



# Age and Body Anthropometry as Predicting Factors for Carpal Tunnel Syndrome among Egyptian Obese Women

Moushira Zaki<sup>1\*</sup>, Maha Ali<sup>2</sup>, Walaa Yousef<sup>1</sup>, Wafaa Ezzat<sup>2</sup>, Walaa Basha<sup>1</sup>

<sup>1</sup>Department of Biological Anthropology, National Research Centre, Cairo, Egypt, <sup>2</sup>Department of Internal Medicine, National Research Centre, Giza, Egypt

## Abstract

**BACKGROUND:** Carpal tunnel syndrome (CTS) is the most prevalent entrapment neuropathy in the upper limb. The most consistent risk factors are female gender, age, and obesity. The results of previous studies are conflicting, and moreover, data from studies regarding obesity and nerve conduction velocity are not available for our Egyptian population.

**AIM:** This study was designed to investigate the contribution of age and body anthropometry as predictor factors to the CTS and to identify patients at high risk for CTS among Egyptian obese women.

**METHODS:** The study included 120 obese women grouped according to the clinical and electrodiagnostic (EDX) findings into two groups: 60 with CTS and 60 without CTS (non-CTS). EDX study was used in the diagnosis of median nerve entrapment at the level of the wrist, according to the American Association of Neuromuscular and EDX Medicine. Body weight and height were measured and then body mass index (BMI) was calculated. Waist-to-hip ratio (WHR) was determined from the measured waist circumference (WC) and hip circumference (HC). Mid upper arm circumference (MUAC) was measured as well. The receiver operating characteristic (ROC) curve was used to assess the power of age and body anthropometry as predictor factors for CTS.

**RESULTS:** CTS obese cases showed significantly lower values of both median motor nerve conduction velocity (MMNCV) and median sensory nerve conduction velocity compared to those without CTS. Significantly higher median sensory latency and median motor latency have been found in CTS cases compared to non-CTS group. Significant differences in the mean age have been found between the two groups and a tendency for higher body anthropometry measures in the CTS cases relative to those without CTS. Moreover, there were negative correlations between MMNCV and obesity indices. Age showed the highest area under the ROC curve, followed by BMI, WHR WC, HC, and MUAC.

**CONCLUSION:** Age and obesity indices are important risk factors that can be used as predictors to CTS in obese women. Age is a more powerful diagnostic tool relative to the anthropometric measurements. Women of age above 40 years and suffering from a high degree of obesity are at risk of developing CTS.

**Edited by:** Mirko Spiroski  
**Citation:** Zaki M, Ali M, Yousef W, Ezzat W, Basha W Age and Body Anthropometry as Predicting Factors for Carpal Tunnel Syndrome among Egyptian Obese Women. Open Access Maced J Med Sci. 2020 Sep 04; 8(B):930-934. <https://doi.org/10.3889/oamjms.2020.3317>  
**Keywords:** CTS; Obese Women; Age; Risk Factors  
**\*Correspondence:** Moushira Zaki, Department of Biological Anthropology, National Research Centre, Cairo, Egypt. Tel.: +20 2 33371362; Fax: +20 2 33370931. E-mail: [moushiraz@yahoo.com](mailto:moushiraz@yahoo.com)  
**Received:** 02-Jul-2019  
**Revised:** 02-Apr-2020  
**Accepted:** 06-Apr-2020  
**Copyright:** © 2020 Moushira Zaki, Maha Ali, Walaa Yousef, Wafaa Ezzat, Walaa Basha  
**Funding:** This study was supported by the National Research Centre, Egypt.  
**Competing Interests:** The authors have declared that no competing interests exist  
**Open Access:** This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0)

## Introduction

Carpal tunnel syndrome (CTS) is a very widespread entrapment neuropathy [1]. It is occurred as a result of compression of the median nerve while it passes through the carpal tunnel [2] and could be reliably diagnosed by electrodiagnostic (EDX) (nerve conduction) studies. Symptoms involve pain and numbness, particularly at night, at the area of the median nerve in the affected hand which could extend to the entire upper limb. It has been previously observed that obesity and age over 30 years are the main factors which increased the risk for CTS. In addition, females, particularly pregnant, are the most affected gender. Medical conditions that increased the risk for CTS include hypothyroidism, rheumatoid arthritis, and osteoarthritis. Other behavioral and occupational factors such as typing and repetitive hand movements are involved as well [3], [4]. There are lots of studies that have explored the relationship

between CTS and occupational activities which collected in systemic reviews that conducted by Barcenilla *et al.* [5], [6].

