Original Article

A Study on the Risk Level of Carpal Tunnel Syndrome (CTS) due to Smartphone Use among Undergraduates in the Faculty of Health Sciences at the National University of Malaysia

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ABSTRACT : *Smartphones are on the rise, especially among youngsters, as they are more dependent on smartphones. Prolonged use of smartphones may result in Carpal Tunnel Syndrome (CTS) due to repetitive movement of hands. This study aims to identify the association between gender and dominance with CTS and determine the relationship between the duration of smartphone use and the risk level of CTS. Boston Carpal Tunnel Questionnaire was randomly distributed to undergraduates of the Faculty of Health Sciences. A total of 310 respondents agreed to participate in this research. The majority of the respondents comprised 92.6 % females and 7.4% males. However, 92.6% of respondents were right-handed, and the rest were left-handed. The CTS symptom severity scale data found that 58.1% of respondents experienced mild symptoms, compared to 40.6% of respondents who did not experience any symptoms. Based on the analysis performed, it was found that there is no association between gender and hand dominance with CTS. Furthermore, there is a weak but significant relationship between the duration of smartphone use and the CTS symptoms. In conclusion, the risk level of CTS due to smartphone use is relatively low.*

Keywords - *Boston Carpal Tunnel Questionnaire, Carpal Tunnel Syndrome, Smartphone, Undergraduates*

1.0 INTRODUCTION

A smartphone is a device that has the power of a computer. This device provides the user with advanced communication and computing ability / than the normal mobile. Smartphones are equipped with internet access, top-quality cameras, and management tools (Boulos et al., 2011). The latest smartphones are viewed as handheld computers instead of the traditional phone due to their powerful computing capability and enormous memory. The potential of running feature-rich applications

on smartphones has made smartphones a more powerful device replacing many devices like alarm clocks, calculators, laptops, GPS navigators, and digital cameras (Singh and Samah 2018).

Smartphones have made the young generation so preoccupied with its technology that it has become a trademark of the young generation. This is because the technology-savvy generation is dependent on advanced touch screen technology, where smartphones can be used at any moment with the accessibility of the internet all day long (Skierkowski and Wood 2012). But, unfortunately, smartphones involve an interaction between the thumb, fingers, and smartphones. While these interactions are generally not burdensome, repeated movements for prolonged periods may cause excessive force on the median nerve and tend to compress it over time. Therefore, repetitive hand movement is one of the factors to cause the occurrence of Carpal Tunnel Syndrome (CTS) (Woo et al. 2019).

Carpal Tunnel Syndrome (CTS) is a medical condition defined by a group of symptoms resulting from the local compression of the median nerve at the wrist. The carpal tunnel is a narrow passageway located on the palmar or anterior aspect of the wrist bound by bones and ligaments. Compression of the nerve leads to symptoms that characterize the syndrome, including numbness, pain, and, eventually, hand weakness (Shaffi Ahamed et al., 2015).

Since the use of smartphones is rising tremendously among all age groups, especially during the pandemic, there is a rise in repetitive hand movement, which is said to be one of the causal factors of CTS. Moreover, only a few studies emphasized the occurrence of CTS due to the use of smartphones by using the questionnaire method.

This research was conducted to determine the relationship between smartphone use among undergraduates of the Faculty of Health Sciences in the National University of Malaysia and the risk level of CTS.

2.0 METHOD

2.1 Study Population

This research was conducted among undergraduate students at the Faculty of Health Sciences, National University of Malaysia. Out of 1600 undergraduate students, 310 participants were selected using a simple random sampling technique (Taherdoost 2018). Sample size calculation was calculated using Raosoft Sample Size Calculator with a 5% margin of error and 95% confidence level. There were several exclusion criteria set for this research. Respondents with a history of wrist surgery and fractures, CTS and other peripheral nerve disorders were excluded from this research. In addition, this study did not select respondents with CTD prone factors, such as diabetes mellitus, rheumatoid arthritis, hypothyroidism, pregnancy or obesity.

2.2 Procedure

A standardized questionnaire used to determine the risk level of Carpal Tunnel Syndrome, the Boston Carpal Tunnel Questionnaire, was distributed to the respondents via Whatsapp and email. In addition, the questionnaire has been converted to Google Form's format for easy answering of questions and data collection. Respondents were required to answer questions about their sociodemographic status, including gender, age, course of study, health issues, frequency, years of smartphone use, dominant hand and CTS diagnosis.

