Use of Smartphones as a Risk Factor for the Development of Morbidities in the Wrist and Fingers*

Uso de smartphones como fator de risco para o desenvolvimento de morbidades no punho e nos dedos

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Abstract

Objective To investigate the long-term use of smartphones as a risk factor for the development of morbidities in the wrist and fingers.

Methods The present is a descriptive, exploratory study with a quantitative approach based on injury prevalence among one hundred smartphone users of a private university in the state of Pernambuco, Northeastern Brazil. We applied a semi-structured questionnaire and the Boston Carpal Tunnel Questionnaire (BCTQ), as well as the Visual Analog Scale (VAS) and the Finkelstein, Phalen, reverse Phalen, and Tinel signal tests on the wrist.

Results The average of the sample was of 22.73 years, with a prevalence of single, right-handed female participants. Most of them had been using smartphones for 5 to 10 years, and 85% reported discomfort in the wrist and fingers while using the device, with numbness as the most prevalent symptom. Most clinical tests were negative, and the Finklestein test showed greater positivity. The BCTQ is composed of a symptom severity scale (S scale) and a functional status scale (F scale): the overall score on the S scale was of 1.61, indicating mild to moderate symptoms, and the F scale revealed that the symptoms did not affect functionality.

Conclusion There was a significant correlation between the length of use of smartphones and discomfort in the wrist and fingers; as such, smartphones are a risk factor for the development of morbidities.

Keywords
- mobile phones
- wrist trauma
- hand trauma
- cumulative trauma disorders

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Resumo

Objetivo Investigar o uso de *smartphones* em longo prazo como fator de risco para o desenvolvimento de morbidades no nível do punho e dos dedos.

Métodos Realizou-se um estudo descritivo, exploratório, de abordagem quantitativa, para a obtenção de medidas de prevalência com cem acadêmicos usuários de *smartphones* de uma faculdade privada localizada no sertão de Pernambuco. Foram aplicados um questionário semiestruturado e o Questionário de Síndrome do Túnel do Carpo de Boston (Boston Carpal Tunnel Questionnaire, BCTQ, na sigla em inglês), além da Escala Visual Analógica (EVA) e dos testes de Finkesltein, Phalen, Phalen reverso, e sinal de Tinel no punho.

Resultados A idade média da amostra foi de 22,73 anos, com prevalência de solteiros, de destros, e do sexo feminino. O tempo de uso do *smartphone* indicado pela maioria dos participantes era entre 5 e 10 anos, e 85% da amostra relatou já ter sentido desconforto no punho e nos dedos durante o uso do aparelho, sendo a dormência o sintoma mais prevalente. Com relação aos testes clínicos, houve prevalência de resultados negativos, e o de Finklestein apresentou maior positividade. Quanto ao BCTQ, dividido em duas escalas, uma de gravidade dos sintomas (escala G) e uma de estado funcional (escala F), a média geral das pontuações foi de 1,61 na escala G, o que indica sintomas de leve a moderados, já a escala F revelou que os sintomas não afetavam a funcionalidade.

Conclusão Foi possível observar uma correlação significativa entre o tempo de uso dos *smartphones* e a presença de desconforto no punho e nos dedos, o que indica que se trata de um fator de risco para o desenvolvimento de morbidades.

Palavras-chave

- telefones celulares
- traumatismos do punho
- traumatismos da mão
- transtornos traumáticos cumulativos

Introduction

The 19th century witnessed the advent of new information and communication technologies; by the late 1870s, the first telephones caused a revolution in culture and communication. However, the real revolution occurred in the 21st century with social/digital networks and mobile technologies. A clear example is the smartphone, which currently surpasses notebook computers as a tool for internet access, communication, and work; it also aggregates functions from several other devices.[1,2]

According to the Brazilian National Telecommunications Agency (Agência Nacional de Telecomunicações, ANATEL, in the Portuguese acronym),[3] Brazil had approximately 236 million cell phones in March 2018; this is a high figure compared to the number of inhabitants, of about 209.1 million per the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, IBGE, in the Portuguese acronym).[4] Cell phones are a valuable invention with several features that make daily life easier. However, while it provides benefits, it can also lead to physical harm, as shown by Guterres et al.,[5] who evaluated musculoskeletal complaints in every region of the body among smartphone users and found the neck (49.4%) as the area most frequently involved, followed by the wrists and hands (37.9%).