The purpose of this study was to evaluate the impact of age and body anthropometry on the incidence of CTS and recognize patients at high risk for CTS among Egyptian obese women.

## Patients and Methods

The study included 120 obese women grouped according to their clinical and EDX findings into two groups: 60 with CTS and 60 Non-CTS. Ninety percent of the patients were housewives in both groups. There was no statistically significant difference between both groups as regards occupation.

### Inclusion criteria

Obese women their body mass index (BMI)  $\geq 30 \text{ kg/m}^2$  with CTS and had no evidence of a generalized neuropathy or other clinical or electrodiagnostic abnormalities.

### Exclusion criteria

Women suffering from diabetes, the duration of symptoms  $< 1$  year, pregnant woman, under-treatment of cardiac arrhythmia, or muscle relaxant drugs and older than 50 years of age were excluded from the study.

### Anthropometric and clinical measurements

Body weight, height, waist circumference (WC), hip circumference (HC), and mid-upper arm circumference (MUAC) were measured for all cases. Body weight was measured to the nearest 0.1 kg and height was measured to the nearest 0.1 cm. BMI was calculated as weight in kilograms divided by height in meters square ( $\text{kg/m}^2$ ).

A questionnaire, inquiring about age and CTS symptoms, has been taken. Clinical examination using both Tinel and Phalen signs, as previously described [7], has been performed for all cases. The pain was assessed by the visual analog scale. The linear scale represents the range of pain that a subject thought she might experience. Usually, the line is 10 cm in length with one end represents "no pain," while the other represents the worst pain. Every woman draws a mark on the line that represents the level of pain being experienced.

### Neurophysiological examination

EDX study has been used in the diagnosis of median nerve entrapment at the level of the wrist, according to the American Association of Neuromuscular and EDX Medicine [8]. The median nerve, both motor and sensory, conduction studies to all cases have been performed as well as needle electromyography of the abductor pollicis brevis muscle to selected cases for evaluation of CTS severity using Deymed TRU-TRACE EMG NCV 4 Channel System machine (AU7-12060002) at the EMG unit of the Medical Center of Scientific Excellence of NRC.

Comparison tests with neighboring nerves have been performed to cases showed clinical symptoms of CTS but normal or equivocal results of median sensory distal latency and motor distal latency.

The recommended comparative tests are the median-ulnar palmar mixed comparison study, the median-ulnar ring finger sensory study, or the median-ulnar second lumbrical-interossei study. The diagnosis of CTS was confirmed if one, and preferably two, of these tests, were abnormal. If the results of these tests are normal, CTS is almost excluded [9].

### Ethical approval

The research was approved by the Ethical Committee of NRC (No: 16361) and followed the World Medical Association's Declaration of Helsinki. Furthermore, each participant in the study signed a written consent after a full description of the study.

### Statistical analysis

The Kolmogorov–Smirnov test was used to test the sample distribution. The appropriate test, either Student's t-tests or Mann-Whitney, was used for the continuous variables and the Chi-square and Fisher exact tests were used for percentages.

The receiver operating characteristic (ROC) curve was used to determine the predictive value of age and body measures for the diagnosis of CTS and to compare their diagnostic power in discriminating CTS from non-CTS.

## Results

The present data revealed that bilateral carpal tunnel CTS was found in 31.8% of cases and unilateral in 68.2%. Most of them were right-sided. The dominant hand was affected first and produces the most severe pain.

A significant difference in the mean age has been found between the two studied groups and a tendency for higher body anthropometry measures in the CTS compared to non-CTS cases, as shown in Table 1.

