*Neurology Asia 2025; 30(4) : 1069 – 1076*

# The relationship between hand volume/body length and hand volume/hand length ratios and severity of carpal tunnel syndrome

Muzaffer Güneş, Oruç Şahin

*Aksaray University Faculty of Medicine Department of Neurology, Aksaray, Turkey*

### *Abstract*

*Background & Objective:* The aim of this study was to investigate whether carpal tunnel syndrome (CTS) would be more severe in individuals with shorter body length and short but more voluminous hands. *Methods:* This study was conducted between December 2024 and February 2025, and a total of 126 patients with CTS and 59 non-CTS individuals were enrolled. CTS patients were further categorized into mild, moderate, and severe subgroups. Demographic characteristics, hand volumes, various hand anthropometric measurements, and derived measurement ratios were recorded for statistical analysis. *Results:* Compared to the control group, the patient group exhibited significantly higher mean hand volume/hand length ratio, and hand volume/body length ratio (P <0.001), whereas the median hand length was lower (P =0.028). Significant differences among the four groups were also observed in the mean hand volume/hand length ratio, and hand volume/body length ratio (P <0.001 and P =0.002). The severity of CTS was negatively correlated with body length (rho =-0.153, P =0.037) but showed positive correlations with hand volume/body length ratio (rho =0.287, P <0.001), and hand volume/hand length ratio (rho =0.278, P <0.001). The areas under the ROC curves were 0.679 (95% CI, 0.595-0.763) for the hand volume/hand length ratio and 0.654 (95% CI, 0.568-0.739) for the hand volume/body length ratio.
*Conclusions:* CTS manifests more severely in patients with shorter body lengths and hands that are short yet relatively voluminous. Hand volume/body length and hand volume/hand length ratios may be predictive of CTS.

*Keywords:* Carpal tunnel syndrome, hand volume, anthropometric measurements, ratios

## INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common entrapment mononeuropathy in the general population[1] and results from the compression of the median nerve within a structure known as the "carpal tunnel" at the wrist.[2] It is well established that CTS is directly associated with factors such as female gender, prior wrist fractures, rheumatoid arthritis, age, obesity, and diabetes mellitus (DM).[2-4] Even in similar environmental or occupational settings, some individuals appear more predisposed to developing CTS than others.[5] This observation suggests that certain aspects of hand and/or body morphology may increase the susceptibility of the median nerve to compression at the wrist. For instance, it has been hypothesized that individuals with square-shaped wrists and shorter hands may be more prone to CTS.[1,5] Moreover, it has been suggested that wrist circumference, middle finger length, and hand width may be reliable indicators of CTS.[6] Various anthropometric measurements—including hand volume, hand length, wrist circumference, wrist width, wrist height, palm length, palm width, palm circumference, and third digit length—have been investigated for their potential roles in the development of CTS.[6,7] Additionally, ratios such as the wrist-to-palm ratio, waist-to-height ratio, and waist-to-hip ratio have also been studied in relation to CTS.[8]

To the best of our knowledge, the ratios of hand volume/body length and hand volume/hand length have not been previously examined in the context of CTS, nor has their significance been comprehensively elucidated. Furthermore, the relationship between these ratios, as well as other

*Address correspondence to:* Muzaffer Güneş, Aksaray University Training and Research Hospital Neurology Clinic, Yeni Sanayi Mahallesi, 68200 Center/Aksaray, Turkey. Tel: 90 536 2651491, E-mail: drmuzaffergunes@gmail.com

Date of Submission: 14 May 2025; Date of Acceptance: 4 August 2025

https://doi.org/10.54029/2025tvi

anthropometric measurements, and the severity of CTS remains unclear. Therefore, in this study, we hypothesized that individuals with shorter body lengths and relatively short but more voluminous hands would exhibit more severe manifestations of CTS. In addition, we investigated the relationships between various anthropometric measurements and CTS severity.

## METHODS

*Study setting and participant selection*

This prospective case–control study was conducted in the Electroneuromyography (ENMG) Laboratory of Aksaray University Training and Research Hospital between December 2024 and February 2025 including patients referred for ENMG testing with a preliminary diagnosis of CTS from the neurology clinic or other clinical departments. Patients whose ENMG examinations confirmed CTS were assigned to the CTS group, whereas those with normal ENMG findings were assigned to the control group.

