**Introduction**

In recent years, high-resolution ultrasonography has emerged as a noninvasive and effective tool in the investigation of peripheral nerve disorders. On nerve ultrasound, peripheral nerve pathology is depicted as focal or diffuse enlargement of the nerves, which is best quantified by measuring the cross-sectional area (CSA) of the nerve. To determine significant abnormalities, valid reference values of nerve size parameters are essential as these may differ in different populations and at different settings.

There have been several studies that have generated the reference values for nerve ultrasound CSA.\(^1\)\(^-\)\(^8\) Most have been derived from the Caucasian population. In studies involving Asian patients, these have been limited to one ethnic group within that population.\(^9\)\(^-\)\(^16\) In one study, the authors investigated the differences in median nerve (MN) CSA between Dutch and Indian participants,\(^17\) suggesting that ethnicity has a significant impact on nerve CSA. Malaysia has a multiethnic population comprising three major ethnic groups (Malay, Chinese, and Indian). The objectives of this study were to establish a set of reference values for CSA of peripheral nerves in a multiethnic Malaysian population, which serves as reference values in the evaluation of peripheral nerve disorders. The ethnic differences in nerve CSA values should be considered during nerve ultrasound.

**Methods**

**Participants**

The study was conducted at University Malaya Medical Centre (UMMC), Kuala Lumpur, from January 2014 to June 2014. Volunteers were relatives of patients, staff, and students of the institution. The study was approved by the UMMC Medical Research Ethics Committee.
Ultrasound examination was performed using a broadband linear array transducer (frequency band 8–13 MHz), which was set at 12 MHz (E Logic Book®, General Electric Healthcare, Waukesha, Wisconsin). All studies were performed by a single assessor (SNOR) with at least 1-year experience in neuromuscular ultrasound. Each examination was performed bilaterally. The ultrasound probe was positioned perpendicularly to the nerve to reduce anisotropy. The CSA of each nerve was measured at standardized anatomical sites, following previous published scanning protocol.[8,9] For the MN and ulnar nerves (UNs), CSA was assessed at the distal wrist crease, mid-forearm (10 cm proximal to distal wrist crease), elbow (antecubital fossa for MN and at the level of medial epicondyle for UN), and midarm (8 cm above elbow). The superficial radial nerve (RN) was assessed at the mid-forearm (midpoint between wrist and elbow). The tibial nerve (TN) was assessed at the popliteal fossa and posterior to medial malleolus at ankle. Fibular nerve (FN) was assessed at the fibular head and lateral popliteal fossa. The sural nerve (SN) was assessed at 10 cm above the lateral malleolus. The CSA at each scanned site was measured by tracing circumferentially inside the hyperechoic rim (intra-epineurium) of each nerve [Figure 1].

Statistical analysis

Statistical analysis was performed using SPSS version 24 software (IBM Corp., USA). Continuous data were presented as mean ± standard deviation (SD). Categorical data were presented as frequencies and percentages. The Chi-square test was used for comparison of proportions. The mean CSA was compared between right and left using paired sample t-test. To determine reference values for nerve CSA at each site, only the values obtained from the right side were used because the inclusion of both sides for each participant would artificially lower the variance. The mean ± 2SD was used to calculate the reference ranges. Student’s t-test was used to compare the differences in gender, and one-way ANOVA with post hoc Tukey analysis was used to compare differences between ethnic groups. The correlation between the nerve CSA and age, weight, height, and BMI was performed using the Pearson’s correlation coefficient (r). For multivariate linear regression analysis, we generated 14 models with the nerve CSA at the indicated location as the dependent variable. A P < 0.05 was considered statistically significant.

RESULTS

Demographics

A total of 84 participants were recruited. The mean age was 40.0 ± 14.4 years (range: 19–69 years) with 46 (54.8%) women and 38 (45.2%) men [Supplementary Table S1]. Three major ethnic groups in Malaysia were equally distributed, with 29 (34.5%) Malays, 28 (33.3%) Chinese, and 27 (32.2%) Indians. The mean height was 1.6 ± 0.1 m, mean weight was 64.7 ± 14.3 kg, and mean BMI was 24.2 ± 4.8 kg/m².

