

# The Determination of Upper Extremity Anthropometric Measurements in Healthy Subjects Aged Between 18-25 Years

## 18-25 Yaş Arası Sağlıklı Kişilerde Üst Ekstremitte Antropometrik Ölçümlerin Belirlenmesi

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### Abstract

**Background:** The present study was aimed to analyze the morphometric measurements of upper extremity dimensions and estimate the total body surface area, hand and palm area in healthy subjects aged between 18-25 years.

**Materials and Methods:** After taking hand tracing, the length and width measurements were performed, and hand-palm indexes were calculated from 407 adult subjects (243 females; 164 males) aged 18 to 25 years. Also, arm span, height and weight were measured. Additionally, total body surface area was calculated using DuBois Formula and hand and palm area was estimated from hand tracing and the percent of hand and palm surface area were formulated.

**Results:** In females, the mean values of age, weight, height, BMI and arm span were found as 19.68±2.42 years, 55.96±8.32 kg, 164.12±5.93 cm and 20.79±3.03 kg/m<sup>2</sup> and 1.60±0.06 m, respectively, whereas the same values were 20.22±3.40 years, 71.48±11.98 kg, 176.96±6.26 cm, 22.80±3.44 kg/m<sup>2</sup>, and 1.76±0.05 m, respectively in males. Moreover, the significant difference was found between measurements such as height, weight, body mass index and arm span and gender. Total body surface area was estimated as 1.88±0.16 m<sup>2</sup> and 1.60±0.12 m<sup>2</sup> in males and females, respectively. Also, hand area of males was found as 156.31±11.25 m<sup>2</sup> and 154.71±11.92 m<sup>2</sup> in right and left side, respectively, whereas the corresponding value of females was measured as 128.15±11.14 m<sup>2</sup> and 125.56±10.80 m<sup>2</sup> in right and left side, respectively. Palm area of males was estimated 88.30±8.11 m<sup>2</sup> and 87.52±8.61 m<sup>2</sup> in right and left side, respectively. The same values of females were 71.51±6.19 m<sup>2</sup> and 70.24±1.60 m<sup>2</sup> in right and left side, respectively. However, there were significant difference in measurements of hand area, palm area, total body surface area, the percents of hand and palm surface area between gender. The hand index was found as 42.33±2.97 (right), 41.67±2.91 (left) in females, whereas the same values were established as 41.95±3.56 (right) and 42.03±2.64 (left) in males.

**Conclusions:** The observations presented in present study, can provide principal knowledge about anatomic parameters. They need to be taken into consideration when surgical procedures are performed in hand region for female and male population. Also, the total body surface area, the percents of hand and palm surface area, hand and palm area values help to determine burns area, or extent of burn and wounds. Moreover, we can say that differences between measurements can depend on some factors such as gender, age, race, ethnic groups, geographical situations.

**Key Words:** Anatomy, Hand index, Hand and palm area, Total body surface area

### Öz

**Amaç:** Bu çalışmada, 18-25 yaş arası sağlıklı bireylerde üst ekstremitte ile ilgili morfometrik ölçümlerin incelenmesi ve tüm vücut yüzey alanı ile el ve el ayası alanının hesaplanması amaçlandı.

**Materyal ve Metod:** El izi ölçümleri alındıktan sonra, 18-25 yaşları arasındaki 407 yetişkin bireyin (243 kadın; 164 erkek) uzunluk ve genişlik ölçümleri yapıldı ve el-el ayası indeksleri hesaplandı. Ayrıca, kulaç uzunluğu, boy uzunluğu ve vücut ağırlığı ölçüldü. Total vücut yüzey alanı, DuBois Formülü kullanılarak hesaplandı ve el-el ayası alanı hesaplandı. El-el ayasının total vücut yüzey alanına oranları belirlendi.