*Hand volume, anthropometric measurements, and materials used*

Following the ENMG examination, all participants received detailed information about the study. For those who provided informed consent, measurements were recorded on a pre-designed form. This form included the following information: age, gender, height, weight, hand dominance, comorbidities, educational level, hand volume (measured from the distal wrist crease), hand length (from the distal wrist crease to the tip of the third finger), wrist circumference (measured at the distal wrist crease), wrist height and wrist width (measured at the distal wrist crease), third finger length (from the distal crease of the third finger to its tip), palm circumference, palm width, and palm length (from the distal wrist crease to the proximal crease of the third finger). These data were subsequently entered into SPSS, and the ratios of hand volume/body length and hand volume/hand length were calculated and recorded for statistical analysis.

For measuring hand volume and other anthropometric parameters, a plastic container with marked volume measurements was used, while a caliper and measuring tape were employed for length measurements.

*Inclusion and exclusion criteria*

Participants aged 18 years or older who were referred for ENMG testing from the neurology or other clinical departments and who provided consent were included in the study. Individuals who declined participation, those with renal or liver disease, patients in whom CTS was diagnosed on the basis of polyneuropathy during ENMG, those with brachial plexopathy or cervical radiculopathy in addition to CTS on ENMG, individuals with malignancies, those using chemotherapeutic agents or medications known to induce neuropathy, and persons under 18 years of age were excluded from the study.

*Electrodiagnostic examination and CTS subgroups*

Bilateral upper extremity nerve conduction studies (NCS) were performed in our ENMG laboratory. Patients diagnosed with CTS based on these studies were subdivided as follows: Mild CTS was defined as having a sensory nerve action potential (SNAP) latency >3.2 m/s and/or a SNAP amplitude <16 μV; moderate CTS was defined as the presence of mild CTS findings in conjunction with a median motor nerve distal latency >4.6 ms; and severe CTS was defined as the absence of a SNAP and/or a compound muscle action potential (CMAP) amplitude of the median nerve <5.0 mV.[9,10] For patients with bilateral CTS of differing neurophysiological severity, the more severely affected side was used for classification. For individuals without CTS, the dominant hand was included in the control group.

*Ethical considerations*

This study was approved by the Aksaray University Health Sciences Faculty, Scientific Research Ethics Committee (Approval Date: 05.12.2024, No: 2024/155).

*Statistical analysis*

The results were expressed as mean ± standard deviation for normally distributed data, median (min-max) for non-normally distributed data, and percentages (%). The Kolmogorov-Smirnov test was applied to assess the normality of data distribution. Palm circumference and hand volume/hand length ratio data exhibited normal distribution and were compared using Student's t-test for independent samples between two groups, and one-way ANOVA across four groups, followed by post-hoc Tukey tests (pairwise comparisons) according to Levene's

test of homogeneity. Data that did not follow a normal distribution were analyzed using the Mann-Whitney U test for comparisons between two groups, and the Kruskal-Wallis test for comparisons among four groups, followed by post-hoc pairwise comparisons. Correlation analysis was conducted using Spearman's correlation test. To identify predictive factors for CTS, univariate and multivariate logistic regression analyses were employed. Variables with a primary comparison P value of less than 0.25 were included in the univariate logistic regression model. Additionally, variables with a P value of less than 0.1 in univariate logistic regression were included in the multivariate logistic regression model. Model fit was evaluated using Hosmer-Lemeshow goodness-of-fit statistics. The consistency between variables was assessed using Cox and Snell pseudo-$R^2$ and Nagelkerke pseudo-$R^2$ tests. To determine the predictive value of variables, receiver operating characteristics (ROC) curve analysis was performed. An area under the ROC curve of 0.5 indicates no discrimination, 0.5-0.7 suggests poor to fair discrimination, 0.7-0.8 indicates acceptable discrimination, 0.8-0.9 signifies excellent discrimination, and 0.9-1.0 represents a very rare outcome.[11] All statistical analyses were conducted using SPSS 30.0 software for MacOS (SPSS Inc., Chicago, IL, USA). A P value of less than 0.05 was considered statistically significant, and Bonferroni-corrected P values were reported for non-parametric pairwise comparisons.