Side-to-side comparison

Peripheral nerve CSA was obtained on both sides. Apart from the CSA of MN at the wrist (right: 6.4 ± 1.4 vs. left: 5.9 ± 1.1 mm², \( P=0.001 \)) and UN at midarm (right: 5.6 ± 1.5 vs. left: 5.3 ± 1.2 mm², \( P=0.040 \)), there were no significant differences in CSA between right and left side [Supplementary Table S2].

Reference values

Table 1 lists the mean, SD, and reference ranges of nerve CSA values at each site. The normal values of each nerve were as follows: MN, 6.4 ± 1.4 mm² at the wrist, 5.2 ± 1.0 mm² at the mid-forearm, 6.8 ± 1.5 mm² at the antecubital fossa, and 7.1 ± 1.4 mm² at the midarm; UN, 4.0 ± 1.0 mm² at the wrist, 4.6 ± 1.0 mm² at the mid-forearm, 6.1 ± 1.4 mm² at the elbow,

![Figure 1: Measurement of the nerve cross-sectional area with tracing method inside the hyperechoic rim of median nerve at wrist (a) and at mid-forearm (b); ulnar nerve at elbow (c), and at midarm (d)](image)

Table 1: Nerve cross-sectional area reference values

| Nerve | Site             | Mean±SD (mm²) | Reference range (mm²) |
|-------|------------------|---------------|-----------------------|
| Median| Wrist            | 6.4±1.4       | 3.6-9.2               |
|       | Mid-forearm      | 5.2±1.0       | 3.2-7.2               |
|       | Elbow            | 6.8±1.5       | 3.8-9.8               |
|       | Mid arm          | 7.1±1.4       | 4.3-9.9               |
| Ulnar | Wrist            | 4.0±1.0       | 2.0-6.0               |
|       | Mid-forearm      | 4.6±1.0       | 2.6-6.6               |
|       | Elbow            | 6.1±1.4       | 3.3-8.9               |
|       | Midarm           | 5.6±1.5       | 2.6-8.6               |
| Fibular| Fibular head   | 8.9±2.0       | 4.9-12.9              |
|       | Knee             | 7.5±1.8       | 3.9-11.1              |
| Tibial| Knee             | 11.8±2.2      | 7.4-16.2              |
|       | Ankle            | 10.1±2.0      | 6.1-14.1              |
| Sural |                  | 1.5±0.6       | 0.3-2.7               |
| Radial|                  | 1.1±0.3       | 0.5-1.7               |

SD: Standard deviation
and 5.6 ± 1.5 mm² at the midarm; FN, 8.9 ± 2.0 mm² at the fibular head, and 7.5 ± 1.8 mm² at the lateral popliteal fossa; TN, 11.8 ± 2.2 mm² at the popliteal fossa, and 10.1 ± 2.0 mm² at the ankle; superficial RN, 1.1 ± 0.3 mm² at the mid-forearm; and SN, 1.5 ± 0.6 mm² at the distal calf.

### Comparison between genders

There was no significance difference in age between men and women [Table 2]. Men were taller (1.7 ± 0.1 vs. 1.6 ± 0.1 m, \( P < 0.001 \)) and heavier than women (72.4 ± 13.0 vs. 58.4 ± 12.1 kg, \( P < 0.001 \)). However, the BMI between the two gender groups was not significantly different. CSA values were higher in men than women at MN mid-forearm (5.4 ± 1.1 vs. 4.9 ± 0.8 mm², \( P = 0.023 \)), MN elbow (7.3 ± 1.5 vs. 6.4 ± 1.4 mm², \( P = 0.007 \)), MN midarm (7.4 ± 1.5 vs. 6.8 ± 1.2 mm², \( P = 0.032 \)), UN wrist (4.3 ± 1.0 vs. 3.8 ± 1.0 mm², \( P = 0.014 \)), TN knee (12.6 ± 2.3 vs. 11.1 ± 1.9 mm², \( P = 0.002 \)), and TN ankle (10.7 ± 1.8 vs. 9.7 ± 1.9 mm², \( P = 0.020 \)).