**Table 1: Age and body anthropometry in CTS and non-CTS cases**

| Variables               | CTS (Mean $\pm$ SD) | Non-CTS (Mean $\pm$ SD) | p-value |
|-------------------------|---------------------|-------------------------|---------|
| Age (years)             | 42.12 $\pm$ 4.6     | 34.61 $\pm$ 7.3         | 0.001   |
| BMI ( $\text{Kg/m}^2$ ) | 33.9 $\pm$ 6.5      | 30.9 $\pm$ 8.0          | 0.13    |
| WHR                     | 0.84 $\pm$ 0.04     | 0.77 $\pm$ 0.05         | 0.10    |
| WC (cm)                 | 96.77 $\pm$ 12.1    | 88.00 $\pm$ 14.3        | 0.06    |
| HC (cm)                 | 117.06 $\pm$ 11.9   | 109.94 $\pm$ 13.7       | 0.12    |
| MUAC (cm)               | 33.4 $\pm$ 4.2      | 30.93 $\pm$ 6.4         | 0.2     |

BMI: Body mass index, WHR: Waist-hip ratio, WC: Waist circumference, HC: Hip circumference, MUAC: Mid upper arm circumference.

CTS cases showed significantly lower values of median motor nerve conduction velocity (MMNCV) and median sensory nerve conduction velocity relative to the non-CTS group. Significantly higher values of median sensory latency and median motor latency have been found in CTS compared to non-CTS cases, as presented in Table 2.

**Table 2: Median nerve conduction parameters in CTS cases and non-CTS individuals**

| Median nerve conduction parameters | CTS (Mean $\pm$ SD) | Non-CTS (Mean $\pm$ SD) |
|------------------------------------|---------------------|-------------------------|
| MMNCV (m/s)                        | 49.59 $\pm$ 7.7**   | 59.23 $\pm$ 4.1         |
| MML (ms)                           | 4.84 $\pm$ 1.3**    | 3.23 $\pm$ 0.3          |
| MSNCV (m/s)                        | 46.31 $\pm$ 7.1**   | 53.01 $\pm$ 4.3         |
| MSL (ms)                           | 4.6 $\pm$ 1.4**     | 3.1 $\pm$ 0.09          |

MMNCV: Median motor nerve conduction velocity, MML: Median motor latency, MSNCV: Median sensory nerve conduction velocity, MSL: Median sensory latency. \* $p < 0.05$ , \*\* $p < 0.01$ .

Table 3 shows the partial correlations between body anthropometry and the nerve conduction parameters. Negative correlations were found between MMNCV and anthropometric measures.

**Table 3: Partial correlations between body anthropometry and median nerve conduction findings, adjusted for age**

| Median nerve conduction findings | BMI (r) | WHR(r)  | WC (r)  | HC (r) | MUAC (r) |
|----------------------------------|---------|---------|---------|--------|----------|
| MMNCV                            | -0.42*  | -0.72** | -0.51** | -0.27  | -0.32    |
| MML                              | -0.09   | 0.16    | 0.02    | -0.05  | 0.014    |
| MSNCV                            | 0.13    | -0.12   | 0.051   | 0.13   | 0.04     |
| MSL                              | -0.14   | 0.17    | -0.05   | -0.15  | -0.06    |

MMNCV: Median motor nerve conduction velocity, MML: Median motor latency, MSNCV: Median sensory nerve conduction velocity, MSL: Median sensory latency, BMI: Body mass index, WHR: Waist-hip ratio, WC: Waist circumference, HC: Hip circumference, MUAC: Mid upper arm circumference. r=correlation coefficient, \*p<0.05, \*\*p<0.01.

The areas under the ROC curve were presented in Table 4 with age showed the highest areas under the ROC curve, followed by BMI, waist-to-hip ratio (WHR) WC, HC, and MUAC. ROC curves of the age and body anthropometry in detecting the presence of CTS in Egyptian women are shown in Figure 1 and Figure 2.