**Bulgular:** Kadınlarda yaş, vücut ağırlığı, boy uzunluğu, BKİ ve kulaç uzunluğu ortalama değerleri sırasıyla; 19,68±2,42 yıl, 55,96±8,32 kg, 164,12±5,93 cm, 20,79±3,03 kg/m<sup>2</sup> ve 1,60±0,06 cm olarak bulundu. Aynı değerler erkeklerde sırasıyla; 20,22±3,40 yıl, 71,48±11,98 kg, 176,96±6,26 cm, 22,80±3,44 kg/m<sup>2</sup> ve 1,77±0,05 cm olarak ölçüldü. Ayrıca, boy uzunluğu, vücut ağırlığı, vücut kitle indeksi ve kulaç uzunluğu ölçümlerinde cinsiyetler arasında anlamlı farklılık bulundu. Toplam vücut yüzey alanı kadınlarda ve erkeklerde sırasıyla 1.88±0.16 m<sup>2</sup> ve 1.60±0.12 m<sup>2</sup> olarak hesaplandı. Ayrıca, erkeklerde el alanı sağ ve sol tarafta sırasıyla 156.31±11.25 m<sup>2</sup> ve 154.71±11.92 m<sup>2</sup> olarak bulundu. Aynı parametre kadınlarda sırasıyla sağ ve sol tarafta 128.15±11.14 m<sup>2</sup> ve 125.56±10.80 m<sup>2</sup> olarak ölçüldü. Erkeklerde el ayası alanı sağ ve sol tarafta sırasıyla 88.30±8.11 m<sup>2</sup> ve 87.52±8.61 m<sup>2</sup> olarak değerlendirildi. Aynı ölçümler kadınlarda sağ ve sol tarafta sırasıyla 71.51±6.19 m<sup>2</sup> ve 70.24±1.60 m<sup>2</sup> olarak bulundu. Bununla birlikte, toplam vücut yüzey alanı, el alanı, el ayası alanı, el-el ayası yüzey alanı oranı cinsiyetler arasında anlamlı farklılık vardır. El indeksi kadınlarda 42,33±2,97 (sağda), 41,67±2,91 (solda) bulunurken, erkeklerde aynı değerler 41,95±3,56 (sağda) ve 42,03±2,64 (solda) olarak belirlendi.

**Sonuç:** Bu çalışmada sunulan değerlendirmeler, anatomik parametreler hakkında temel bilgiler sağlayabilir. Ayrıca kadın ve erkek popülasyonu için el bölgesinde gerçekleştirilmesi düşünülen cerrahi işlemlerin planlanmasında dikkate alınabilir. Ayrıca, toplam vücut yüzey alanı, el-el ayası yüzey alan oranları, el, el ayası alanı değerleri yanık bölgesi, yanık boyutu ve yaralanma düzeyini belirlemeye yardımcı olur. Ölçüm sonuçları arasındaki farklılıkların ise cinsiyet, yaş, ırk, etnik gruplar, coğrafi durumlar gibi bazı faktörlere bağlı olabileceğini söyleyebiliriz.

**Anahtar Kelimeler:** Anatomi, El indeksi, El ve el ayası alanı, Toplam vücut yüzey alanı

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## Introduction

The internal structure of hand is variety of bones, muscles, nerves, and veins. The hand is primarily formed twenty seven bones and it divided into three groups named as eight carpals, five metacarpals and fourteen phalanges. Carpals play an important role in backwards and forwards movement of hand/wrist; whereas metacarpals which are five in number, are located in palm. The fourteen phalanges divided into three groups called as proximal, medial and distal (1-3). The two phalanges are located in thumb; whereas, three phalanges are in each four fingers. Bones are the most significant part of the human hand and function for about all the activities of the hand (3).

Hand suffers damage from industrial hazard nearly in the ratio of 1/3. It is declared hand is connected with brain development in anthropology and thumb plays a significant role in fine motor skills (1). Hand measurement parameters are essential for planning surgical procedure in design of hand held objects. In addition, hand anthropometric measurements are suitable parameters for sports of rowing, and judo as well as sports of handball, volleyball and basketball. They play a crucial role in grip and these parameters helps to evaluate which sports branch can be more suitable for the athletes/subjects (4-10).

Hand anthropometric measurements give important information in design of hand-held devices such as surgical stapler, computer mice and lantoscopic devices. The design of hand-held devices requires especially finger anthropometry providing fine motor skills and especially thumb is a key point in fine motor skills (1,11). Amirshaybani et al reported that hand length could be a good predictor of the body surface area independent of the gender (12). Also, the human palm is defined as the inner portion of the hand starting from the wrist to the root of the fingers (3). Additionally, index finger morphometry is an important parameter and can explain hand movement and help in determining finger motive forces of index finger dominant hand-held devices (11).

