Int. J. Morphol.,
42(4):991-998, 2024.

Evaluation of Hand Morphometry in Healthy Young Individuals from Different Countries

Evaluación de la Morfometría de la Mano en Individuos Jóvenes Sanos de Diferentes Países

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SAHIN, N. E.; BAKICI, R. S.; TOY, S. & ONER, Z. Evaluation of hand morphometry in healthy young individuals from different countries. *Int. J. Morphol., 42(4)*:991-998, 2024.

SUMMARY: This study aims to examine the hand morphometry of healthy young individuals from different countries and investigate the differences between countries in typing of hand based on the morphometric values obtained. In the study, 16 different parameters, including two surface areas and 14 lengths, were measured from the right hand of 579 volunteers (250 females, 329 males) from 7 different countries (Turkey, Chad, Morocco, Gabon, Kazakhstan, Senegal and Syria). Factor analysis was performed on the parameters, cluster analysis was performed according to the factor score obtained, and the hand types in the study were determined. As a result of the study, four different hand types were defined, and the distribution of these types according to countries was analyzed. All parameters showed significant differences between countries in both genders ($p<0.05$). According to the results of the study, there was a difference between male and female hand types between countries. In females, the type 1 hand type was found only in Gabon, the type 2 hand type was found only in Senegal, the type 3 hand type was found in Turkey, Morocco and Kazakhstan, while the type 4 hand type was significantly distributed in Senegal and Gabon ($X^2 =104.62$; df=18, $p<0.05$). In males, type 1 hand type was found in Turkey, type 2 hand type in Senegal and Gabon, type 3 hand type in Turkey, while type 4 hand type was significantly distributed in Morocco and Kazakhstan ($X^2 =76.964$; df=18, $p<0.05$).

KEY WORDS: Hand morphometry; Hand typing; Anthropology; Geographic variation; Cluster analysis.

INTRODUCTION

Anthropometric data is a basic requirement for the design of machines and systems. The integration of this data enables user-friendly, secure and high-performance designs (Anema *et al*., 2004). Anthropometry is a comprehensive field within the discipline of ergonomics that studies the interactions between the dimensions of the human body and spatial and technical systems applicable in various sectors (Bhattacharya & McGlothlin, 1996).

Unlike in the past when functionality was the priority in hand tool design, today, the focus is on comfort of use (Kuijt-Evers *et al*., 2007). Comfortable use of hand tools can improve users' health, productivity and job satisfaction (Kadefors *et al*., 1993; Kuijt-Evers *et al*., 2007). The use of tools and equipment that are not suitable for hand anthropometry can lead to musculoskeletal disorders and health problems (García-Cáceres *et al*., 2012). Non-ergonomic hand tool design, repetitive use and accumulation of musculotendinous tension can trigger tendinitis, peritendinitis, ulnar nerve compression, carpal tunnel syndrome, etc. (Andréu *et al*., 2011; García-Cáceres *et al*., 2012; Kong & Kim, 2015). Ensuring compliance with anthropometric principles in the design of hand tools is vital to prevent loss of productivity in the long term and prevent a decline in work performance, as this is a critical factor in protecting workers' health and improving work efficiency (Imrhan *et al*., 1993).

Socioeconomic status determines the living conditions of the individual such as income, education, nutrition, and access to health and social services. These conditions can affect the physical development and growth of individuals, leading to anthropometric differences (Widyanti *et al*., 2015). It is known that anthropometric differences vary between nations, regions and ethnicities and these differences are related to factors such as ethnicity, sex, nationality, occupation and age (Shahnavaz, 1985). It has been emphasized that imported equipment in developing

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Received: 2024-03-20 Accepted: 2024-04-29

countries may not be suitable for the anthropometric data of the local population, which may lead to problems in health, safety and task performance (Shahnavaz, 1985; Okunribido, 2000; Kar *et al*., 2003). Due to the lack of reliable data on hand anthropometry, problems with hand injuries and disorders will likely persist in developing countries (Contreras & Imrhan, 2005) . Equipment design based on anthropometric data for the populations of importing countries may help to alleviate the problems (Mandahawi *et al*., 2008).

This study aims to systematically evaluate the right hand morphometric measurements of healthy young individuals selected from various geographical regions and the distribution of hand types according to countries. This evaluation aims to reveal the changes in anthropometric data of the hand depending on geographical and demographic factors and increase the knowledge of the literature on this subject.

MATERIAL AND METHOD

This study was initiated of the local ethics committee of October 25, 2022 and the number 2022/751. The study included the right hands of 579 volunteers (250 females, 329 males) aged 16-32 years, including 94 Turkish, 82 Chadian, 69 Moroccan, 85 Gabonese, 90 Kazakh, 83 Senegalese, and 78 Syrian citizens (250 females, 329 males) who were students at the university. Oral and written informed consent was obtained from each participant. Individuals with a history of hand surgery, fracture or injury were excluded.

