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Prevalence of Carpal Tunnel Syndrome Among the Faculty of Computer Science and Information Technology (FCSIT) Undergraduate Students in UNIMAS and Its Association with Computer Usage

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ABSTRACT

Carpal Tunnel Syndrome (CTS) is the most common type of nerve entrapment and it is due to the compression of the median nerve which passes through the carpal tunnel in the wrist. Previous research had found that the development of CTS is related to the prolonged use and repetitive movement of the wrist such as typing. Thus, this research is conducted to determine the prevalence of CTS among the Faculty of Computer Science and Information Technology (FCSIT) undergraduate students in UNIMAS and its association with computer usage. To achieve the study's objective, a quantitative cross-sectional study was conducted to assess the prevalence of CTS and its association with computer use among UNIMAS FCSIT undergraduate students. The data was collected by distributing a self-administrated questionnaire through online platforms. The questionnaire contained 4 main sections, which consisted of the respondent demographic information, respondent's computer usage and knowledge on computer ergonomics, Patient Rated Wrist Evaluation (PRWE) and Boston Carpal Tunnel Syndrome questionnaire (BCTQ). The collected data were analysed by using SPSS statistical software version 21. A total of 338 responses from UNIMAS FCSIT students with a mean age of 22.04 were collected; 59.5% of the respondents were females and 40.5% were males. Among the 338 respondents, about 90.8% were healthy with no pre-existing medical condition while only 3.8% of them were diagnosed with CTS prior to this study. Next, most of the respondents had average knowledge on computer ergonomics. (28.4%). According to the PRWE result, most of the respondents had minimal pain (44.1%). For the BCTQ severity score result, most of the respondents showed minimal CTS symptoms (42%) while for the BCTQ function score, up to 60.7% of the respondents did not show CTS symptoms. Other findings of our study showed that there was no relationship between CTS and computer usage either in terms of daily duration on computer use, years on computer use or knowledge on computer ergonomics. In conclusion, there is minimal correlation between computer usage and the risk of developing CTS.

Keywords: Carpal Tunnel Syndrome (CTS), FCSIT undergraduate students, Patient Rated Wrist Evaluation (PRWE), Boston Carpal Tunnel Questionnaire (BCTQ)

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common type of nerve entrapment and it is due to the compression of the median nerve which passes through the carpal tunnel in the wrist (Chammas et al., 2014). The median nerve provides motor supply to the thenar muscles, index fingers, middle fingers, and the radial side of ring fingers and it also provides sensory innervation to the second digits, then third digits, and ventral-lateral two-thirds of the hand (Rapp & Soos, 2020). Apart from the median nerve, the carpal tunnel also serves as a canal for the tendon of *flexor pollicis longus*, four *flexor digitorum profundus*, and four flexor *digitorum superficialis* (Presazzi et al., 2011). Entrapment of the median nerve occurs when the pressure in the carpal tunnel increases and increased pressure in the carpal tunnel can be due to the flexion and extension of the wrist, and the flexion of fingers (Bland, 2007). In CTS, median nerve entrapment will lead to a series of symptoms such as tingling, numbness, burning, or pain sensation (Ashworth, 2016). These symptoms are described to deteriorate from midnight until awakening from sleep (Aroori & Spence, 2008).

People who are elderly (Blumenthal et al., 2006), hypothyroid (Palumbo et al., 2000), or who have experienced distal wrist fracture (Yeh et al., 2020) have potential risk of CTS. There is also a study indicating that females are more prone to suffer from CTS than males (Lam & Thurston, 1998). Apart from that, overuse and improper positioning of the wrist in daily life will also lead to CTS. In a study done among female touchscreen users in Majmaah University, the results showed that females have a high prevalence of CTS (Mohammad, 2019). Furthermore, people who remain in an unnatural wrist posture for a long time also have a doubly increased risk of CTS (You et al., 2014).

Nowadays, computers and the internet have become very important (Diomidous et al., 2016). Tasks like typing and scrolling using the mouse or on screen require frequent movement of wrists and fingers. A study with a sample of 648 computer professionals showed that they have a high risk for CTS (Ali & Sathiyasekaran, 2006). Another study conducted in Southern Taiwan concluded that an extreme extension of the wrist when typing on the keyboard would increase the risk of getting CTS (Liu et al., 2003). Moreover, another study suggested that prolonged typing may result in acute changes to the median nerve (Toosi et al., 2011). In contrast, there is a study that concluded that computer use actually has no marked relation to CTS (Bhanderi et al., 2017). In a review conducted by Thomsen et al. (2008), it was found that there was lack of evidence to link computer usage and CTS. Furthermore, the risk of CTS among computer users and the general population appeared to be the same (Stevens et al., 2001). To date, there is no uniform agreement about the relationship between computer use and CTS.