Body surface area is a significant measurement method in administration of drugs in the normalization of physiological responses, and in systems design inherent in study of clinicians, physiologist, and ergonomists (13,14). The total BSA is commonly used in scientific studies and clinical practice to standardize various measurements related with cardiac function, body heat transfer, renal function, body metabolism, body aerodynamics and hydrodynamics in sports, toxicology, development of manual equipments in ergonomics and the drug dosage in chemotherapy (14-17). Also, hand surface area (HSA) measurements are an easy, practical method for evaluation the burns magnitude (18). HSA is mostly estimated as %1 of total body surface area, while palmar surface area (PSA) is predicted as %0.5 or %1 of total body surface area for adults (18,19). Hand sur-

face area, and palm surface area are crucial reference regions in clinical practice such as physiology and medicine. These play role in emergency room for determination of burned skin area in burn therapy and skin grafting (14,19). The objective of this study is to investigate and to provide data about hand morphometry such as the length of hand (HL), the width of hand (HW), the length of thumb (TL), index finger length (IFL), hand index, the length of palm, and arm span in our population. Also, this study is aimed to measurements of the total body surface area, the persents of hand and palmar surface area, the hand area and palm area in our healthy population and compare them to the other population.

## Materials and Methods

Bilateral hand tracing were obtained from 407 adult subjects (243 females, 164 males) between 18 and 25 years of age with no history of trauma or congenital anomalies. Each individual was asked to place her/his hand in suitable position to measure on a paper. A hand tracing was made by a pen. The following parameters were measured using electronic digital caliper, and non-elastic tape measure.

**Hand length:** The subjects were asked to place their hand on paper with the palm facing upwards with fingers extended and adducted and the tracing made from the radial styloid process to ulnar styloid process. A line was drawn between radial and ulnar styloid process. This line was determined as interstyloid line. It was measured from the midpoint of the interstyloid line to distal tip of the middle finger (14,20-22).

**Hand width:** The distance between the radial side of the second metacarpal joint to the ulnar side of the fifth metacarpal joint were measured and recorded as mm (8,23).

After these measurements, hand shape (hand index) was measured by dividing the hand width by hand length and multiplied by 100 (23).

**Palm length:** The distance between the midpoint of the distal wrist crease and the base of the middle finger (5,23).

**Thumb length:** The distance from the base of the finger to distal tip of the thumb was measured (23).

**Index finger length:** The distance from the base of the index finger to distal tip of the index finger was measured (23).

After these measurements obtained from hand tracing, body surface area, hand area, palm area, and the persents of hand and palm surface area were estimated.

Body surface area was calculated using DuBois Formula  $[0.007184 \cdot (\text{body height in cm}^{0,725}) \cdot (\text{body weight in kg}^{0,425})]$  (12,14,18,19).

Hand width was multiplied with the hand length and palm to calculate hand and palm area, respectively (14).

**Arm span:** The distance was measured from the tip of the middle finger of one hand to the tip of the middle finger of the other hand with the subject standing with their back to the wall with both arms abducted to 90°, the elbows and

wrists extended and the palms facing directly forward (24). Body height: The distance between floor and the highest point on the head when subject was in standard standing position (21). Also, the body mass index (BMI) was calculated from height and weight ( $\text{kg}/\text{m}^2$  formula) (14).

This study was approved by the Institutional Review Ethics Committee at Cukurova University. (Ethics Committee number 10 and date 10 November, 2017). The research study was explained to each participant prior to data collection. All subjects signed the informed consent form before taking part in study.

### Statistical Analysis

The SPSS 22.0 program was used for statistical analysis of the measurement results. From these measurements, means, standard deviations (SD), minimum and maximum values were calculated. Normality were evaluated by Shapiro Wilks test and the data tested were normally distributed ( $p > 0.05$ ). Also, one way ANOVA test were one of the parametric tests were chosen to determine the significance between gender. The Pearson Correlation analysis were performed to assess the relation between measurements. Additionally, the  $p < 0.05$  value was considered as significant.