Anatomically, the wrist is considered one of the most complex joints in the body. It performs flexion, extension, ulnar deviation, radial deviation, and circumduction movements. The hand is the distal end of the upper limb, and it is considered the most important functional part of the upper appendicular skeleton. The carpometacarpal joints consist of the second row of the carpal bones and metacarpal bones. The metacarpophalangeal joints, formed by the metacarpal bones and the proximal phalanges, perform flexion, extension, hyperextension, adduction, and abduction movements. Lastly, the interphalangeal joints are located between the phalanges and enable flexion and extension movements.[6,7]

The thumb is the first digit, and it presents the highest level of functionality. Its carpometacarpal joint consists of the trapezium and the base of the first metacarpal bone, and it enables flexion, extension, adduction, abduction, opposition, reposition, and circumduction of the thumb. Although the thumbs are highly mobile, their design does not enable the heavy lifting required to handle a smartphone; as such, the level of effort may vary depending on the mode and speed of typing.[8]

The highest prevalence of upper-limb symptoms resulting from repetitive efforts occurs in the hands. These symptoms are due to repetitive movement, vibration, use of hand tools, high forces, and inadequate postures, which cause discomfort, feeling of heaviness, pain, numbness, tingling, and decreased functionality and strength.[9] Among these disorders, De Quervain tenosynovitis and carpal tunnel syndrome prevail.[10]

Although the association between repetitive movements and musculoskeletal morbidities is a fact, few studies in the literature report these conditions with the use of smartphones. It is possible to prevent or delay these physical health issues by using smartphones in moderation and correctly; the population and healthcare professionals must know

these risks to formulate preventive strategies and measures. Thus, the present study aims to investigate the long-term use of smartphones as a risk factor for the development of wrist and fingers conditions.

Materials and Methods

The present is a descriptive, exploratory study with a quantitative approach to assess the prevalence of injuries among smartphone users. The research was conducted at a college, and the sample consisted of one hundred students. The Research Ethics Committee approved the study under opinion number 2,889,152 before data collection.

The subjects included were enrolled at the college during the research period, had been using smartphones for more than 5 years, and were 21 to 30 years old. The excluded subjects were those performing any paid activity other than their college studies, or those who had a previous diagnosis of rheumatic diseases.

After presenting the study to the participants, they signed an informed consent form before data collection, which occurred in three stages. The first stage was the application of a semi-structured questionnaire (►**Appendix A, Supplementary material**), available on-line only[11] consisting of closed questions with a single alternative to be checked, except when otherwise stated. This questionnaire enabled the collection of data pertaining to the sociodemographic profile and routine cell phone use of the participants. The presence of pain on evaluation was verified using the visual analog scale (VAS).

The second stage consisted of the application of the Boston Carpal Tunnel Questionnaire (BCTQ) to quantify six critical domains: pain, paresthesia, numbness, weakness, nocturnal symptoms, and global functional status. This questionnaire has two scales, one for the severity of symptoms (S scale) and one for functional status (F scale). The S scale contains 11 multiple-choice questions with scores from 1 to 5, in which 1 represents the absence of symptoms and 5, severe symptoms. The score is an average of these 11 individual items. The F scale addresses 8 usual activities, with scores from 1 to 5 points, in which 1 represents no difficulty, and 5 indicates that the subject cannot perform the activity. Its total score is the average value of these eight items.

The sample data were descriptively analyzed and tabulated using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, IBM Corp., Armonk, NY, United States) software, version 22.0, to determine the means, minimum, maximum, standard deviation (SD), and percentage distribution per the specificity of each variable. The Chi-squared test evaluated the significance between the variables with a 95% confidence interval (95%CI; $p < 0.05$). The results are shown in tables.

Results

►**Table 1** shows the sociodemographic profile of the research participants. The average age of the students was of 22.73 years (SD: ± 2.296). Regarding gender, there was a prevalence of females (69%). In addition, right-handed subjects were predominant (89%).