Therefore, this research is conducted to study the prevalence of CTS and its association with computer use among the undergraduate students of Faculty of Computer Science and Information Technology (FCSIT) in University Malaysia Sarawak (UNIMAS).

MATERIALS AND METHODS

Study design and participants

This research is a cross-sectional study assessing the prevalence of Carpal Tunnel Syndrome among the Faculty of Computer Science and Information Technology undergraduate students in UNIMAS and its association with computer use.

Sample size determination

Keeping the confidence level of 95%, margin of error of 5% and indicator percentage of 0.50, the calculated sample size for this research was 323. The calculation of minimum representative sample size was done using a Raosoft sample size calculator.

Data collection instrument

The self-administered questionnaire had a total of four sections. The first section was on the respondent demographic information, which includes questions regarding their gender, age, year of study, pre-existing medical condition, and whether they had ever been diagnosed with Carpal Tunnel Syndrome. The second section was about respondent's computer usage and knowledge on computer ergonomics which were divided into two components. The first component was the respondent's computer usage in which the respondents were questioned regarding their computer usage, which include the types of computers they owned, hours spent on computer, years of exposure, awareness of wrist and body position while using the computer. The second component pertained to knowledge on computer ergonomics; the questions were adopted from the Computer Workstation Ergonomics: Self-Assessment Checklist. Respondents were asked if they were aware of their wrist position whenever they used their computers, if their mouse was comfortable to use and whether they had short breaks after prolonged use of the computer. They were also asked whether they had a comfortable environment in which to use a computer (Abida Ellahi et al., 2011). Next, the questions for section 3 were adopted from the Patient Rated Wrist Evaluation (PRWE). The last section of the questionnaire also adopted the questions from Boston Carpal Tunnel Questionnaire (BCTQ) which comprises two subscales: Symptom Severity Scale and Functional Status Scale.

Data collection procedure

The questionnaire was first created in Google Form before distribution via online platforms or social media, targeting the undergraduate students of the Faculty of Computer Science and Information Technology of UNIMAS. The undergraduate students were selected using purposive sampling. The respondents were required to answer all the questions in the questionnaire and the answers were automatically saved upon submission.

Data entry and analysis

All data obtained were analysed using Statistical Package for the Social Sciences (SPSS) software. The total scores for Sections 3 and 4 with the maximum scores of 100 and 10 respectively were calculated. For Section 4 which is the Patient Rated Wrist Evaluation (PRWE), the 'pain' subscale score is the sum of the five items while the

'function' subscale score is calculated by the sum of the ten items divided by two. The total score of the PRWE is the sum of the scores of both subscales. A score of 100 represents the worst functional score, whereas 0 represents no disability (Macdermid et al., 1998). For Section 4 which is the Boston Carpal Tunnel Syndrome Questionnaire (BCTQ), the total score for both subscales are also summed up. The score totals used for symptom severity were categorized into the following areas: asymptomatic, mild, moderate, severe and very severe. At the same time, function scores were grouped into the following categories: asymptomatic, mild, moderate, severe and very severe (Rozali et al., 2012).

RESULT

Demographics

338 respondents from FCSIT participated in our study. 201 (59.5%) of them were female while 137 (40.5%) of them were male. The mean age of the respondents was 22.04 years old. Most of the respondents were second year students (30.2%), followed by fourth year students (26.0%), first year students (25.1%), third year students (17.8%) and lastly fifth year students (0.9%). About 90.8% (n=307) of the respondents had no pre-existing medical conditions and only 3.8% (n=13) of the respondents had been previously diagnosed with CTS.

76% of the respondents owned a laptop and most of them (63.9%) had used a computer for more than 5 years. The majority of the respondents (43.5%) spent 4-8 hours on the computer per day. Although the respondents had a long period of computer usage, 62.1% of them were not aware of their wrist position (62.1%) while 59.5% would slouch during their computing activities.

Knowledge on computer ergonomics

Table 1. Respondents' Level of Knowledge on Computer Ergonomics

Level of knowledge	n	%	Mean
1. Very bad	4	1.2	4.53
2. Bad	22	6.5	
3. Fairly bad	44	13.0	
4. Average	96	28.4	
5. Fairly good	85	25.1	
6. Good	69	20.4	
7. Very good	18	5.3	

Based on Table 1, most of the respondents (28.4%) had an average knowledge on computer ergonomics (mean: 4.53). The results suggested that the respondents did not fully understand computer ergonomics.