### Results

The records of 407 healthy females and males aged between 18-25 years were assessed. The mean and standard deviation values of age, weight, height, BMI and arm span measurements were found to be,  $19.68 \pm 2.42$  years,  $55.96 \pm 8.32$  kg,  $164.12 \pm 5.93$  cm,  $20.79 \pm 3.03$   $\text{kg}/\text{m}^2$  and  $1.60 \pm 0.06$  m in females, whereas the same values were  $20.22 \pm 3.40$  years,  $71.48 \pm 11.98$  kg,  $176.96 \pm 6.26$  cm,  $22.80 \pm 3.44$   $\text{kg}/\text{m}^2$  and  $1.77 \pm 0.05$  m in males respectively (Table 1). The significant difference were found in height, weight, body mass index and arm span. The hand anthropometric values of adult subjects were shown in Table 2. Moreover, there were significant difference in phalanx I length, phalanx II length, hand width, hand length, and palm length between females and males. The hand index were found as  $42.33 \pm 2.97$  (right),  $41.67 \pm 2.91$  (left) in females, whereas the same values were established as  $41.95 \pm 3.56$  (right) and  $42.03 \pm 2.64$  (left) in males (Table 2). Total body surface area was estimated as  $1.88 \pm 0.16$   $\text{m}^2$  and  $1.60 \pm 0.12$   $\text{m}^2$  in males and females, respectively. Also, hand surface area of males was found as  $156.31 \pm 11.25$   $\text{m}^2$  and  $154.71 \pm 11.92$   $\text{m}^2$  in right and left side, respectively, whereas the corresponding value of females was measured as  $128.15 \pm 11.14$   $\text{m}^2$  and  $125.56 \pm 10.80$   $\text{m}^2$  in right and left side, respectively. Palm surface area of males was estimated  $88.30 \pm 8.11$   $\text{m}^2$  and  $87.52 \pm 8.61$   $\text{m}^2$  in right and left side, respectively. The same values of females were  $71.51 \pm 6.19$   $\text{m}^2$  and  $70.24 \pm 6.19$   $\text{m}^2$  in right and left side, respectively.

**Table 1.** Demographic data in healthy subjects aged between 18-25 years

Measurement	Age (years)	Height (cm)	Weight (kg)	Body mass index ( $\text{kg}/\text{m}^2$ )	Arm span (m)	
Gender	Female (243)	$19.68 \pm 2.42$	$164.12 \pm 5.93$	$55.96 \pm 8.32$	$20.79 \pm 3.03$	$1.60 \pm 0.06$
	Male (164)	$20.22 \pm 3.40$	$176.96 \pm 6.26$	$71.48 \pm 11.98$	$22.80 \pm 3.44$	$1.77 \pm 0.05$
P	0.060	<0.001	<0.001	<0.001	<0.001	

cm: centimeter; kg: kilogram; m: meter; P: significant value

**Table 2.** The hand anthropometric values in healthy adult females and males

Measurements	Female (243)	Male (164)	P
Phalanx I length right (mm)	$60.33 \pm 7.43$	$63.92 \pm 9.08$	<0.001
Phalanx I length left (mm)	$59.80 \pm 7.76$	$63.56 \pm 9.27$	<0.001
Phalanx II (index finger) length right (mm)	$71.85 \pm 6.04$	$75.51 \pm 6.59$	<0.001
Phalanx II (index finger) length left (mm)	$71.85 \pm 6.04$	$75.11 \pm 6.04$	<0.001
Hand width right (mm)	$73.51 \pm 3.61$	$81.01 \pm 2.93$	<0.001
Hand width left (mm)	$72.22 \pm 4.08$	$80.55 \pm 4.23$	<0.001
Hand length right (cm)	$174.22 \pm 10.75$	$192.86 \pm 10.74$	<0.001
Hand length left (mm)	$173.76 \pm 9.59$	$191.97 \pm 8.85$	<0.001
Palm length right (mm)	$97.208 \pm 5.914$	$108.90 \pm 7.79$	<0.001
Palm length left (mm)	$97.214 \pm 5.857$	$108.56 \pm 7.45$	<0.001
Hand index right	$42.33 \pm 2.97$	$41.95 \pm 3.56$	0.249
Hand index left	$41.67 \pm 2.91$	$42.03 \pm 2.64$	0.202

mm: millimeter; p: significant value

**Table 3.** The area surface measurements in healthy females and males

Measurements	Female (243)	Male (164)	P
Total body surface area ( $0.007184 * (\text{height}^{0.725}) * (\text{weight}^{0.425}) \text{ m}^2$ )	$1.60 \pm 0.12$	$1.88 \pm 0.16$	<0.001
Hand area (right) $\text{m}^2$	$128.15 \pm 11.14$	$156.31 \pm 11.25$	<0.001
Hand area (left) $\text{m}^2$	$125.56 \pm 10.80$	$154.71 \pm 11.92$	<0.001
Palm area (right) $\text{m}^2$	$71.51 \pm 6.19$	$88.30 \pm 8.11$	<0.001
Palm area (left) $\text{m}^2$	$70.24 \pm 6.19$	$87.52 \pm 8.61$	<0.001
Hand surface area right (% of total surface area)	$0.80 \pm 0.07$	$0.84 \pm 0.07$	<0.001
Hand surface area left (% of total surface area)	$0.79 \pm 0.07$	$0.83 \pm 0.07$	<0.001
Palm surface area right (% of total surface area)	$0.45 \pm 0.04$	$0.47 \pm 0.05$	<0.001
Palm surface area left (% of total surface area)	$0.44 \pm 0.04$	$0.47 \pm 0.05$	<0.001