### Comparison between ethnics

There was a significant difference in BMI between ethnic groups (\( P = 0.046 \)), with Malays having a higher BMI compared to Chinese (25.5 ± 5.3 vs. 22.4 ± 4.5 kg/m²) participants [Table 3]. However, there were no significant differences in age, height, weight, and gender distribution between the three ethnic groups. CSA values were significantly different between ethnic groups at UN mid-forearm (\( P = 0.008 \)), SN (\( P = 0.006 \)), and RN (\( P = 0.038 \)). Malays had larger CSA of UN at mid-forearm (5.0 ± 1.2 vs. 4.2 ± 0.8 mm²)

### Table 2: Nerve cross-sectional area reference values with respect to gender

| Demographic | Gender, mean±SD (mm²) | \( P \) |
|-------------|-----------------------|-------|
| Age, years  | Female (n=46) 40.4±14.0, Male (n=38) 39.5±14.9 | 0.789 |
| Height, m   | Female (n=46) 1.6±0.1, Male (n=38) 1.7±0.1 | <0.001 |
| Weight, kg  | Female (n=46) 58.4±12.1, Male (n=38) 72.4±13.0 | <0.001 |
| BMI, kg/m²  | Female (n=46) 25.4±4.8, Male (n=38) 25.1±4.6 | 0.111 |

| Nerve  | Site                  | Gender, mean±SD (mm²) | \( P \) |
|--------|-----------------------|-----------------------|-------|
| Median | Wrist 6.2±1.6, Mid-forearm 4.9±0.8, Elbow 6.4±1.4, Midarm 6.8±1.2 | 0.167, 0.023, 0.007, 0.032 |
| Ulnar  | Wrist 3.8±1.0, Mid-forearm 4.4±0.9, Elbow 6.0±1.4, Midarm 5.3±1.3 | 0.014, 0.051, 0.198, 0.075 |
| Tibial | Wrist 7.2±1.6, Mid-forearm 6.3±1.2 | 0.093, 0.051 |
| Ulnar  | Wrist 9.2±2.1 | 0.116 |
| Tibial | Wrist 12.6±2.3, Mid-forearm 9.2±1.3 | 0.002, 0.051 |
| Sural  | Wrist 1.4±0.6, Elbow 1.2±0.4 | 0.158, 0.295 |
| Radial | Wrist 1.1±0.3 | 0.295 |

SD: Standard deviation, BMI: Body mass index

### Table 3: Nerve cross-sectional area reference values with respect to ethnicity

| Demographic | Ethnicity, mean±SD (mm²) | \( P \) |
|-------------|--------------------------|-------|
| Age, years  | Malay 39.7±12.7, Chinese 41.2±16.3, Indian 39.0±14.4 | 0.847 |
| Height, m   | Malay 1.6±0.1, Chinese 1.6±0.1, Indian 1.7±0.1 | 0.107 |
| Weight, kg  | Malay 66.1±14.3, Chinese 60.1±14.6, Indian 68.0±13.1 | 0.102 |
| BMI, kg/m²  | Malay 25.5±5.3, Chinese 22.4±4.5, Indian 24.7±4.0 | 0.046 |
| Gender      | Malay 16:13, Chinese 15:13, Indian 15:12 | 0.988 |

| Nerve  | Site                  | Ethnicity, mean±SD (mm²) | \( P \) |
|--------|-----------------------|--------------------------|-------|
| Median | Wrist 6.6±1.3, Mid-forearm 5.1±0.9, Elbow 6.7±1.3, Midarm 7.0±1.6 | 0.017, 0.028, 0.091, 0.953 |
| Ulnar  | Wrist 3.9±1.1, Mid-forearm 4.4±1.0, Elbow 6.6±1.3, Midarm 5.9±1.2 | 0.458, 0.008, 0.075, 0.619 |
| Tibial | Wrist 10.7±1.8, Elbow 6.6±1.3, Midarm 5.5±1.2 | 0.020, 0.020, 0.619 |
| Sural  | Wrist 1.1±0.6, Elbow 1.2±0.4 | 0.158, 0.295 |
| Radial | Wrist 1.1±0.3 | 0.295 |

SD: Standard deviation, BMI: Body mass index

*Significant difference. SD: Standard deviation, BMI: Body mass index
and SN (1.7 ± 0.7 vs. 1.3 ± 0.5 mm²) compared to Indians. The SN (1.7 ± 0.7 vs. 1.4 ± 0.5 mm²) and RN CSA (1.2 ± 0.4 vs. 1.0 ± 0.2 mm²) were also larger in Malays when compared to Chinese.

Correlation of nerve cross-sectional area with demographics
Table 4 shows the correlation between demographic factors and nerve CSA at each site. Age, height, weight, and BMI correlated significantly with nerve CSA. Nerve CSA at MN midarm, TN knee, and TN ankle positively correlated with age and height, while FN at fibular head only positively correlated with age. Nerve CSA at MN elbow, UN wrist, UN midarm, and FN at fibular head and knee positively correlated with weight and BMI, whereas TN knee only positively correlated with weight.