Patient-Rated Wrist Evaluation

Table 2. FCSIT undergraduate score on PRWE

PRWE score	n	%	Mean
1. No pain	52	15.4	2.46
2. Minimal pain	149	44.1	
3. Mild pain	81	24.0	
4. Moderate pain	45	13.3	
5. Severe pain	9	2.7	
6. Very severe pain	2	0.6	

Based on Table 2, the result showed that most of the respondents were at low risk to develop wrist pain (mean: 2.46). Only 2 (0.6%) respondents faced very severe pain while doing the activities stated in the PRWE questionnaire.

Boston Carpal Tunnel Syndrome Questionnaire (BCTQ)

Table 3.1 Categorization of BCTQ Severity Scoring (N=338)

Respondents' symptoms category based on BCTQ Symptoms severity score	n (%)	Mean
Asymptomatic	142 (42.0)	1.70
Mild symptoms	160 (47.3)	
Moderate symptoms	32 (9.5)	
Severe symptoms	4 (1.2)	

Table 3.2 Categorization of BCTQ function scoring

Respondents' symptoms category based on BCTQ function score	n (%)	Mean
Asymptomatic	205 (60.7)	1.45
Mild symptoms	118 (34.9)	
Moderate symptoms	10 (3.0)	
Severe symptoms	5 (1.5)	

Tables 3.1 and 3.2 showed that the mean score for BCTQ symptoms severity score and function score were 1.70 and 1.45 respectively. Both results indicated that the majority of the respondents were asymptomatic, which means that the respondents, who were computer science students, had low risk to develop CTS. Besides, only 4 (1.2%) respondents and 5 (1.5%) respondents respectively from both tables were categorized as having severe CTS symptoms.

Relationship between computer usage and CTS

Table 4 below showed the summary of p-values obtained from the Chi-square tests. Chi-square tests were done to discover the relationship between computer usage and CTS.

Table 4. Chi-square test results

Tests	Variables			
	Years of computer usage	Daily hours of computer usage	Body positions while computing	Knowledge on computer ergonomics
PRWE score	0.14	0.58	0.68	0.57
BCTQ symptom severity score	0.49	0.45	0.60	0.35
BCTQ functional score	0.36	0.49	0.85	0.45

According to Table 4, all the p-values were greater than the standard alpha value, 0.05. Hence, the results suggest that there is statistically no significant relationship between CTS and computer usage.

DISCUSSION

In this study, it was found that the female respondents outnumbered the male respondents by 19%. This is supported by Yong (2017) which noted a Gender Parity Index was greater than 2.0 which means female undergraduates exceeded male undergraduates by two to one. The mean age of the overall respondents was 22.04 years with ages ranging from 19 to 28 years old. The majority of the respondents were from Year 2 followed by Year 4, Year 1, Year 3 and Year 5. 90.8% of respondents were healthy without pre-existing medical conditions which means that the FCSIT undergraduate students were generally healthy. Among the respondents, 76% of respondents owned a laptop and the majority (63.9%) of them had been using a computer for more than 5 years. For daily usage, 43.5% used their laptop for about 4-8 hours per day. The result showed that the use of computers in education had become a general trend and it would potentially revolutionize the way the student learns in the future (Schindler et. al., 2017).

Practising good computer ergonomics is a strategy to prevent musculoskeletal diseases (MSD) that is initiated through risk assessment, safety measures and control procedures of computer users (Khan et al, 2012). In our study, the respondents were questioned regarding their knowledge and practices while using their computers on a daily basis. Based on the overall results, the study showed a mean of 4.5, indicating that most of the respondents had average knowledge regarding computer ergonomics despite being computer science students. This was in line with Jasmine et al. (2020) which noted that only 9% of software engineers had adequate knowledge on ergonomics.