## RESULTS

For this study, 126 patients with CTS [30 males and 96 females, median age: 52 (27-86) years] and 59 healthy individuals [9 males and 50 females, median age: 46 (24-83) years] were eligible. Gender distribution was not different between the groups (P =0.184, $X^2$ =1.768), however, the CTS group was significantly older compared to the control group (52 years vs. 46 years, P <0.001). Comparisons between CTS and control groups revealed that (Table 1) the median body length, body weight, wrist circumference, wrist height, wrist width, third finger length, palm width and palm length did not significantly differ between the groups (P =0.075, P =0.101, P =0.353, P =0.714, P =0.308, P =0.535, P =0.133, and P =0.693, respectively). However, the mean palm circumference, the mean hand volume/hand length ratio, the median hand volume and hand volume/body length ratio were significantly greater (P =0.002, P <0.001, P =0.008, and P <0.001, respectively); and the median hand length (P =0.028) was significantly lower in the CTS group, compared to the control group.

The comparison of categorical variables (presence) between the CTS and control groups was as follows: The rates of DM (P =0.03, $X^2$ =4.714) and arterial hypertension (P =0.002, $X^2$ =9.408) were significantly higher in CTS group compared to the control group. No significant differences of the rates of hyperlipidemia (P =0.18, $X^2$ =1.799) and coronary artery disease

**Table 1: Comparisons between carpal tunnel syndrome and control groups**

| | Carpal tunnel syndrome (n=126) | Control (n=59) | P value |
|---|---|---|---|
| Palm circumference (cm) | 20.9 ±1.4 | 20.2 ±1.3 | 0.002 |
| Hand volume/hand length ratio | 18.8 ±2.5 | 17.1 ±2.7 | <0.001 |
| Age (year) | 52 (27-86) | 46 (24-83) | <0.001 |
| Body Length (cm) | 160 (141-180) | 160 (150-184) | 0.075 |
| Body Weight (kg) | 80 (55-120) | 77 (50-117) | 0.101 |
| Hand volume (ml) | 340 (220-550) | 310 (200-490) | 0.008 |
| Hand length (cm) | 18.25 (15.5-21.5) | 18.6 (15.7-21.2) | 0.028 |
| Wrist circumference (cm) | 18 (15-22.7) | 17.6 (15-19.7) | 0.353 |
| Wrist height (cm) | 4.4 (3.5-5.8) | 4.3 (3.5-5.2) | 0.714 |
| Wrist width (cm) | 6 (4.8-7.8) | 5.9 (4.8-7) | 0.308 |
| Third finger length (cm) | 7.6 (6.2-9.8) | 7.7 (6.4-9) | 0.535 |
| Palm width (cm) | 8.4 (6.8-10.5) | 8.1 (7-9.5) | 0.133 |
| Palm length (cm) | 11 (8.8-13.8) | 11 (7.1-13.2) | 0.693 |
| Hand volume/body length ratio | 2.13 (1.47-3.14) | 1.94 (1.19-2.66) | <0.001 |

(P =0.065, $X^2$ =3.407) were observed between the CTS and control groups.

Comparisons among the severe, moderate and mild CTS and control groups revealed that (Table 2) the mean palm circumference, the median body length, body weight, wrist circumference, wrist width, third finger length and palm width did not significantly differ between the groups (P =0.05, P =0.069, P =0.347, P =0.08, P =0.628, P =0.214 and P =0.505, respectively). However, a significant difference of the mean hand volume/ hand length ratio, the median age, hand volume, hand length, wrist height, palm length and hand volume/body length ratio were evident among four groups (P <0.001, P <0.001, P =0.034, P =0.004, P =0.026, P =0.034 and P =0.002, respectively). According to the post- hoc pairwise comparisons, the mean hand volume/hand length ratio of severe, moderate and mild CTS groups were significantly greater compared to the control group (P =0.025, P <0.001 and P =0.009, respectively). Additionally, the median hand length of moderate CTS group was significantly lower compared both to the control group and severe CTS group (P =0.042 and P =0.035, respectively). Moreover, the median wrist height and palm length of severe CTS group was significantly greater compared to the mild CTS group (P =0.021 and P =0.024, respectively). Lastly, the median hand volume/body length ratio of both severe and moderate CTS groups were significantly greater compared to the control group (P =0.008 and P =0.007).

Spearman correlation analysis revealed a significant negative but weak correlation of the severity of CTS with body length (rho :-0.153, P =0.037) and, a significant positive but weak correlation of the severity of CTS with hand volume (rho :0.215, P =0.003), hand volume/body length ratio (rho :0.287, P <0.001) (Figure 1), palm circumference (rho :0.215, P =0.003), age (rho :0.388, P <0.001) and hand volume/hand length ratio (rho :0.278, P <0.001).