Multivariable analysis
As weight and BMI were highly correlated with each other, BMI was selected to be included with age, ethnic, gender, and height as independent variables in multivariate linear regression models. A significant correlation of nerve CSA at some of the locations with age, ethnic, gender, and BMI, but not height remained in multivariable models [Supplementary Table S3].

Discussion
In the current study, we report the reference values for nerve CSA of six commonly evaluated nerves at 14 different sites. Our results were comparable to published values at most sites. Table 5 shows some of the main studies that have published normative values for CSA of the peripheral nerves. In the current study, the CSA of MN at the wrist (6.4 ± 1.4 mm²) and UN at the forehand (4.6 ± 1.8 mm²) were similar to Niu et al. (6.4 ± 0.9 mm²) and (4.6 ± 0.8 mm²). For UN at the wrist, our result (4.0 ± 1.0 mm²) was comparable to Sugimoto et al. (4.1 ± 1.0 mm²) and Bedewi et al. (4.1 ± 1.6 mm²). Similarly, nerve CSA of TN at ankle (10.1 ± 2.0 mm²) in the current study was comparable to values reported by Grimm et al. (10.2 ± 2.0 mm²), and FN CSA at fibular head (8.9 ± 2.0 mm²) was identical to the value reported by Boehm et al. (8.9 ± 2.0 mm²) and Bedewi et al. (8.9 ± 3.2 mm²). These results support the consistency of the nerve ultrasound technique between different laboratories and the validity of this imaging modality.

Despite the similarities, there were differences in certain measurements in the current study from published values. When comparing the mean, our CSA reference values were lower than those obtained by Cartwright et al. and Qrimli et al. For example, the CSA of the MN at the wrist was reported to be 9.8 ± 2.4 mm² by Cartwright et al. and 10.0 ± 2.4 mm² by Qrimli et al. compared to our value of 6.4 ± 1.4 mm² at the same location. Similarly, the CSA of the UN at elbow was found to be 6.1 ± 1.4 mm² in our study as compared with Boehm et al. and Grimm et al. who found a value of 7.6 ± 2.1 mm² and 8.7 ± 2.0 mm², respectively. The CSA of the TN at the knee was lower in our study (11.8 ± 2.2 mm²) compared with the values reported by Cartwright et al. (35.3 ± 10.3 mm²) and Grimm et al. (23.2 ± 4.9 mm²). These discrepancies may very well relate to the differences in demographic factors such as ethnicity, gender, height, and weight. The majority of participants in other studies were Caucasian, taller, and heavier than our Asian participants.

One of the objectives of the current study was to investigate the influence of ethnicity on nerve size. Interestingly, we found that participants of Malay ethnicity had larger nerve CSA compared to other ethnic groups in univariate analysis. This could relate to the higher BMI in this ethnic group. Nerve CSA has been shown to correlate with weight and BMI. The differences of nerve CSA between ethnic groups were still significant in multivariable models when the BMI was controlled, indicating the difference was not solely influenced