m: meter; P: significant value

However, there were significant difference in measurements of the total body surface area, hand area, palm area and the persents of hand and palm surface area between two gender (Table 3). The right and left side comparisons of measurements in healthy adult females and males were shown in Table 4. Additionally, according to the comparison of right and left measurements there were significant

difference in all parameters (except palm length). The correlation analysis of hand and phalanx measurements were shown in Table 5.

**Table 4.** The right and left side comparison of measurements in adult females and males

Measurements	P
Phalanx I length (mm)	<0.001
Phalanx II (index finger) length (mm)	=0.001
Hand width (mm)	<0.001
Hand length (mm)	=0.023
Palm length (mm)	=0.124
Hand index	0.004
Hand area m <sup>2</sup>	<0.001
Palm area m <sup>2</sup>	<0.001
Hand surface area left (% of total surface area)	<0.001
Palm surface area left (% of total surface area)	<0.001

mm:millimeter; p:significant value; %:percent

## Discussion

The human hand is incomparable structure in habitual locomotor duty and functions of manipulation. The importance of hand in these activities is due to special arrangement of the bones and muscles. Hand play an important role in both special motor tasks and transmission of sensory information such as temperature, figure, characteristic of objects to the brain (5). Hand anthropometric measurements give important information in design of hand-held devices such as surgical stapler, computer mice and lant-hoscopic devices. The design of hand-held devices requires especially finger anthropometry providing fine motor skills and especially thumb provides critical information in fine motor skills (1,11). Hand length parameter was found as  $156.11 \pm 0.86$  mm and  $172.76 \pm 0.84$  mm in Malay female and male, whereas the same parameter was  $157.58 \pm 1.05$  mm and  $168.36 \pm 0.84$  mm in females and males of Chinese population (21). In Swedish males the same measurement was reported as 19.3 cm (right) and 19.4 cm (left) (25). Moreover, in a study performed in three different regions from Nigeria, the hand length of females was 19.85 cm in Hausa population, 19.97 cm in Igbo population, 19.27 cm in Yoruba population. The corresponding value was found as 20.62 cm in Hausa region, 20.22 cm in Igbo area and 19.55 cm in Yoruba region (26). In several papers from different populations, it was declared that the hand length value as  $17.00 \pm 0.80$  cm and  $18.30 \pm 1.10$  cm in Malay females and males (27); 18.00 cm and 19.00 cm Indonesia females and males; 17.00 and 19.00 cm in Singaporean females and males (28);  $17.95 \pm 3.44$  cm and  $19.75 \pm 7.82$  cm in Phillipino females and males (6); 17.3 cm and 18.4 cm in Thailand female and male (29). However, this dimension ranged from  $159.56 \pm 0.70$  mm –  $171.4 \pm 6.70$ ; to  $178.04 \pm 0.85$  mm  $188.3 \pm 10.9$  in Indian females and males (4,21). Additionally, the hand length was

$174.22 \pm 10.75$  mm (R) –  $173.76 \pm 9.59$  mm (L) and  $192.86 \pm 10.74$  mm- $191.97 \pm 8.85$  mm in this study. We found some differences in the mean value of hand length of Indians, Malays, Chinese, Indonesia, and Thailand with our population; having lower than Turks. From this data, our results are close to Singaporean, Philippines, and Sweden population.

The hand width was reported as 8.1 cm ve 7.2 cm in Malay males and females, respectively; whereas the same parameter was measured as 9.00 cm ve 8.00 cm in Indonesia males and females. The same parameter was declared as 9.80 cm ve 9.20 cm in Phillipine males and females, while the hand width was 7.8 cm in Thai females, respectively (6,27-29). In Nigerian population the same parameter was found as 9.73 cm and 9.00 cm in Hausa males and females; 9.57 cm and 9.22 cm in males and females in Nigeria Igbo region; 9.57 cm and 9.38 cm in Nigeria Yoruba male and female population (26). In present paper, the same measurement of female subjects was measured as  $73.51 \pm 3.61$  mm and  $72.22 \pm 4.08$  mm in right and left side; whereas, this parameter of males was  $81.01 \pm 2.93$  mm and  $80.55 \pm 4.23$  mm in right and left side. Our results are different from Indonesia, Philipines, Thai and Nigeria population; having higher than Turkish population Conversely, our results are similar to Malay males.