Table 3 represents the univariate and multivariate logistic regression analysis results. In the univariate logistic regression model, the age, palm circumference, hand volume/hand length ratio, hand volume, hand volume/body length ratio, hypertension and DM were predictive factors of CTS (P <0.001, P =0.003, P <0.001, P =0.004, P <0.001, P =0.004 and P =0.036, respectively). However, only age was found to be predictive factor of CTS in the multivariate logistic regression model (P =0.025).

Figure 2 shows the ROC curve representing the predictive values of age and anthropometric parameters for CTS. The areas under curve were listed in Table 4.

**Table 2: Comparisons among the severe, moderate and mild CTS and control groups**

| | Severe CTS (n=27) | Moderate CTS (n=50) | Mild CTS (n=49) | Control (n=59) | P value |
|---|---|---|---|---|---|
| Palm circumference | 21±1.4 | 20.9±1.5 | 20.9±1.3 | 20.2±1.3 | 0.05 |
| Hand volume/ hand length ratio | 19±2.5 | 19.1±2.5 | 18.5±2.5 | 17.1±2.7 | <0.001 |
| Age | 65 (36-86) | 52 (29-83) | 50 (27-77) | 46 (24-83) | <0.001 |
| Body Length | 160 (145-180) | 157 (145-178) | 162 (141-180) | 160 (150-184) | 0.069 |
| Body Weight | 77 (55-120) | 80 (55-110) | 80 (59-115) | 77 (50-117) | 0.347 |
| Hand volume | 350 (270-490) | 340 (250-550) | 330 (220-490) | 310 (200-490) | 0.034 |
| Hand length | 19 (16.7-21) | 18 (15.5-21) | 18.2 (15.8-21.5) | 18.6 (15.7-21.2) | 0.004 |
| Wrist circumference | 18.4 (16-22.7) | 18 (15-21) | 17.5 (15.6-21) | 17.6 (15-19.7) | 0.08 |
| Wrist height | 4.6 (3.7-5.8) | 4.4 (3.5-5.6) | 4.3 (3.6-5.6) | 4.3 (3.5-5.2) | 0.026 |
| Wrist width | 6.1 (5.1-7) | 5.9 (5-7.5) | 6 (4.8-7.8) | 5.9 (4.8-7) | 0.628 |
| Third finger length | 7.9 (6.7-9.1) | 7.5 (6.2-9.8) | 7.7 (6.8-9) | 7.7 (6.4-9) | 0.214 |
| Palm width | 8.5 (7.2-10) | 8.35 (7.1-10.5) | 8.4 (6.8-10.5) | 8.1 (7-9.5) | 0.505 |
| Palm length | 11.5 (9.1-13) | 11 (8.8-13.2) | 11 (9.3-13.8) | 11 (7.1-13.2) | 0.034 |
| Hand volume/ body length ratio | 2.26 (1.7-2.7) | 2.17 (1.61-3.14) | 2.07 (1.47-2.75) | 1.94 (1.19-2.66) | 0.002 |

CTS: Carpal tunnel syndrome

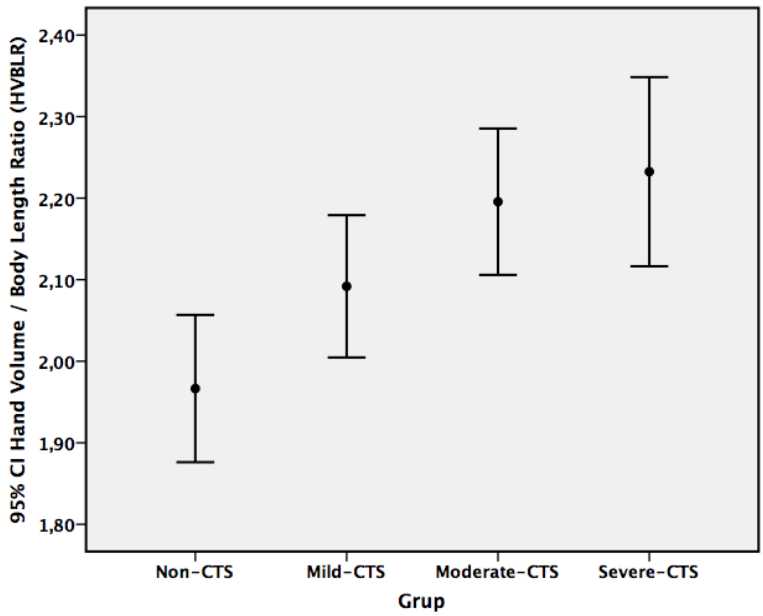


Figure 1. Relationship between severity of carpal tunnel syndrome and hand volume/body length ratio.