| Table 4: Correlation between nerve cross-sectional area and demographic factors |
|-----------------|---------------|---------------|-----------------|---------------|---------------|
| Nerve          | Site          | Age           |               |               | Height        |               |               |               | Weight        |               |               | BMI            |
|                |               | r             | P             |               | r             | P             |               | r             | P             |               | r             | P             |               |
| Median         | Wrist         | 0.160         | 0.146         | 0.111         | 0.314         | 0.119         | 0.281         | 0.083         | 0.450         |               |               |               |
| Mid-forearm    | -0.049        | 0.658         | 0.105         | 0.342         |               | 0.042         | 0.705         | 0.009         | 0.938         |               |               |               |
| Elbow          | 0.168         | 0.126         | 0.206         | 0.060         | 0.300         | 0.006         | 0.220         | 0.045         |               |               |               |               |
| Midarm         | 0.264         | 0.015         | 0.229         | 0.036         | 0.148         | 0.179         | 0.044         | 0.693         |               |               |               |               |
| Ulnar          | Wrist         | 0.020         | 0.855         | 0.135         | 0.219         | 0.262         | 0.016         | 0.237         | 0.030         |               |               |               |
| Mid-forearm    | 0.013         | 0.904         | 0.114         | 0.304         | 0.199         | 0.069         | 0.161         | 0.143         |               |               |               |               |
| Elbow          | 0.114         | 0.303         | 0.160         | 0.146         | 0.081         | 0.463         | -0.015        | 0.889         |               |               |               |               |
| Midarm         | 0.113         | 0.307         | 0.129         | 0.242         | 0.349         | 0.001         | 0.326         | 0.003         |               |               |               |               |
| Fibular        | Fibular head  | 0.257         | 0.018         | 0.123         | 0.265         | 0.343         | 0.001         | 0.328         | 0.002         |               |               |               |
|                | Knee          | 0.140         | 0.205         | 0.159         | 0.149         | 0.299         | 0.006         | 0.246         | 0.024         |               |               |               |
| Tibial         | Knee          | 0.224         | 0.041         | 0.258         | 0.018         | 0.262         | 0.016         | 0.141         | 0.202         |               |               |               |
|                | Ankle         | 0.238         | 0.030         | 0.268         | 0.014         | 0.168         | 0.128         | 0.037         | 0.737         |               |               |               |
| Sural          | -0.179        | 0.103         | -0.030        | 0.785         | 0.143         | 0.196         | 0.190         | 0.084         |               |               |               |               |
| Radial         | 0.022         | 0.846         | -0.067        | 0.545         | 0.031         | 0.779         | 0.069         | 0.532         |               |               |               |               |

BMI: Body mass index
by body weight. Other possible explanations for this difference include socioeconomic differences, for example, occupation and nutritional status, or factors inherent to the individuals such as different nerve structure. In one previous study, Dutch participants were found to have significantly larger MN size compared to Indian participants.\[12,15,16\] In the current study, nerve CSA values were smaller when compared to Caucasian participants\[1,4-6\] but comparable with Asian participants.\[15,16\]

In our study of Malaysian Indian participants, we found the nerve CSA for MN at forearm (5.0 ± 0.9 mm²) and UN at the wrist (3.9 ± 0.9 mm²) were comparable to the values reported by Bathala et al.\[15,16\] in Indian participants from India (4.8 ± 0.9 and 3.6 ± 0.5 mm², respectively). We also compared results from our Malaysian Chinese cohort to studies on Chinese participants from China.\[12\] We found similar results on nerve CSA of the MN at wrist (6.5 ± 1.3 mm²) and UN at forearm (4.4 ± 1.0 mm²) to their reported values (6.4 ± 0.9 and 4.6 ± 0.8 mm², respectively). Other possibilities for differences with Caucasian and Western cohorts could be the effect of temperature on nerve size. One study reported that cold exposure may cause swelling of the nerve.\[20\] Malaysia, being a tropical country, has average temperatures that are higher than that in Western countries.

Nerve size was found to correlate with different demographic factors such as gender, age, height, weight, and BMI at different sites. In the current study, CSA values were higher in men compared to women. This could relate to the fact that men are taller and heavier than women. Our findings are supported by previous reports of gender differences in nerve size\[4,6,11,12\] although this relationship has not been supported by other studies.\[1,9\]

Previous studies have demonstrated a positive correlation between nerve CSA and age.\[1,6-8,12,21,22\] In the current study, we found a similar correlation, and patients who are older had larger nerve CSA. In one Japanese study, the authors found the MN CSA at wrist was positively correlated with age, which was

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**Table 5: Comparison with published normative data in the literature**