Table 1 Sociodemographic profile of the students

Variables	Categories	n	%	Average	Standard deviation
Age		–	–	22.73 years	± 2.296
Gender	Female	69	69	–	
	Male	31	31		–
Dominant hand	Right	89	89	–	
	Left	11	11		–

Table 2 Data on smartphone use (N = 100)

Variables	Categories	n	%
Time of use	5–10 years	57	57
	10–15 years	33	33
	More than 15 years	10	10
Time of daily use	More than 10 hours	28	28
	5–8 hours	28	28
	8–10 hours	19	19
	Other	25	25
Pauses during use	Up to 20 minutes	33	33
	30 minutes to 1 hour	27	27
	No pauses	22	22
	Other	18	18
Main activity performed	Typing	84	84
	Talking	8	8
	Other	8	8

►**Table 2** reveals that most students (57%) had been using smartphones for 5 to 10 years; 33% reported taking breaks of up to 20 minutes during use, and only 22% reported not doing so. As for daily time distribution, 28% used the smartphone for more than 10 hours, and 84% reported typing as the main activity performed.

►**Table 3** describes the most frequent way of handling and typing. A total of 51% of the subjects held the device only with their right hand, and 71% typed using both hands.

►**Table 4** shows a positive correlation between the time of use and discomfort ($p = 0.000$). Out of the 28 students reporting cell phone use for more than 10 hours a day, 89.3% mentioned some episode of discomfort during use, as well as in all other time variables. This confirms that the daily use of smartphones can cause wrist and finger soreness, regardless of the number of years that the device has been used, as even those who had been using them for shorter periods reported discomfort.

Table 3 Smartphone handling (N = 100)

Variables	Categories	n	%
How the smartphone is held	With the right hand	51	51
	With both hands	45	45
	With the left hand	4	4
How one types	With both hands	71	71
	With a single hand	29	29

Table 4 Awareness on risks and symptoms related to smartphone use (N = 100)

Variables	Categories		n	%
Have you ever felt any discomfort during use?	Yes		85	85
	No		15	15
Where?	Wrist		54	26.3
	Thumb		49	23.9
	Hand		28	13.7
	Forearm		20	9.8
	Other		54	26.3
Symptom	Numbness		43	30.7
	Tingling		34	24.3
	Pain		30	21.4
	Other		33	23.6
Visual Analog Scale	With pain – 24% (n = 24)	Moderate	13	54.2
		Mild	11	45.8
	No pain	–	76	76

When asked if they had ever felt any discomfort in the upper limbs while using a smartphone, 85% of the subjects answered yes. The most affected regions were the wrist (26.3%) and the thumb (23.9%). Regarding the characteristics of these symptoms, 30.7% reported numbness, 24.3%, tingling, and 21.4%, pain. Only 24% of the sample reported pain on the VAS assessment; among them, 54.2% described moderate symptoms.

Participants self-reported numbness and tingling as the most common discomfort, especially in the wrist, thumb, and hand. These findings may indicate carpal tunnel syndrome and De Quervain tenosynovitis, or a predisposition for their development.

►**Table 5** shows the overall mean score on the S scale of the BCTQ and the mean values per symptomatology. The overall mean score was of 1.61 (SD: ± 0.485), indicating mild symptoms, since 1 and 2 respectively refer to no and few symptoms. When analyzing each individual symptom, the highest mean score, of 1.68 (SD: ± 0.657), was for tingling, followed by pain (1.65; SD: ± 0.560), weakness (1.59; SD: ± 0.727), and difficulty picking up objects (1.11; SD: ± 0.423).

Table 5 Average scores on the symptom severity scale (S scale) of the Boston Carpal Tunnel Questionnaire

Variable	Mean	Standard deviation
Overall average on the S scale	1.61	± 0.485
Average tingling score	1.68	± 0.657
Average pain score	1.65	± 0.560
Average weakness score	1.59	± 0.727
Average difficulty picking up objects	1.11	± 0.423

Table 6 Average scores on the functional status scale (F scale) of the Boston Carpal Tunnel Questionnaire

Variable	Mean	Standard deviation
Overall average on the F scale	1.43	± 0.493
Ability to carry grocery bags	1.63	± 0.816
Ability to hold the telephone	1.61	± 0.827
Ability to perform household work	1.60	± 0.912
Ability to open a glass jar	1.50	± 0.870
Ability to write	1.49	± 0.771
Ability to hold a book during reading	1.40	± 0.663
Ability to button up clothes	1.14	± 0.348
Ability to shower and get dressed	1.08	± 0.338

The average score on the S scale regarding difficulty picking up objects was of 1.11 (SD: ± 0.423). This value had a positive correlation with the overall average score on the F scale ($p = 0.000$), showing virtually no difficulty in picking up objects. This finding confirms that symptoms do not affect the quality of life of participants probably because their condition is mild.