In Kosovan male and female subjects aged between 18-20 years, the mean value of the arm span were  $1.81 \pm 0.07$  m and  $1.65 \pm 0.06$  m, respectively. The stature measurement were less than arm span values (1.68 m) in males, whereas, in females the corresponding value were similar to height value (30). The arm span measurement was found 1.73 m and 1.64 m in Nigerian males and females, respectively. The stature value was less than arm span 0.055 m and 0.039 m in males and females, respectively (31). The corresponding measurement of Serbian females and males is 1.70 m and 1.85 m, respectively (32). In Indian females and males, the arm span was found range from 1.59 m to 1.61 m; from 1.71 m to 1.76 m, respectively (24,33). In Nepal females and males, the same dimension was 1.59 m and 1.68 m, respectively (34). In this study, the same value was measured as  $1.60 \pm 0.06$  m and  $1.77 \pm 0.05$  m in females and males, respectively. The mean value of arm span were less than stature measurement as average 0.04 in females, whereas the mean value of arm span were close to height.

In Italian females, the palm length was found as  $105.26 \pm 4.41$  mm and  $105.83 \pm 4.71$  mm in right and left side (right handers), whereas the same value was  $104.87 \pm 3.51$  and  $105.87 \pm 4.99$  mm in right and left side (left handers). In Italian males, the corresponding value was  $96.05 \pm 4.19$  mm and  $95.93 \pm 4.33$  mm in right and left side (right handers), whereas the same dimension was  $97.03 \pm 4.92$  mm and  $96.18 \pm 5.09$  mm in right and left side (left handers) (35).

**Table 5.** Correlation analysis of hand anthropometric data of hand in adult subjects

r	Gender	H	W	BMI	AS	PL <sub>R1</sub>	PL <sub>L1</sub>	PL <sub>R2</sub>	PL <sub>L2</sub>	HW <sub>R</sub>	HW <sub>L</sub>	HL <sub>R</sub>	HL <sub>L</sub>	EA <sub>R</sub>	EA <sub>L</sub>	HI <sub>R</sub>	HI <sub>L</sub>
H	-0.721	1	0.634	0.143	0.799	0.229	0.229	0.425	0.436	0.618	0.603	0.747	0.752	0.648	0.653	-0.240	-0.116
W	-0.608	0.634	1	0.851	0.613	0.088	0.090	0.278	0.271	0.573	0.597	0.548	0.565	0.497	0.498	-0.078	0.070
BMI	-0.295	0.143	0.851	1	0.246	-0.032	-0.029	0.081	0.065	0.323	0.358	0.206	0.225	0.210	0.208	0.057	0.158
ASL	-0.816	0.799	0.613	0.246	1	0.235	0.231	0.368	0.382	0.690	0.659	0.702	0.671	0.585	0.582	-0.139	0.038
PL <sub>R1</sub>	-0.212	0.229	0.088	-0.032	0.235	1	0.974	0.210	0.242	0.203	0.154	0.163	0.202	0.256	0.265	0.021	-0.030
PL <sub>L1</sub>	-0.215	0.229	0.090	-0.029	0.231	0.974	1	0.204	0.237	0.218	0.166	0.169	0.204	0.256	0.271	0.026	-0.019
PL <sub>R2</sub>	-0.276	0.425	0.278	0.081	0.368	0.210	0.204	1	0.928	0.374	0.399	0.466	0.471	0.368	0.369	-0.159	-0.049
PL <sub>L2</sub>	-0.283	0.436	0.271	0.065	0.382	0.242	0.237	0.928	1	0.384	0.395	0.482	0.492	0.368	0.367	-0.165	-0.076
HW <sub>R</sub>	-0.740	0.618	0.573	0.323	0.690	0.203	0.218	0.374	0.384	1	0.872	0.587	0.624	0.613	0.597	0.241	0.327
HW <sub>L</sub>	-0.703	0.603	0.597	0.358	0.659	0.154	0.166	0.399	0.395	0.872	1	0.564	0.592	0.571	0.559	0.161	0.504
HL <sub>R</sub>	-0.649	0.747	0.548	0.206	0.702	0.163	0.169	0.466	0.482	0.587	0.564	1	0.917	0.785	0.780	-0.569	-0.341
HL <sub>L</sub>	-0.694	0.752	0.565	0.225	0.671	0.202	0.204	0.471	0.492	0.624	0.592	0.917	1	0.837	0.839	-0.427	-0.395
PL <sub>R</sub>	-0.649	0.648	0.497	0.210	0.585	0.256	0.256	0.368	0.368	0.613	0.571	0.585	0.837	1	0.980	-0.308	-0.247
PL <sub>L</sub>	-0.649	0.653	0.498	0.208	0.582	0.265	0.271	0.369	0.367	0.597	0.559	0.780	0.839	0.980	1	-0.310	-0.263
HI <sub>R</sub>	0.057	-0.240	-0.078	0.057	-0.139	0.021	0.026	-0.159	-0.165	0.241	0.161	-0.569	-0.427	-0.308	-0.310	1	0.647
HI <sub>L</sub>	-0.063	-0.116	0.070	0.158	0.038	-0.030	-0.019	-0.049	-0.076	0.327	0.504	-0.341	-0.395	-0.247	-0.263	0.647	1