## DISCUSSION

The key findings of this study are as follows: First, there was a positive relationship between CTS severity and hand volume, palm circumference, age, hand volume/body length ratio, and hand volume/hand length ratio, whereas a negative relationship was found with body length. Second, multivariate logistic regression analysis revealed that age was the most significant factor influencing CTS development. Third, ROC curve analysis identified hand volume, age, hand length, palm circumference, hand volume/hand length ratio, and hand volume/body length ratio as predictive factors for CTS. To the best of our knowledge,

**Table 3: The univariate and multivariate logistic regression analysis results**

| | Univariate | | Multivariate | |
|---|---|---|---|---|
| | **OR (95% CI)** | ***P* value** | **OR (95% CI)** | ***P* value** |
| Age | 1.059 (1.03-1.089) | <0.001 | 1.041 (1.005-1.079) | 0.025 |
| Palm circumference | 1.442 (1.135-1.830) | 0.003 | 1.418 (0.927-2.169) | 0.107 |
| Hand volume/hand length ratio | 1.318 (1.151-1.51) | <0.001 | 2.117 (0.113-39.503) | 0.615 |
| Body length | 0.965 (0.929-1.003) | 0.068 | 0.719 (0.463-1.116) | 0.141 |
| Body weight | 1.017 (0.994-1.041) | 0.152 | - | - |
| Hand volume | 1.008 (1.003-1.014) | 0.004 | 1.124 (0.956-1.322) | 0.156 |
| Hand length | 0.784 (0.595-1.034) | 0.085 | 0.896 (0.054-14.786) | 0.939 |
| Palm width | 1.542 (0.961-2.475) | 0.073 | 0.907 (0.425-1.935) | 0.801 |
| Hand volume/body length ratio | 6.855 (2.396-19.606) | <0.001 | 0 (0-31293.8) | 0.175 |
| Arterial hypertension | 4.32 (1.598-11.677) | 0.004 | 1.476 (0.472-4.616) | 0.504 |
| Hyperlipidemia | 2.144 (0.688-6.681) | 0.188 | - | - |
| Coronary artery disease | 0 (0-0) | 0.999 | - | - |
| Diabetes mellitus | 2.945 (1.073-8.089) | 0.036 | 1.435 (0.444-4.637) | 0.546 |
| | | | Cox & Snell pseudo-$R^2$= 0.244<br>Nagelkerke pseudo-$R^2$ = 0.341<br>Hosmer- Lemeshow *P* =0.928 | |

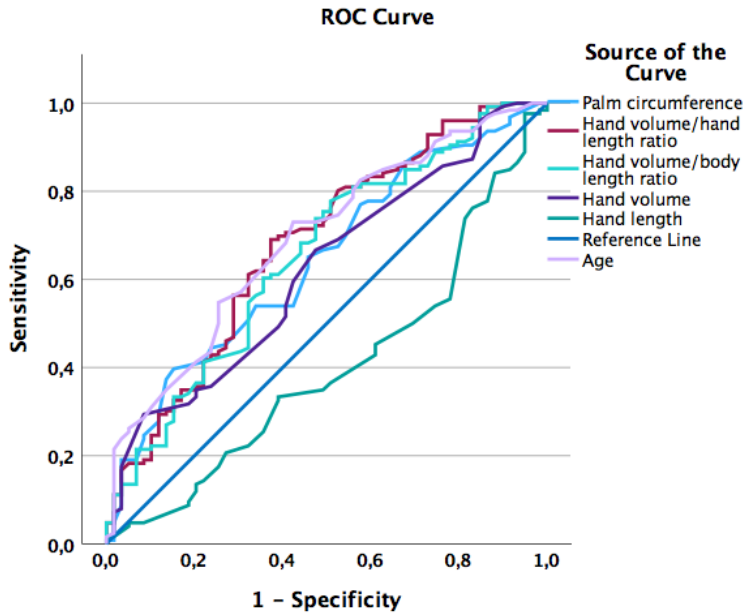


Figure 2. Showing the ROC curve representing the predictive values of age and anthropometric parameters for carpal tunnel syndrome.

the relationship between CTS severity and the hand volume/hand length ratio and hand volume/body length ratio has not been fully investigated. Therefore, we believe that this study will make a significant contribution to the literature.