Measurements. In this study, the right hands of individuals were scanned using a Canon Pixma E414 scanner. A ruler was placed next to the hands during scanning. The acquired images were analyzed using the ImageJ Software package (version 1.52a, Wayne Rasband, National Institutes of Health-NIH, Maryland, USA). Known values from the image of the placed ruler were introduced into the program, and the accuracy of the measurements was optimized. A total of 16 parameters, 14 lengths and two surface areas were calculated. Measured parameters; Hand width (HW): The distance between the most medial and most lateral points of the hand at the level of the metacarpophalangeal joint. Hand length (HL): The distance between the distal end of the middle finger and the middle of the wrist line. 2nd-5th finger length (2, 3, 4, 5FL): Each measurement was measured as the distance between the distal end of the respective finger and the proximal flexion bend of the finger. 2nd-5th proximal interphalangeal joint width (2, 3, 4, 5PIP): It was determined as the distance between the most medial and most lateral points of the flexion bend of the PIP of the 2nd-5th finger. Distance of the 2nd-5th fingers to the wrist (2, 3, 4, 5DFW): Each measurement was performed as the distance from the center of the wrist line to the proximal flexion crease of the respective finger. Hand surface area (HSA): The entire surface area distal to the wrist. Palmar area (PA): The surface area from the wrist to the metacarpophalangeal joint (Fig. 1).

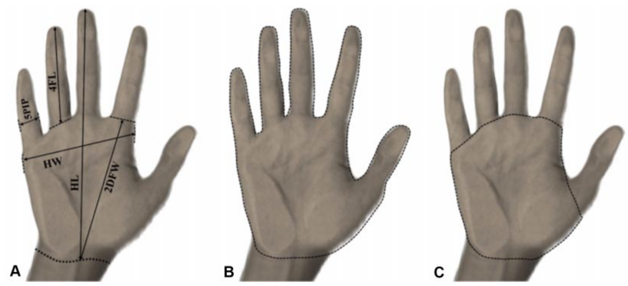

Fig. 1. A) Demonstration of length parameters of the right hand B) Hand surface area (HSA) measurement. C) Palmar area (PA) measurement.

Statistical analysis. All data were analyzed using SPSS 22 and Minitab 17. Descriptive statistics (mean and standard deviation) were calculated for the value of each hand size and are presented here. The Anderson-Darling test was performed to test whether the data set of measurements fit a normal distribution, and One-Way ANOVA (post-hoc: Tukey, Dunnet C) and Kruskal-Wallis H test were used according to the normal distribution. Factor analysis was performed with 18 variables to identify a set of factors suitable to explain the variability in hand shape (Direct Oblimin rotation). After factor analysis, Ward's method of using Euclidean distance was used to measure the distance between groups and cluster analysis was performed for the factor. The hands in the study were divided into four groups. A cluster analysis was performed to identify groups with similar characteristics belonging to a single category. Typing of hand by country was performed.

RESULTS

A total of 579 individuals, 329 (56.82 %) males and 250 (43.18 %) females, were included in the study. The mean ages of males and females were 20±5 and 19±6 years, respectively. The mean body mass index (BMI) of the females was 22.04±3.72 kg/m^2, and that of the males was 22.33±3.65 kg/m^2. The mean height of males was 177.9±7.1 cm and 164.5±6.9 cm for females. The mean weight of females was 59.6±10.4 kg, and that of males was 70.7±11.9 kg. There was a statistically significant difference in age, height and weight parameters according to sex ($p<0.05$). BMI did not show a significant difference according to sex ($p>0.05$). The sex distribution of the participants is given in Table I.

Table I. Distribution of sex by country.

Country	Female	Male	Total
Türkiye	25	69	94
Morocco	38	31	69
Chad	31	51	82
Syria	33	45	78
Senegal	40	41	83
Gabon	39	46	85
Kazakhstan	44	46	90
Total	250	329	579