H:height; W:weight; BMI: body mass index; ASL: Arm span length; PLR1: phalanx length I right side; PLL1: phalanx length I left side; PLR: phalanx length II right side; PLL: phalanx length II left side; HWR: hand width right side; HWL: hand width left side; HLR: hand length right side; HLL: hand length left side; PLR: palm length right side; PLL: palm length left side; HIR: hand index right side; HIL: hand index left side

In our population, palm length was found as 97.208±5.914 mm and 97.214±5.857 mm in right and left side, respectively in female subjects. The same dimension of male subjects was measured as 108.90±7.79 mm and 108.56±7.45 mm in right and left side, respectively.

In right handers, thumb length measurement of Italian male population was given as 63.02± 4.52 mm and 62.55± 4.33 mm in right and left side, whereas the same dimension was reported as 63.14± 3.85 mm and 62.43± 5.26 mm in right and left side (left handers). In right handers, the same dimension of Italian female subjects was measured as 56.94 ± 3.33 mm and 56.44± 3.52 mm in right and left side, whereas in left handers the corresponding value was 57.33 ±4.59 mm and 56.33± 5.05 mm in right and left side (35). In right handers, index finger length measurement of Italian male population was declared as 71.39 ±3.44 mm and 71.86±3.46 mm in right and left side, whereas the same dimension was found as 71.14 ±5.01 mm and 72.43 ±4.79 mm in right and left side (left handers). In right handers, the same dimension of Italian female subjects was measured as 66.38± 3.15 mm and 66.25± 3.20 mm in right and left side, whereas in left handers the corresponding value was 67.50 ±2.88 mm and 67.83±2.64 mm in right and left side (35). In Korean female and male population the thumb length value was found 56.08±3.49 mm and 61.23±3.94 mm, respectively, whereas the index finger length of female and male Korean population was measured as 66.26±4.28 mm and 70.48±4.33 mm, respectively (36). In

this paper, the thumb length (60.33±7.43 mm and 59.80±7.76 mm) and index finger length values (71.85±6.04 mm and 71.85± 6.09 mm) was found in female subjects, whereas in males the thumb length (63.92±9.08 mm and 63.56±9.27 mm) and index finger length (75.51±6.59 mm and 75.11±6.04 mm) were measured, respectively. According to this data, our thumb and index finger length values are greater than Italian and Korean subjects.

In Egyptian population, the hand index was measured as 39.54 ±1.50 and 39.51±1.59 in right and left side (female); 41.78±1.51 and 41.79±1.44 (male) in right and left side, respectively (37). In Nigerian male and female population, the corresponding value was 44.68±0.19 and 43.29±0.19, respectively (38). In Saudi population, the same dimension was measured as 42.87 ± 1.32 and 42.87 ± 1.29 (female) in right and left side; 39.95 ± 1.74 and 39.91 ± 1.79 (male) in right and left side, respectively (39). Our results (41.95±3.56 and 42.03±2.64; 42.33±2.97 and 41.67±2.91) are different from Egyptian, Nigerian and Saudi population. In Amirshaybani et al's study performed with Americans the mean value of total body surface area was calculated as 1.84m<sup>2</sup> and 1.68m<sup>2</sup> in male and females, respectively (12). Tikuisis et al reported as 2.03 m<sup>2</sup> and 1.73 m<sup>2</sup> in males and females, respectively (13). The corresponding value of Chinese adults was found as 1.83m<sup>2</sup> and 1.57m<sup>2</sup> in males and females, respectively (18). In Indians, the mean