| Nerve/site, mean±SD | Current study (n=84) | Cartwright et al. (n=60) | Zaidman et al. (n=90) | Won et al. (n=97) | Kerasnoudis et al. (n=75) | Sugimoto et al. (n=60) |
|---------------------|----------------------|--------------------------|----------------------|----------------------|--------------------------|------------------------|
| MN wrist            | 6.4±1.4              | 9.8±2.4                  | 9.7±1.9              | 8.3±1.5              | 8.4±2.1                  | 8.5±1.7                |
| MN forearm          | 5.2±1.0              | 7.5±1.6                  | 7.9±2.4              | 6.5±1.1              | 6.6±1.6                  | 6.0±1.3                |
| MN elbow            | 6.8±1.5              | 8.6±2.3                  | 8.1±1.6              | 9.1±2.2              |                          |                        |
| MN arm              | 7.1±1.4              | 8.9±2.1                  | 8.9±2.0              | 9.4±1.4              | 8.4±2.9\*                | 8.2±1.7                |
| UN wrist            | 4.0±1.0              | 5.9±1.1                  | 4.3±0.8              | 5.2±1.0              | 4.1±1.0                  |                        |
| UN forearm          | 4.6±1.0              | 6.3±1.0                  | 5.5±1.4              | 6.3±1.0              | 5.5±1.3                  | 4.7±1.0                |
| UN elbow            | 6.1±1.4              | 6.5±0.9                  | 7.3±1.7              | 7.2±1.4              | 5.3±1.4                  | 6.7±1.9                |
| UN arm              | 5.6±1.5              | 6.1±0.9                  | 6.2±1.4              | 5.9±1.1              | 6.5±1.8\*                | 4.8±1.0                |
| FN FH               | 8.9±2.0              | 11.2±3.3                 | 11.7±4.6             | 13.2±1.4             | 8.6±1.8                  |                        |
| FN knee             | 7.5±1.8              | 11.7±4.6                 | 13.9±4.3             | 9.6±4.0              | 6.4±1.5                  |                        |
| TN knee             | 11.8±2.2             | 35.3±10.3                | 10.1±2.0             | 13.7±4.3             | 9.6±4.0                  |                        |
| TN ankle            | 10.1±2.0             | 35.3±10.3                | 9.6±4.0              | 6.4±1.5              |                        |                        |
| SN                  | 1.5±0.6              | 5.3±1.8                  | 3.6±1.1              | 1.8±0.6              |                        |                        |
| RN                  | 1.1±0.3              | 7.9±2.7\*                | 2.0±0.5              | 3.3±1.5\*            |                        |                        |

*Spiral groove, †Axilla. MN: Median nerve, UN: Ulnar nerve, FN: Fibular nerve, TN: Tibial nerve, SN: Sural nerve, RN: Radial nerve, SD: Standard deviation
postulated to be the results of repetitive mechanical stress.\cite{10} However, other studies have refuted this relationship,\cite{2,3,4,9,11} and in one study, the author found a negative correlation.\cite{9}

The relationship between height and nerve CSA has also been varied. Some authors reported a positive correlation,\cite{1,2,9,11,12} whereas others found either no significant correlation\cite{3,4,6-8} or a negative correlation.\cite{10} In the current study, we initially detected a positive correlation, which became nonsignificant once other confounders were considered.

In this study, weight and BMI correlated most frequently with nerve CSA. BMI and weight showed stronger correlation with nerve CSA than height. In support of our findings, previous studies have consistently reported that weight and BMI were correlated with nerve size.\cite{1,6-9,11,12} This was in contrast to a study by Zaidman et al.,\cite{2} in which the author did not find any correlation, whereas Kerasnoudis et al.\cite{3} found an only weak correlation. These findings are important when considering patients who are obese or very thin individuals.

The current study had several limitations. The possibility of subclinical entrapment neuropathy at common sites cannot be entirely excluded. Electrophysiological studies to exclude the effects of demographic factors are helpful in the evaluation of nerve CSA between different assessors may be of value in determining the validity of the mode of investigation.

**CONCLUSION**

The CSA reference values of the common peripheral nerves and differences between ethnic groups are reported. Nerve CSA at certain sites correlated with age, gender, ethnicity, height, weight, and BMI. Of note, the ethnic differences in nerve CSA values in healthy Malaysian participants should be considered during nerve ultrasound. These normal reference values and the effects of demographic factors are helpful in the evaluation of peripheral neuropathy.

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**Conflicts of interest**

There are no conflicts of interest.

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## Supplementary Tables

### Table S1: Demographic data of normal subjects

| Demographic | Total (n=84) |
|-------------|-------------|
| Age (years), mean±SD | 40.0±14.4 |
| Gender, n (%) | | |
| Female | 46 (54.8) |
| Male | 38 (45.2) |
| Ethnic, n (%) | | |
| Malay | 29 (34.5) |
| Chinese | 28 (33.3) |
| Indian | 27 (32.2) |
| Height (m), mean±SD | 1.6±0.1 |
| Weight (kg), mean±SD | 64.7±14.3 |
| BMI (kg/m^2), mean±SD | 24.2±4.8 |