**Table 4: Area under the receiver operating characteristic curve (AUC) for age, anthropometric measurements of the studied participants**

| Variables                | AUC   | Cutoff points | Sensitivity (%) | Specificity (%) |
|--------------------------|-------|---------------|-----------------|-----------------|
| Age (years)              | 0.811 | 40.5          | 77              | 75              |
| BMI (Kg/m <sup>2</sup> ) | 0.680 | 30.25         | 75              | 59              |
| WHR                      | 0.680 | 0.796         | 82              | 53              |
| WC (cm)                  | 0.671 | 91            | 75              | 65              |
| HC (cm)                  | 0.662 | 113.5         | 69              | 71              |
| MUAC (cm)                | 0.642 | 30.5          | 69              | 53              |

AUC: Area under the curve, BMI: Body mass index, WHR: Waist-hip ratio, WC: Waist circumference, HC: Hip circumference, MUAC: Mid upper arm circumference.

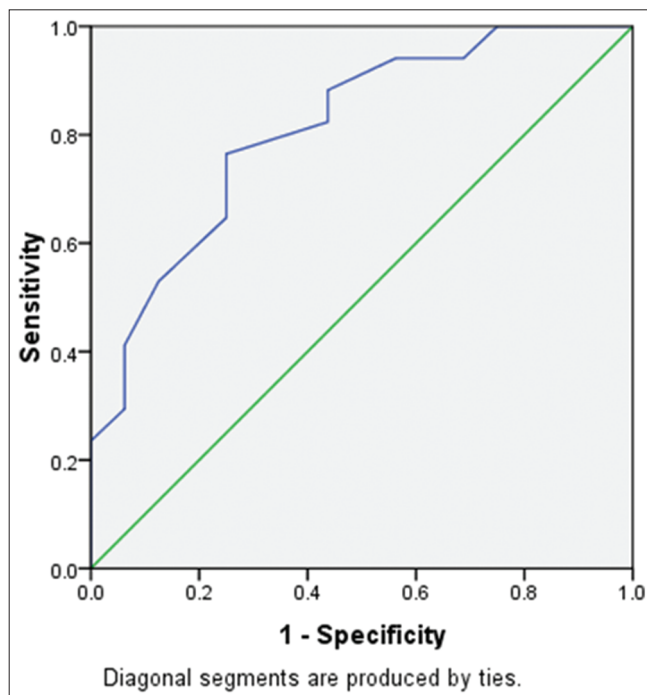


Figure 1: Receiver operating characteristic curve of age in detecting the presence of carpal tunnel syndrome in Egyptian women

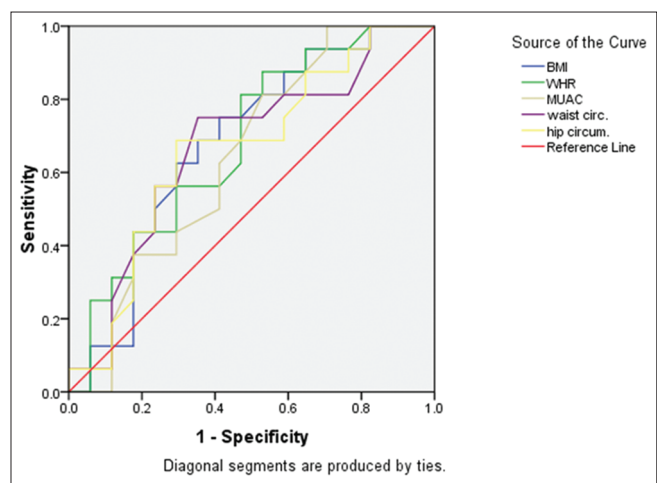


Figure 2: Receiver operating characteristic curve of body mass index, waist-hip ratio, mid-upper arm circumference, waist circumference, and hip circumference in detecting the presence of carpal tunnel syndrome in Egyptian women.

## Discussion

The incidence of CTS was previously estimated in different populations. A very wide occurrence range has been reported where the prevalence is varied in different populations and highly affected by the type of occupation [10]. EDX studies have been considered as a gold standard for CTS diagnosis [11], [12], [13]. CTS is typically presented with pain and/or dysesthesia of the fingers that might spread throughout the hand and radiate to the wrist. Symptoms usually become worse at night or in the early morning. In severe cases, atrophy of the thenar eminence and/or weakness of thumb abduction and opposition could be observed [13].