CTS is known to be associated with various factors such as obesity, female sex, age, DM, and systemic inflammation.[3,10] However, it has been reported that some individuals with the same conditions are more susceptible to CTS.[5,12] This is thought to be due to differences in hand and body structure among individuals.[5,12] However, the exact nature of these differences has not been fully elucidated. A review of the literature indicates that, to our knowledge, the role of hand volume in CTS has been examined in only two studies. In the first study by Arslan *et al*.,[7] conducted with 85 CTS patients and 80 control subjects, it was found that CTS patients had thicker and larger hands compared to individuals without CTS. However, in the same study, when CTS patients were categorized into three subgroups (mild, moderate, and severe), no significant difference in hand volume was found among these groups. This may be due to the small number of patients in the CTS subgroups or the exclusion of the control group from the analysis. In another study on hand volume, it was found that CTS patients had shorter fingers and a more voluminous hand compared to those without CTS.[13] Neither of these two studies[7,13] investigated relationship between CTS severity and hand volume, hand volume/hand length ratio, and hand volume/body length ratio. However, in the present study, conducted on 126 neurophysiologically diagnosed CTS patients (49 mild, 50 moderate, and 27 severe cases) and 59 neurophysiologically confirmed non-CTS individuals (control group), we compared

**Table 4: The areas under the ROC curve**

| | Area Under the ROC Curve | 95% Confidence Interval |
|---|---|---|
| Age | 0.691 | 0.611 - 0.771 |
| Hand volume/hand length ratio | 0.679 | 0.595 - 0.763 |
| Hand volume/body length ratio | 0.654 | 0.568 - 0.739 |
| Palm circumference | 0.643 | 0.559 - 0.726 |
| Hand volume | 0.620 | 0.535 - 0.705 |
| Hand length | 0.6 | 0.513 - 0.687 |

both two groups (CTS and non-CTS) and four groups (non-CTS, mild CTS, moderate CTS, and severe CTS) and identified statistically significant differences between the groups. Additionally, correlation analysis revealed a positive correlation between CTS severity and hand volume, hand volume/hand length ratio, and hand volume/body length ratio, whereas a negative correlation was found between body length and CTS severity. Evaluated together, these findings indicate that individuals with short and thick hands and short stature experience more severe CTS. In light of this information, we believe that clinicians should take this into account when diagnosing CTS in individuals with short stature and short but thick hands, adjusting treatment plans accordingly and following up with patients more frequently.

In the present study, although the wrist circumference, wrist height, wrist width, palm width, and palm length were higher in the patient group compared to the control group, these differences were not statistically significant, in contrast to previous studies.[14-17] This discrepancy may be due to the relatively small sample sizes in our study groups, the lack of gender stratification, or the measurement of anthropometric parameters in centimeters rather than millimeters.

This study has several limitations. First, it was conducted in a single center which may limit the generalizability of our findings. Another limitation is that the control group did not consist of completely asymptomatic individuals. Instead, our control group comprised individuals who were referred to our neurophysiology laboratory for an electromyography (EMG) examination with a preliminary diagnosis of CTS but were ultimately not diagnosed with CTS. Ideally, the control group could have consisted of entirely asymptomatic individuals, but identifying such participants is challenging. Therefore, we included individuals who were neurophysiologically confirmed to be CTS-negative. Furthermore, this study could have been designed with five separate groups: an asymptomatic group, a clinical CTS group, and groups with mild, moderate, and severe CTS diagnosed neurophysiologically. Additionally, we did not investigate the temporal relationship between hand and body proportions and CTS severity. Considering these factors, future studies with larger, multicenter cohorts may provide further insights.

In conclusion, CTS tends to be more severe in individuals with a body structure characterized by a larger hand volume relative to body and hand length—namely, those with shorter stature and shorter but thicker hands. However, this study did not investigate the time frame over which CTS progresses to severe stages. Compared to individuals with long, slender hands and taller stature, those with shorter stature and thicker hands may experience a more rapid progression to severe CTS. Other contributing factors are also likely to play a role. Future research may help elucidate the temporal relationship between body anthropometric measurements and CTS severity.