The etiology of computer related CTS is not fully understood but is suggested to be multifactorial (Khan et al., 2012). In a study conducted by Burt et al. (2011), the summarized risk factors were force, repetition, posture, vibration and computer use. Despite being exposed to these factors, most of the study respondents were healthy and only 3.8% of them had been previously diagnosed with CTS, indicating that there is a low prevalence of CTS among FCSIT students. It was found that less than half (44.10%) had minimal pain followed by mild pain and only 15.4% of the respondents did not experience wrist pain, according to the PRWE classification score. The PRWE score results showed a mean of 1.46 indicating that the FCSIT students had a low risk of developing wrist pain. This outcome is in line with a study by IJmker et al. (2011) which noted that there was a low risk of experiencing arm-wrist-hand symptoms upon the usage of computers during two years of study follow-up. For the BCTQ symptoms severity subscale, almost half of the respondents (47.3%) had mild symptoms of CTS. This result is in line with Mat Zain et al. (2014) whereby most of the study respondents experienced mild CTS symptoms. Moving on to the results of BCTQ functional status score, 60.7% of participants had normal functions or were asymptomatic in carrying out their daily activities and only 1.5% experienced severe symptoms. This result is in line with Al Shahrani et al. (2019), in which there was no significant number of respondents scored highly on the functional status scale, as the scores were affected by other factors rather than CTS only.

The result from this study shows that there was no significant relationship between computer use and CTS among undergraduate students ($p > 0.05$). Bhanderi et al. (2017) supports this finding, in which their study reported a

negative association between computer use and CTS. In contrast, a meta-analysis by Shiri and Falah-Hassani (2015) highly suggested there was a positive association between computer use and CTS by comparing computer workers with that of the general population. Ali and Sathiyasekaran (2006) also reported a high risk of CTS among 648 participants with more intensive exposure to computer work. This study found that there was no significant association between knowledge of computer ergonomics and the prevalence of CTS symptoms among FCSIT undergraduate students ($p > 0.05$). Such a result is in contrast with Jacobs et al. (2009) which found that students who had a good score on their ergonomic quiz had significantly less computer-related musculoskeletal discomfort including wrist pain. In addition, there is no significant association between hours of computer work per day or years of computer exposure and CTS symptoms found in our study ($p > 0.05$). This is in contrast to a study by Burt et al. (2011), which noted some association between CTS and mouse usage for over 20 hours a week but not with keyboard usage. Besides, it is found that people with 4 or more years of computer work and 8 or more hours of computer work per day had a higher prevalence of CTS (Mohamed Ali & Sathiyasekaran, 2006). There was also no significant association between wrist posture and CTS symptoms in our study ($p > 0.05$) although a study found that wrist posture and repetition led to higher risk of CTS when the wrist is kept flexed or extended when compared to a neutral position (Mohamed Ali & Sathiyasekaran, 2006). However, a study conducted in Soetomo General Hospital Surabaya showed there was no correlation between extension of hand position with CTS based on the nerve conduction study median nerve wrist results (Rahardjo et al., 2020).

CONCLUSION

The results of this study showed the prevalence of CTS among the FCSIT undergraduate students in UNIMAS and its association with computer use. The findings showed that most of the respondents were healthy and only 3.8% of them had been previously diagnosed with CTS. Besides, laptops were the most preferred type of computer device and most of the respondents have worked with computers for many years. However, despite being FCSIT students, most of the respondents only had average knowledge regarding computer ergonomics.

Meanwhile, according to the results from PRWE and BCTQ in our study, there was a low prevalence of CTS among the FCSIT undergraduate students. Besides, the results indicated that there is no significant relationship between CTS and computer use. Hence, we concluded that there is minimal correlation between computer usage and the risk of developing CTS.

REFERENCES

Abida Ellahi & M. Shahid Khalil & Fouzia Akram. (2011, February 2). *Computer users at risk: Health disorders associated with prolonged computer use*. Economics and Finance Research | IDEAS/RePEc. https://ideas.repec.org/a/etr/series/v2y2011i4p171-182.html

Al Shahrani, A. S., Albogami, S. S., Alabdali, A. F., Alohali, S. K., Almedbal, H. S., & Aldossary, G. F. (2019). Does the use of electronic devices provoke the carpal tunnel syndrome (CTS) symptoms and functional impairment? A cross-sectional study. *The Egyptian Rheumatologist, 41*(4), 313-317. https://doi.org/10.1016/j.ejr.2019.03.001

Ali, K. M., & Sathiyasekaran, B. W. (2006). Computer professionals and Carpal Tunnel Syndrome (CTS). *Int J Occup Saf Ergon, 12*(3), 319-325. https://doi.org/10.1080/10803548.2006.11076691

Aroori, S., & Spence, R. A. (2008, Jan). Carpal tunnel syndrome. *The Ulster Medical Journal, 77*(1), 6-17. https://www.ncbi.nlm.nih.gov/pubmed/18269111