Results of the present study showed significant age differences between the two groups; CTS cases were significantly older compared with non-CTS. We found that age >40.5 years (area under the curve [AUC]=0.81, 77% sensitivity and 75% specificity) is a very important risk factor for CTS in obese females. It has been previously found that the age of 41–60 years is an independent risk factor for CTS which agreed with our results [3]. Although in the present study there were no significant differences in anthropometric measurements between the two groups, the CTS group tends to have higher anthropometric measurements (BMI, WC, WHR, HC, and MUAC). This might indicate the association between the severity of obesity and the developing of CTS. It has been previously shown that body mass index and obesity are strongly associated with CTS, with every one-unit increase in body mass increasing the risk of the condition by 8% [14]. The statistically significant correlation between age, obesity, and CTS has been reported previously by Tunç and Güngen (2017). The association between obesity and CTS might be explained as follow; the compressive effect on the median nerve could result from the accumulation

of fat tissue inside the carpal tunnel or an increase in hydrostatic pressure through this canal [3]. Moreover, the high carpal tunnel pressure may lead to fibrosis and thickening of the subsynovial connective tissue in the canal [15], [16]. The association between body anthropometry and CTS has been previously found; however, the anthropometric measurements were of low accuracy and had limited value as diagnostic tools for CTS [17]. This is consistent with our results where the AUC for the anthropometric measurements is ranging from 0.64 to 0.68.

Factors that have also been suggested to increase the risk for CTS include females in their first menopausal year and those taking the oral contraceptive pill or taking hormone replacement therapy [18].

Regarding the relationship between anthropometric measurements and median nerve conduction parameters, the present study showed that anthropometric measurements are negatively correlated with MMNCV. WHR is the anthropometric measurement that showed the strongest correlation. However, a study that has been done by Majumdar *et al.* [19] found negative correlations between BMI, WHR, and MMNCV in a sample of obese subjects who are not suffering from CTS. Hence, it has been suggested that obese individuals might suffer from the slowing of motor nerve conduction and this biological factor should be considered [19]. We can suggest that anthropometric measurements and age have to be taken into considerations while interpreting nerve conduction studies and they can be measured as important factors in CTS cases under the same occupational settings and stresses.

There are some limitations to this study. The relatively small sample size and only investigated women.

## Conclusion

Age and obesity are age and obesity indices can be used as predictors to CTS in obese women for CTS; age is more valuable as a diagnostic tool, though. Women with a high degree of obesity and above 40 years of age are particularly at high risk for CTS.