## DISCLOSURE

Financial support: None

Conflicts of interest: None

## REFERENCES

1. Padua L, Cuccagna C, Giovannini S, *et al*. Carpal tunnel syndrome: Updated evidence and new questions. *Lancet Neurol* 2023; 22:255-67. doi: 10.1016/S1474-4422(22)00432-X
2. Lam KHS, Wu Y-T, Reeves KD, *et al*. Ultrasound-guided interventions for carpal tunnel syndrome: A systematic review and meta-analyses. *Diagnostics* 2023; 13:1138. doi: 10.3390/diagnostics13061138
3. Malakootian M, Soveizi M, Gholipour A, *et al*. Pathophysiology, diagnosis, treatment, and genetics of carpal tunnel syndrome: A review. *Cell Mol Neurobiol* 2023; 43:1817-31. doi: 10.1007/s10571-022-01297-2
4. Pourmemar H, Heliovaara M, Viikari-Juntura E, *et al*. Carpal tunnel release: Lifetime prevalence, annual incidence, and risk factors. *Muscle Nerve* 2018; 58(4):497-502. doi:10.1002/mus.26145
5. Boz C, Ozmenoglu M, Altunayoglu V, *et al*. Individual risk factors for carpal tunnel syndrome: an evaluation of body mass index, wrist index and hand anthropometric measurements. *Clin Neurol Neurosurg* 2004; 106(4):294-9. doi:10.1016/j.clineuro.2004.01.002
6. Yetiş M, Kocaman H, Canlı M, *et al*. Carpal tunnel syndrome prediction with machine learning algorithms using anthropometric and strength-based measurement. *PLoS One* 2024;19(4): e0300044. doi: 10.1371/journal.pone.0300044
7. Arslan Y, Bülbül İ, Öcek L, *et al*. Effect of hand volume and other anthropometric measurements on carpal tunnel syndrome. *Neurol Sci* 2017; 38(4):605-10. doi:10.1007/s10072-017-2809-9
8. Mondelli M, Farioli A, Mattioli S, *et al*. Severity of carpal tunnel syndrome and diagnostic accuracy of hand and body anthropometric measures. *PLoS ONE* 2016; 11(10):e0164715. doi:10.1371/journal.pone.0164715
9. Stevens JC. AAEM minimonograph #26: The electrodiagnosis of carpal tunnel syndrome. American Association of Electrodiagnostic Medicine. *Muscle Nerve* 1997; 20(12):1477-86.
10. Güneş M, Büyükgöl H. Correlation of neutrophil/lymphocyte and platelet/lymphocyte ratios with the

severity of idiopathic carpal tunnel syndrome. *Muscle Nerve* 2020; 61:369-74. doi:10.1002/mus.26791
11. Forthofer RN, Lee ES, Hernandez M. Biostatistics: A guide to design, analysis and discovery. 2nd Ed. USA: Elsevier Academic Press, 2007
12. Chiotis K, Dimisianos N, Rigopoulou A, *et al*. Role of anthropometric characteristics in idiopathic carpal tunnel syndrome. *Arch Phys Med Rehabil* 2013; 94:737-44. doi:10.1016/j.apmr.2012.11.017
13. Sahebalam M, Ghayyem Hassankhani G, Azhari A, *et al*. Do carpal tunnel hands have different shape compare to normal hands? *Arch Bone Jt Surg* 2021; 9(2):180-8. doi: 10.22038/abjs.2020.41835.2131
14. Mokhtarinia HR, Parsons D, Bain CR, *et al*. Independent risk factors of carpal tunnel syndrome: Assessment of body mass index, hand, wrist and finger anthropometric measurements. *Work* 2022; 73:157-64. doi:10.3233/WOR-210910
15. Ozcakir S, Sigirli D, Avsaroglu H. High wrist ratio is a risk factor for carpal tunnel syndrome. *Clin Anat* 2018; 31:698-701. doi:10.1002/ca.23198
16. Trybus M, Stepanczak B, Koziej M, *et al*. Hand anthropometry in patients with carpal tunnel syndrome: a case-control study with a matched control group of healthy volunteers. *Folia Morphologica* 2019; 78(1):182-90. doi: 10.5603/FM.a2018.0049
17. Imam MH, Hasan MM, ELnemr RA, *et al*. Body, wrist, and hand anthropometric measurements as risk factors for carpal tunnel syndrome. *Egypt Rheumatol Rehabil* 2019; 46:35-41. doi: 10.4103/err.err_21_18