Breadth among 200 participants

	Palm Length	Hand Breadth
Wrist /Hand Pain		-0.06
		p≤.05

Table 14. Correlation between Wrist/Hand pain and Palm Length

		Wrist/hand pain	Palm length	Hand Breadth
Wrist/hand pain	Pearson Correlation	1	-0.049	-0.06
	Sig. (2-tailed)		0.494	≤0.05
	N	200	200	200
Palm length	Pearson Correlation	-0.049	1	
	Sig. (2-tailed)	0.494		
	N	200	200	
Hand Breadth	Pearson Correlation			1
	Sig. (2-tailed)			
	N			

Conclusion

A strong direct correlation was noted between smartphone overuse and neck pain of the participants but no relationship was observed between the use of smartphone and wrist pain. This could be because of the very short duration of the study and limited number of participants. The findings showed a positive association between smartphone overuse and neck pain and no correlation was established between smartphone overuse with wrist pain or hand anthropometry.

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Conflicts of Interest

The Authors have no Conflicts of Interest to declare that they are relevant to the content of this Article.

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