## References

1. Werner RA, Andary M. Carpal tunnel syndrome: Pathophysiology and clinical neurophysiology. *Clin Neurophysiol.* 2002;113(9):1373-81. [https://doi.org/10.1016/s1388-2457\(02\)00169-4](https://doi.org/10.1016/s1388-2457(02)00169-4) PMID:12169318
2. Kouyoumdjian JA, Zanetta DM, Morita MP. Evaluation of age, body mass index, and wrist index as risk factors for carpal tunnel syndrome severity. *Muscle Nerve.* 2002;25(1):93-7. <https://doi.org/10.1002/mus.10007> PMID:11754190
3. Becker J, Nora DB, Gomes I, Stringari FF, Seitensius R, Panosso JS, *et al.* An evaluation of gender, obesity, age and diabetes mellitus as risk factors for carpal tunnel syndrome. *Clin Neurophysiol.* 2002;113(9):1429-34. [https://doi.org/10.1016/s1388-2457\(02\)00201-8](https://doi.org/10.1016/s1388-2457(02)00201-8) PMID:12169324
4. Hendriks SH, van Dijk PR, Groenier KH, Hout P, Bilo HJ, Kleefstra N. Type 2 diabetes seems not to be a risk factor for the carpal tunnel syndrome: A case control study. *BMC Musculoskelet Disord.* 2014;15:346. <https://doi.org/10.1186/1471-2474-15-346> PMID:25315096
5. Barcenilla A, March LM, Chen JS, Sambrook PN. Carpal tunnel syndrome and its relationship to occupation: A meta-analysis. *Rheumatology.* 2012;51(2):250-61. <https://doi.org/10.1093/rheumatology/ker108> PMID:21586523
6. Kozak A, Schedlbauer G, Wirth T, Euler U, Westermann C, Nienhaus A. Association between work-related biomechanical risk factors and the occurrence of carpal tunnel syndrome: An overview of systematic reviews and a meta-analysis of current research. *BMC Musculoskelet Disord.* 2015;16:231. <https://doi.org/10.1186/s12891-015-0685-0> PMID:26323649
7. Phalen GS. The carpal-tunnel syndrome. Seventeen years' experience in diagnosis and treatment of six hundred fifty-four hands. *J Bone Joint Surg Am.* 1966;48(2):211-28. <https://doi.org/10.2106/00004623-196648020-00001> PMID:5934271
8. Wang L. Electrodiagnosis of carpal tunnel syndrome. *Phys Med Rehabil Clin N Am.* 2013;24(1):67-77. PMID:23177031
9. Basiri K, Katirji B. Practical approach to electrodiagnosis of the carpal tunnel syndrome: A review. *Adv Biomed Res.* 2015;4:50. <https://doi.org/10.4103/2277-9175.151552> PMID:25802819
10. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosén I. Prevalence of carpal tunnel syndrome in a general population. *JAMA.* 1999;282(2):153-8. <https://doi.org/10.1001/jama.282.2.153> PMID:10411196
11. Aroori S, Spence RA. Carpal tunnel syndrome. *Ulster Med J.* 2008;77(1):6-17. PMID:18269111
12. Graham B. The value added by electrodiagnostic testing in the diagnosis of carpal tunnel syndrome. *J Bone Joint Surg Am.* 2008;90(12):2587-93. <https://doi.org/10.2106/jbjs.g.01362> PMID:19047703
13. Ibrahim I, Khan WS, Goddard N, Smitham P. Carpal tunnel syndrome: A review of the recent literature. *Open Orthop J.* 2012;6:69-76. <https://doi.org/10.2174/1874325001206010069> PMID:22470412
14. Nordstrom DL, Vierkant RA, DeStefano F, Layde PM. Risk factors for carpal tunnel syndrome in a general population. *Occup Environ Med.* 1997;54(10):734-40. <https://doi.org/10.1136/oem.54.10.734> PMID:9404321
15. Tunç A, Güngen BD. Carpal tunnel syndrome: Investigating the sensitivity of initial-diagnosis with electro-diagnostic tests in 600 cases and associated risk factors especially manual

- milking. *J Back Musculoskelet Rehabil.* 2017;30(2):333-8. <https://doi.org/10.3233/bmr-160547>  
PMid:27858695
16. Chiotis K, Dimisianos N, Rigopoulou A, Chrysanthopoulou A, Chroni E. Role of anthropometric characteristics in idiopathic carpal tunnel syndrome. *Arch Phys Med Rehabil.* 2013;94(4):737-44. <https://doi.org/10.1016/j.apmr.2012.11.017>  
PMid:23178273
17. Mondelli M, Aretini A, Ginanneschi F, Greco G, Mattioli S. Waist circumference and waist-to-hip ratio in carpal tunnel syndrome: A case-control study. *J Neurol Sci.* 2014;338(1-2):207-13. <https://doi.org/10.1016/j.jns.2014.01.012>  
PMid:24468538
18. Solomon DH, Katz JN, Bohn R, Mogun H, Avorn J. Nonoccupational risk factors for carpal tunnel syndrome. *J Gen Intern Med.* 1999;14(5):310-4. <https://doi.org/10.1046/j.1525-1497.1999.00340.x>  
PMid:10337041
19. Majumdar S, Chaudhuri A, Ghar M, Rahaman WB, Hai A. Effect of obesity on nerve conduction study in an urban population of a developing country. *Saudi J Sports Med.* 2017;17:162-7. [https://doi.org/10.4103/sjsm.sjsm\\_8\\_17](https://doi.org/10.4103/sjsm.sjsm_8_17)