of same value was reported as 1.59m<sup>2</sup> and 1.44m<sup>2</sup> in males and females (17). This parameter was 1.88m<sup>2</sup> and 1.64m<sup>2</sup> in males and females, respectively in Belgium (16). In Göker and Bozkir's study performed with 294 healthy subjects aged between 18-25 years, the same parameter was reported as 1.90m<sup>2</sup> and 1.63m<sup>2</sup> in males and females, respectively (14). According to literature data, our results of males (1.88 m<sup>2</sup> in males) are different from Americans, Indians, Chinese, and Turkish population. The values of Americans, Indians and Chinese population are lower than our study. The value of Belgium are similar to our males' finding. Also, our data of females (1.60 m<sup>2</sup> in females) is lower than American, Turkish and Belgium population. In a study of performed with 300 Indian adults by Agarwal and Sahu hand area was reported as 146.50 m<sup>2</sup> and 132.42 m<sup>2</sup> in males and females respectively, whereas palm area was indicated as 77.85cm<sup>2</sup> and 73.66cm<sup>2</sup> in males and females, respectively (17). Choi et al reported the hand area as 119.50 m<sup>2</sup> (19). In a study performed with Turkish population, the hand area was found as 158.34 m<sup>2</sup> and 127.87 m<sup>2</sup> in males and females, respectively; while palm area was calculated as 82.98 cm<sup>2</sup> and 63.91 cm<sup>2</sup> in males and females, respectively (14). The mean hand area [(right side; 156.31 cm<sup>2</sup>, males; 128.15 cm<sup>2</sup>, females; left side; 154.71 cm<sup>2</sup>, males; 125.56 cm<sup>2</sup>, females)], and palm area [(right side; 88.30, males; 71.51, females; left side; 87.52, males; 70.24, females)] values of the present study were higher than Indian males, lower than females. Also, our findings were similar to Turkish population. In a study performed with male and female Indians of Agarwal and Sahu's, the ratio of the HSA to BSA were found as 0.9223 and 0.9216, respectively (17). The HSA/BSA value was 0.76 and 0.73 in Chinese male and female population, respectively (18). Amirshaybani et al stated as 0.85 and 0.79 in American males and females, respectively (12). In Korean adults the corresponding value was 0.66 (19). Göker and Bozkir declared this parameter as 0.83 and 0.78 in males and females, respectively (14). In present study, the same parameter was estimated as 0.84 (right) - 0.83 (left) and 0.80 (right) - 0.79 (left) in Turkish males and females, respectively. Due to the these reports, we found some differences in mean values of Indian and Korean populations compared with our results: Indians have greater values than us. Koreans have lower values than us. Also, Americans and Turkish population' values are closer to that the report from our results. In a study performed with male and female Indians of Agarwal and Sahu's, the ratio of the PSA to BSA were found as 0.49 and 0.51 Indian males and females, respectively (17). In Turkish males and females aged between 18-25, the same value was estimated as 0.43 and 0.39, respectively (14). In present study, the same parameter was estimated as 0.47 (right side)-0.47 (left side) and 0.45 (right side)-0.44 (left side) in Turkish

males and females, respectively. Additionally, these differences in measurements can arise from race, gender, age, genetic factors, and methodology.

As a result, we believe that the data obtained in present study can provide principal information for hand morphometry and may help the orthopaedic surgeons and rheumatologists design for having a successful surgery and minimize the related problems. Also, we think that the hand region besides the importance of ergonomics, becomes even more important in the motion of the fine motor skills, hand implantation and orthopaedic surgery for determining the value of the muscle strength should be in this area and also our study will make a significant contribution to the literature about the hand morphometry and anatomy what anthropometric measurements must be in healthy subjects in our population. Also, surface area measurements like hand, palmar and total body help to determine burns area, or extent of burn and wounds.

*This study was approved by the Institutional Review Ethics Committee at Cukurova University. (Ethics Committee number: 70/10 and date 10 November, 2017).*

#### Conflict of Interest

*The authors declare that there is no financial support and there is no conflict of interest*

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