Ashworth, N. L. (2016, Nov 15). Carpal Tunnel Syndrome. *American Family Physician, 94*(10), 830-831. https://www.ncbi.nlm.nih.gov/pubmed/27929273

Bhanderi, D. J., Mishra, D. G., Parikh, S. M., & Sharma, D. B. (2017, Sep-Dec). Computer Use and Carpal Tunnel Syndrome: A Case-control Study. *Indian J Occup Environ Med, 21*(3), 109-114. https://doi.org/10.4103/ijoem.IJOEM_66_17

Bland, J. D. (2007, Aug 18). Carpal tunnel syndrome. *BMJ, 335*(7615), 343-346. https://doi.org/10.1136/bmj.39282.623553.AD

Blumenthal, S., Herskovitz, S., & Verghese, J. (2006, Jul). Carpal tunnel syndrome in older adults. *Muscle Nerve, 34*(1), 78-83. https://doi.org/10.1002/mus.20559

Burt, S., Crombie, K., Jin, Y., Wurzelbacher, S., Ramsey, J., & Deddens, J. (2011). Workplace and individual risk factors for carpal tunnel syndrome. *Occupational and Environmental Medicine, 68*(12), 928–933. https://doi.org/10.1136/oem.2010.063677

Chammas, M., Boretto, J., Burmann, L. M., Ramos, R. M., Dos Santos Neto, F. C., & Silva, J. B. (2014, Sep-Oct). Carpal tunnel syndrome - Part I (anatomy, physiology, etiology and diagnosis). *Rev Bras Ortop, 49*(5), 429-436. https://doi.org/10.1016/j.rboe.2014.08.001

Diomidous, M., Chardalias, K., Magita, A., Koutonias, P., Panagiotopoulou, P., & Mantas, J. (2016, Feb). Social and Psychological Effects of the Internet Use. *Acta Inform Med*, *24*(1), 66-68. https://doi.org/10.5455/aim.2016.24.66-68

IJmker, S., Huysmans, M., van der Beek, A., Knol, D., van Mechelen, W., Bongers, P., & Blatter, B. (2011). *Software-recorded and self-reported duration of computer use in relation to the onset of severe arm-wrist-hand pain and neck-shoulder pain*. https://doi.org/10.1136/oem.2010.056267

Jacobs, K., Johnson, P., Dennerlein, J., Peterson, D., Kaufman, J., Gold, J., Williams, S., Richmond, N., Karban, S., Firn, E., Ansong, E., Hudak, S., Tung, K., Hall, V., Pencina, K., & Pencina, M. (2009). University students' notebook computer use. *Applied Ergonomics*, *40*(3), 404–409. https://doi.org/10.1016/j.apergo.2008.11.009

Jasmine, M., Fasna, L., Chellaiyan, V. G., Raja, V. P., & Ravivarman, G. (2020, August 25). A study on knowledge and practice of ergonomics among the software engineers in a private firm, Chennai, Tamil Nadu. PubMed Central (PMC). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7586624/

Khan, R., Surti, A., Rehman, R., & Ali, U. (2012). Knowledge and practices of ergonomics in computer users. *JPMA. The Journal of the Pakistan Medical Association*, *62*(3), 213–217. https://pubmed.ncbi.nlm.nih.gov/22764450/

Lam, N., & Thurston, A. (1998, Mar). Association of obesity, gender, age and occupation with carpal tunnel syndrome. Aust N Z J Surg, 68(3), 190-193. https://doi.org/10.1111/j.1445-2197.1998.tb04743.x

Liu, C. W., Chen, T. W., Wang, M. C., Chen, C. H., Lee, C. L., & Huang, M. H. (2003, Dec). Relationship between carpal tunnel syndrome and wrist angle in computer workers. *Kaohsiung J Med Sci*, *19*(12), 617-623. https://doi.org/10.1016/S1607-551X(09)70515-7

MacDermid, J. C. (1996). Development of a Scale for Patient Rating of Wrist Pain and Disability. *Journal Of Hand Therapy*, *9*, 178-183. https://doi.org/10.1016/s0894-1130(96)80076-7

Mat Zain, N. H., Jaafar, A., Abdul Razak, F. H. (2014). Severity Scoring of Symptoms Associated with Carpal Tunnel Syndrome Based on Recall of Computer Game Playing Experiences. *Journal of Theoretical & Applied Information Technology, 63*(1), 125-135.