2.3 Boston Carpal Tunnel Questionnaire (BCTQ)

BCTQ is a standardized questionnaire developed by Levine et al. 1993 to determine the risk level of CTS. This questionnaire consists of two sections: Symptoms Severity Scale (SSS) and the Functional Status Scale (FSS). The SSS includes questions about the most common symptoms of CTS, such as wrist pain, tingling sensation, numbness, weakness, and difficulty grasping

objects. Each symptom was rated for severity and frequency. Meanwhile, the FSS section focused on the difficulties experienced by respondents in performing daily activities, which involve using the hands, such as writing, buttoning clothes, holding a book while reading, gripping the handle of the telephone, opening jars, household chores, carrying grocery bags, bathing, and dressing.

2.4 Statistical Analysis

Data collected from 310 respondents were analysed by using the IBM Statistical Package for the Social Sciences version 25. Chi-square contingency test analysis was used to identify the association between gender and the prevalence of hand dominance with symptom severity and respondent's functional status score. In contrast, the relationship between the frequency of smartphone use among undergraduates and the risk level of CTS was determined using correlation analysis.

3.0 RESULTS

3.1 Sociodemographic Status

A total of 310 respondents agreed to participate in this research. The majority of the respondents are females with 92.6%, and only 23 are male respondents with a lower percentage of 7.4%. A total of 92.6% of respondents were in the lowest age group, which is 19 to 23 years, 6.8% and 0.6% respondents in 24 to 28 year and 29 to 33 year age group, respectively. The distribution of respondents between courses was not equally the same, because respondents were selected at random. Most of the respondents were from the course of Biomedical Sciences, with a total of 73 respondents. On the contrary, the second-highest respondents were from the Environmental Health and Industrial Safety course with a total of 63 respondents and 39 respondents were from the course of Optometry and Vision Science. Approximately 93.5% of respondents have no health issues and only 20 of them have health issues such as asthma, G6PD, allergies, back pain and low blood pressure.

The most important part of this research is to determine the frequency and years of smartphone use among the respondents. Almost half of the respondents, 48.7%, use a smartphone for more than seven hours a day, while 40.6% use a smartphone for five to six hours a day. Also, 45.8% of respondents have been using a smartphone for more than seven years, 35.2% for five to seven years, and 19% in less than four years. In addition, information about the dominant hand of the respondents was also requested for this research. As expected, there were more respondents with the dominant right hand, 287 respondents, equivalent to 92.6%, and 23 respondents, with the left dominant hand, equivalent to 7.4%. Finally, none of the respondents were diagnosed with CTS and received no treatment.

3.2 Symptom Severity Scale (SSS)

Scores obtained from each respondent were aggregated to obtain a total score for each symptom. Table 1 shows the range of scores assigned to symptom severity, asymptomatic, mild, moderate, severe, and very severe.

Table 1 SSS Scores and Severity

Scores	Severity
0 to 11	Asymptomatic
12 to 22	Mild
23 to 33	Moderate
34 to 44	Severe
45 to 55	Very Severe

Table 2 shows the total scores obtained for the categories assigned. The scores were grouped based on the symptom severity levels. Based on Table 2, the highest percentage of 58.1% of respondents have mild symptoms of CTS, whereas 40.6% of respondents have no symptoms at all.

Table 2 SSS Scores

Severity	Total Score	Percentage (%)
Asymptomatic	126	40.6
Mild	180	58.1
Moderate	2	0.6
Severe	2	0.6
Very Severe	0	0.0

3.3 Functional Severity Scale (FSS)

The scores obtained from each respondent were summed to obtain a total score for each symptom. Table 3 shows the score range assigned as asymptomatic, mild, moderate, severe and very severe according to symptom severity level.

Table 3 FSS Scores and Severity

Scores	Severity
0 to 8	Asymptomatic
9 to 16	Mild
17 to 24	Moderate
25 to 32	Severe
33 to 40	Very Severe

Table 4 shows the total scores obtained for the assigned categories. Scores are grouped according to symptom severity levels. Based on Table 4, 73.5% of the respondents are asymptomatic, they can perform their daily activities without any difficulty. On the other hand, 24.5% of the respondents have mild difficulty in performing their daily activities.

Table 4 FSS Scores

Severity	Total Score	Percentage (%)
Asymptomatic	228	73.5
Mild	76	24.5
Moderate	4	1.3
Severe	0	0.0
Very Severe	2	0.6

3.4 Association between Gender and Hand Dominance with Symptoms Severity and Functional Status Score

Chi-squared analysis was used to determine the association between gender, the severity of symptoms, and respondents' functional status scores. The analysis showed no significant association between gender with symptom severity scores and gender with a functional status score, where p values were = 0.878 and 0.306, respectively. The p values obtained were higher than the value of $p < 0.05$, contributing to a non-significant association.

Chi-square analysis was also used to identify whether the dominant hand is associated with respondents' symptom severity and functional status. The test indicated no association between hand dominance and symptom severity score obtained, where $p = 0.140$, $p < 0.05$. Similarly, there was no significant association between hand dominance and a functional status score of respondents as the value of p was 0.967.