Lastly, the F scale of the BCTQ, shown in ►**Table 6**, assessed how much these symptoms affect activities of daily living. In addition, we calculated the mean scores for each task; the highest value referred to the ability to carry grocery bags (1.63; SD: ± 0. 85), and the lowest value, to the ability to shower and get dressed (1.08; SD: ± 0.34).

Discussion

The average age of the participants was of 22.73 years, which is consistent with other studies on the use of smartphones by university students, including the one by Xie et al.,[12] in which the average age was of 23.9 years. The prevalence of females in the present study corroborates the research by Taufiq et al.,[13] who evaluated the association between De Quervain

tenosynovitis and excessive typing on smartphones among 137 medical students, 80% of whom were female. Ali et al.[14] observed that out, of 300 students, 94% were right-handed, corroborating the present study. The literature does not specify why most people are right-handed, but there is a potential association with genetic, anatomical, and cultural factors.[15]

Pereira et al.[16] conducted an online survey with one hundred subjects to assess the relationship between smartphone use and carpal tunnel syndrome; they found out that half of the sample had been using smartphones for more than five years, confirming our data. As for taking breaks, 58% of the participants did not do it during smartphone use. This data does not corroborate our research, since the percentage of those who did not take breaks was lower.

As for the distribution of daily time, Guterres et al.[5] found that most subjects (22%) use smartphones for more than 10 hours, confirming our results. Eapen et al.[17] verified the prevalence of cumulative trauma in the upper limbs from cell phone users and observed that 96.5% of respondents used the phone to type text messages.

In an observational study on typing postures and styles, Gold et al.[18] observed that 46.1% of the subjects held the smartphone with both hands and 36.2%, with the right hand; in addition, 82.3% typed using the thumb, corroborating our findings.

Xie et al.[12] performed an electromyographic study and found that the upper limbs had increased activity when typing with only one hand, requiring greater amplitude and more repetitive movements of the thumb. These authors[12] suggested that smartphones should be held with both hands, using both thumbs to prevent muscle overload and morbidities.

Studies on smartphone handling show that we must limit the daily use of these devices to avoid morbidities in the upper limbs. In addition, we must use both hands and both thumbs to hold the smartphone, take frequent breaks, avoid typing at high speed, and support the forearms while typing.[14,19] In the present study, the time of daily use was consistent with the results found by Oliveira,[20] in which 72.11% of subjects using the device for more than 10 hours had discomfort, and there was discomfort regardless of the time of daily use.

Regarding discomfort in the upper limbs with the use of smartphones, our findings corroborate those of the research by Oliveira,[20] in which 71.2% of college students reported discomfort in the wrist and fingers. Eapen et al.[17] reported that 53% of subjects complained of discomfort in the thumbs, and 13%, in the wrists. In addition, these authors state[17] that several symptoms were related to repetitive strain injuries, especially pain, followed by discomfort and tingling. They also observed a high prevalence of pain (61.7%). Thus, our data is consistent with the main types of symptoms presented; however, pain was the third most frequent symptom in the present study, but the literature indicates it as the main symptom.

Oliveira[20] reported that 71.15% of the participants complained of pain, mostly classified as moderate (75.2%), which corroborates the level of pain found in the present study. The overall mean score obtained by Oliveira[20] was of 1.82, which is also considered mild. Regarding individual symptoms, pain prevailed, with the highest average (2.04), followed by tingling (average score: 1.72), weakness (average score: 1.64), and difficulty picking up objects (average score: 1.31). These figures do not corroborate the most prevalent symptom, but are similar to the average values, ranges, and least prevalent symptom.

Comparing the difficulty picking up objects found in the present study and the same finding by Oliveira,[20] which was of of 1.31 on average, one can observe that they were similar, since both samples presented mild difficulty. The scores on the F scale of the BCTQ are consistent with those of the literature, which shows that symptoms do not affect the functionality and activities of daily living of participants, such as in the study by Pereira et al.,[16] who reported that subjects had no major issues or difficulty when handling a smartphone.

Conclusion

Given the aforementioned data, we conclude that there is a significant association between the time of daily smartphone use and the presence of discomfort; smartphones are a risk factor for the development of wrist and finger morbidities. Furthermore, we suggest further studies to investigate not only subjective symptoms, but also physical capacity quantitatively, as well as the muscle biomechanics of typing. This will enable the development of more specific preventive measures, which are critical because the incidence of smartphone-associated repetitive strain injuries tends to rise.

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Conflict of Interests
The authors have no conflict of interests to declare.

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