Mohamed Ali, K. & Sathiyasekaran, B. W. C. (2006). Computer Professionals and Carpal Tunnel Syndrome (CTS). *International Journal of Occupational Safety and Ergonomics*, *12*(3), 319–325. https://doi.org/10.1080/10803548.2006.11076691

Mohammad, W. S. (2019, Sep-Oct). Work-related risk factors for Carpal Tunnel Syndrome among Majmaah University female touchscreen users. *Pak J Med Sci*, *35*(5), 1221-1226. https://doi.org/10.12669/pjms.35.5.683

Palumbo, C. F., Szabo, R. M., & Olmsted, S. L. (2000, Jul). The effects of hypothyroidism and thyroid replacement on the development of carpal tunnel syndrome. *J Hand Surg Am, 25*(4), 734-739. https://doi.org/10.1053/jhsu.2000.8642

Presazzi, A., Bortolotto, C., Zacchino, M., Madonia, L., & Draghi, F. (2011, Mar). Carpal tunnel: Normal anatomy, anatomical variants and ultrasound technique. *J Ultrasound*, *14*(1), 40-46. https://doi.org/10.1016/j.jus.2011.01.006

Rapp, F. A., & Soos, M. P. (2020). Anatomy, Shoulder and Upper Limb, Hand Cutaneous Innervation. In *StatPearls*. https://www.ncbi.nlm.nih.gov/pubmed/31334967

Rahardjo, J., Hamdan, M., Basuki, M., Fidiana, Fadil, & Susetyo, H. (2020). Correlation between Duration of Work and Hand Position Using Computer with Carpal Tunnel Syndrome(CTS) at the Registration Administration Officer in Dr. Soetomo General Hospital Surabaya. *Indian Journal of Public Health Research & Development*, *11*(3), 2604-2609. http://repository.unair.ac.id/97534/1/Correlation%20between%20Duration.pdf

Rozali, Z. I., Noorman, F. M., De Cruz, P. K., Feng, Y. K., Razab, H. W., & Sapuan, J., Singh, R. & Sikkandar, F. M. (2012). Impact of carpal tunnel syndrome on the expectant woman's life. *Asia Pacific Family Medicine*, *11*(1). https://doi.org/10.1186/1447-056x-11-1

Schindler, L. A., Burkholder, G. J., Morad, O. A., & Marsh, C. (2017). Computer-based technology and student engagement: a critical review of the literature. *International Journal of Educational Technology in Higher Education*, *14*(1), 25. https://doi.org/10.1186/s41239-017-0063-0

Shiri, R., & Falah-Hassani, K. (2015). Computer use and carpal tunnel syndrome: A meta-analysis. *Journal of The Neurological Sciences, 349(1-2)*, 15-19. https://doi.org/10.1016/j.jns.2014.12.037

Stevens, J. C., Witt, J. C., Smith, B. E., & Weaver, A. L. (2001). The frequency of carpal tunnel syndrome in computer users at a medical facility. *Neurology*, *56*(11), 1568-1570. https://doi.org/10.1212/wnl.56.11.1568

Thomsen, J. F., Gerr, F., & Atroshi, I. (2008). Carpal tunnel syndrome and the use of computer mouse and keyboard: a systematic review. *BMC Musculoskelet Disord*, *9*, 134. https://doi.org/10.1186/1471-2474-9-134

Toosi, K. K., Impink, B. G., Baker, N. A., & Boninger, M. L. (2011, Nov). Effects of computer keyboarding on ultrasonographic measures of the median nerve. *Am J Ind Med*, *54*(11), 826-833. https://doi.org/10.1002/ajim.20983

Yeh, K. T., Lee, R. P., Yu, T. C., Wang, J. H., Liu, K. L., Peng, C. H., Chen, H. W., Chen, I. H., Hsu, C. Y., Lin, C. L., & Wu, W. T. (2020, Jan 16). Risk factors for carpal tunnel syndrome or trigger finger following distal radius fracture: a nationwide study. *Sci Rep*, *10*(1), 469. https://doi.org/10.1038/s41598-020-57415-x

Yong, J. T. (2017). The Gender Gap in Malaysian Public Universities: Examining The 'Lost Boys'. *Journal of International and Comparative Education*, *6*(1). https://doi.org/10.14425/JICE.2017.6.1.0116

You, D., Smith, A. H., & Rempel, D. (2014, Mar). Meta-analysis: association between wrist posture and carpal tunnel syndrome among workers. *Saf Health Work*, *5*(1), 27-31. https://doi.org/10.1016/j.shaw.2014.01.003