SD: Standard deviation, BMI: Body mass index

### Table S2: Side-to-side differences of nerve cross-sectional area

| Nerve | Site | Mean±SD | P   |
|-------|------|---------|-----|
|       |      | Left    | Right |     |
|       | Median | Wrist | 5.9±1.1 | 6.4±1.4 | 0.001 |
|       | Mid-forearm | 5.2±1.5 | 5.2±1.0 | 0.706 |
|       | Elbow | 6.8±1.5 | 6.8±1.5 | 0.944 |
|       | Midarm | 7.2±1.4 | 7.1±1.4 | 0.225 |
| Ulnar | Wrist | 3.9±0.8 | 4.0±1.0 | 0.446 |
|       | Mid-forearm | 4.4±1.0 | 4.6±1.0 | 0.118 |
|       | Elbow | 6.0±1.3 | 6.1±1.4 | 0.274 |
|       | Midarm | 5.3±1.2 | 5.6±1.5 | 0.040 |
| Fibular | Fibular head | 8.8±2.2 | 8.9±2.0 | 0.654 |
|       | Knee | 7.4±1.9 | 7.5±1.8 | 0.524 |
| Tibial | Knee | 11.5±2.9 | 11.8±2.2 | 0.307 |
|       | Ankle | 10.4±2.5 | 10.1±1.9 | 0.344 |
| Sural | | 1.7±1.1 | 1.5±0.6 | 0.058 |
| Radial | | 1.1±0.5 | 1.1±0.3 | 0.726 |

SD: Standard deviation

### Table S3: Multivariable regression analysis

| Nerve | Site | Age | Ethnic | Gender | Height | BMI | R^2 |
|-------|------|-----|--------|--------|--------|-----|-----|
|       |      | β  | P     | β     | P     | β  | P  |     |
| Median | Wrist | 0.157 | 0.162 | −0.175 | 0.130 | 0.082 | 0.608 | 0.101 | 0.534 | 0.026 | 0.824 | 0.079 |
|       | Mid-forearm | −0.035 | 0.754 | −0.149 | 0.183 | 0.324 | 0.044 | −0.086 | 0.590 | −0.053 | 0.641 | 0.100 |
|       | Elbow | 0.147 | 0.176 | 0.021 | 0.850 | 0.246 | 0.115 | 0.039 | 0.804 | 0.149 | 0.186 | 0.138 |
|       | Midarm | 0.282 | 0.011 | 0.009 | 0.937 | 0.166 | 0.285 | 0.122 | 0.437 | −0.041 | 0.717 | 0.140 |
| Ulnar | Wrist | −0.014 | 0.897 | −0.098 | 0.384 | 0.235 | 0.137 | −0.001 | 0.994 | 0.192 | 0.093 | 0.119 |
|       | Mid-forearm | −0.011 | 0.917 | −0.339 | 0.003 | 0.111 | 0.469 | 0.117 | 0.449 | 0.121 | 0.272 | 0.165 |
|       | Elbow | 0.131 | 0.252 | −0.026 | 0.827 | 0.073 | 0.654 | 0.119 | 0.471 | −0.055 | 0.641 | 0.045 |
|       | Midarm | 0.055 | 0.607 | −0.111 | 0.321 | 0.064 | 0.681 | 0.118 | 0.451 | 0.297 | 0.009 | 0.142 |
| Fibular | Fibular head | 0.206 | 0.056 | −0.013 | 0.905 | 0.068 | 0.655 | 0.091 | 0.555 | 0.274 | 0.014 | 0.166 |
|       | Knee | 0.100 | 0.363 | −0.151 | 0.183 | 0.021 | 0.891 | 0.186 | 0.242 | 0.214 | 0.061 | 0.119 |
| Tibial | Knee | 0.225 | 0.036 | 0.061 | 0.574 | 0.294 | 0.056 | 0.049 | 0.749 | 0.048 | 0.660 | 0.171 |
|       | Ankle | 0.254 | 0.019 | −0.158 | 0.153 | 0.097 | 0.524 | 0.246 | 0.114 | −0.039 | 0.722 | 0.166 |
| Sural | | −0.220 | 0.037 | −0.296 | 0.007 | 0.179 | 0.233 | −0.090 | 0.551 | 0.180 | 0.097 | 0.201 |
| Radial | | −0.005 | 0.965 | −0.244 | 0.037 | −0.236 | 0.144 | 0.154 | 0.951 | 0.096 | 0.406 | 0.075 |

BMI: Body mass index