3.5 Relationship between Frequency of Smartphone Use and the Risk Level of Carpal Tunnel Syndrome (CTS)

Table 5 Correlation between Frequency of Smartphone Use and Total Score of SSS and FSS

			Frequency of Smartphone Use	Symptoms Severity Scale (SSS)	Functional Status Scale (FSS)
Kendall's tau-b	**Frequency of Smartphone Use**	Correlation Coefficient		0.109	0.027
		Sig. (2 tailed)		0.045	0.614
	Total SSS Score	Correlation Coefficient	0.109		0.348
		Sig. (2 tailed)	0.045		0.000
	Total FSS Score	Correlation Coefficient	0.027	0.348	
		Sig. (2 tailed)	0.614	0.000	

According to Table 5, Kendall's tau-b indicated that the relationship between frequency of smartphone use and the total score of SSS is a weak positive correlation, $\tau = 0.109$, $p = 0.045$. Meanwhile, the relationship between frequency of smartphone use and total FSS scores is a negligible correlation as the tau value is, $\tau = 0.027$, $p = 0.614$.

4.0 DISCUSSION

4.1 Association between Gender, Symptoms Severity Score and Functional Status Score

Based on the results obtained, it is clear that the gender, symptom severity, and functional status scores are not significant, that is the variables do not influence each other. In other words, the gender of respondents does not influence Carpal Tunnel Syndrome (CTS), as the majority of those surveyed reported mild to moderate symptoms that could be corrected in a short time. Moreover, these symptoms do not cause any difficulty in performing daily routine activities. However, several studies indicate that gender is one of the CTS prone factors. For example, Atroshi et al. Noted that women possess two to three times greater risk of developing CTS compared to men. This may be due to natural occurrences of women's bodies such as menopause, hypothyroidism, and pregnancy. Besides that, a study conducted by Sassi and Giddins 2016 noted that there is a significant mean difference in the cross-sectional area of the carpal tunnel in women than men because women have smaller hands. Therefore, smaller hands mean smaller cross-sectional areas, this explains why women are more prone to CTS.

4.2 Association between Dominant Hand, Symptoms Severity Score and Functional Status Score

Tests performed to analyze the association between dominant hand and symptom severity scores and functional status scores showed that there was no significance between the hand dominance and scores obtained. According to this study, this means hand dominance does not impact the risk level of Carpal Tunnel Syndrome (CTS) because most of the respondents reported only asymptomatic and mild symptoms and no difficulty performing some of their daily activities listed in the questionnaire. Moreover, the symptoms experienced could be relieved in a short time. Nevertheless, evidence indicated that CTS is more prone to happen in the dominant hand as it involves more repetitive movement of the wrist and fingers (Zambelis et al., 2010). In a research conducted by Woo et al. 2017, the researcher stated that there is a significant difference in the cross-sectional area in both hands and the flattening ratio of median nerve and thickness of transverse carpal ligament. However, since most of the participants did not report any severe symptoms in their dominant hand, this research proves otherwise. 4.3 Relationship between Frequency of Smartphone Use and Risk Level of Carpal Tunnel Syndrome. Statistical tests performed indicated a weak correlation, which means there is only a little association between the frequency of smartphone use and the risk of developing CTS. This is parallel with research conducted by Gustafsson et al. 2018, where he stated that smartphone operation only requires smaller thumb movement and muscle activity. Hence, it is acceptable when the respondents reported that they only experience mild to moderate CTS symptoms. In addition, most of them do not face any difficulties in carrying out their daily activities.

However, in a study conducted by Shim 2012, there is a significant relationship between smartphone use and changes in the carpal tunnel of the respondents involved in the study. This might be due to the ultrasonography method used throughout the study to obtain data from the respondents, where ultrasonography is a clinical diagnosis method of identifying CTS. The carpal tunnel of the respondents was measured using ultrasonography before and after smartphone use for 30 minutes. According to the researcher, there was a significant difference in the median nerve circumference length, area of the median nerve area, the distance between the highest point of the median nerve to the lunate, and distance between the bottom point of the median nerve the lunate. Hence, it can be seen that a clinical diagnosis provides accurate data compared to diagnosis through the questionnaire.

5.0 CONCLUSION

Overall, the risk level of CTS due to a smartphone is low. Even though there is only a weak relationship between smartphone use among students and the risk level of CTS, mild symptoms of CTS were present among the students. These symptoms might develop as the students become more dependent on smartphones due to online studies and the rising use of social media. The limitation of this study is the method of study. The use of the questionnaire to obtain data may not be accurate as some of the symptoms experienced by respondents may not be entirely due to smartphone use. Therefore, a more reliable diagnosis like ultrasonography may have provided a more accurate date on the risk level of CTS due to smartphone use.

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