In females showed normal distribution for HL, 2-5DFW, 2-5FL, HW, 2-5PIP, and HSA parameters (p>0.05), while 3FL and PA parameters deviated from normal distribution (p<0.05). Among females, Senegal had the longest HL, significantly longer than Chad and Gabon. Participants from Chad, Senegal, and Gabon participants had significantly longer 2, 3, and 4DFW compared to other countries, while Turkey had the shortest. Senegal had significantly longer 5DFW compared to other countries, and Chad and Gabon were longer than Turkey, Morocco, and Kazakhstan; Turkey was shorter than Syria. Gabon had the longest 2FL, longer than Kazakhstan, and the longest in Senegal. Senegal had the longest 4FL and shorter 5FL compared to Turkey, and longer than Morocco, Syria, and Kazakhstan, while Turkey had longer 5FL compared to Gabon and shorter than Kazakhstan, Morocco, Chad, and Gabon. HW was significantly longer in Senegal compared to other countries except Gabon, and Gabon was significantly longer than Chad and Senegal. Senegal had the widest 2PIP, higher than other countries except Gabon, which was higher than Turkey, Morocco, and Kazakhstan, and Syria was higher than Turkey and Chad. The 3PIP is higher in Gabon and Chad than in other countries, and higher in Syria than in Kazakhstan. 4PIP was higher in Gabon compared to other countries, and higher in Turkey, Morocco, and Kazakhstan compared to Gabon. Senegal had a higher 5PIP than Chad and Kazakhstan, and Gabon had a higher 5PIP than Kazakhstan. HSA and PA were significantly higher in Senegal and Gabon compared to other countries (p<0.05). The detailed results for females are shown in Tables II and III.

In males, HL, 2-4DFW, 2-4FL, 2-5PIP, HSA, and PA showed normal distribution (p>0.05), while 5DFW, 5FL, and HW did not (p<0.05). Gabon had significantly shorter HL compared to Morocco, Syria, and Kazakhstan, and Turkey was shorter than Chad, Senegal, and Gabon, with Senegal longer than Kazakhstan. Turkey, Syria, and Kazakhstan had shorter 2DFW compared to other countries, while Morocco was longer than Turkey and shorter than Chad and Senegal. Senegal and Gabon had significantly longer 3DFW compared to Turkey, Morocco, and Kazakhstan, with Gabon longer than Syria, and Chad longer than Turkey and Kazakhstan. Chad, Senegal, and Gabon had longer 4DFW compared to other countries, while Turkey had significantly shorter 4DFW compared to Syria. Chad and Gabon had significantly longer 5DFW compared to other countries except Senegal, and it was shorter in Kazakhstan compared to Senegal and Turkey, and shorter in Turkey compared to Syria and Senegal. Turkey had significantly shorter 2FL compared to Senegal and Gabon, and shorter than Kazakhstan, Syria, Senegal, and Gabon. Chad had significantly longer 3FL and 4FL compared to Turkey and Kazakhstan, and longer than Senegal compared to Turkey, Morocco, and Kazakhstan, with Gabon longer than Turkey,

Table II. Results of normally distributed parameters in females by country.

Parameters	Türkiye	Morocco	Chad	Syria	Senegal	Gabon	Kazakhstan	P
HL (cm)	17.19±0.60	17.58±0.75	18.33±0.75	17.62±0.66	18.96±0.71	18.41±0.83	17.29±0.85	0.000
2DFW (cm)	9.66±0.34	10.07±0.49	10.51±0.42	10.01±0.50	10.68±0.49	10.42±0.43	9.86±0.49	0.000
3DFW (cm)	9.68±0.35	10.04±0.48	10.52±0.41	9.97±0.45	10.70±0.45	10.51±0.45	9.87±0.50	0.000
4DFW (cm)	9.27±0.36	9.63±0.48	10.04±0.46	9.58±0.44	10.31±0.43	10.07±0.44	9.45±0.49	0.000
5DFW (cm)	8.49±0.41	8.78±0.49	9.14±0.41	8.86±0.43	9.48±0.43	9.17±0.48	8.71±0.46	0.000
2FL (cm)	6.92±0.35	6.84±0.35	6.93±0.36	6.90±0.32	7.41±0.48	7.07±0.49	6.74±0.42	0.000
4FL (cm)	6.99±0.37	7.06±0.42	7.26±0.38	7.10±0.36	7.75±0.445	7.42±0.59	6.97±0.43	0.000
5FL (cm)	6.64±026	5.76±0.43	5.86±0.44	5.73±0.31	6.14±0.45	5.97±0.44	5.48±0.42	0.000
HW (cm)	7.97±0.33	7.98±0.30	8.08±0.36	8.03±0.36	8.36±0.35	8.32±0.35	7.99±0.29	0.000
2PIP (cm)	1.77±0.10	1.82±0.11	1.85±0.11	1.86±0.09	1.94±0.08	1.90±0.10	1.80±0.09	0.000
3PIP (cm)	1.80±0.10	1.82±0.11	1.84±0.11	1.88±0.08	1.94±0.10	1.90±0.11	1.80±0.08	0.000
4PIP (cm)	1.73±0.11	1.71±0.11	1.75±0.11	1.76±0.07	1.86±0.08	1.82±0.13	1.69±0.10	0.000
5PIP (cm)	1.51±0.10	1.52±0.10	1.50±0.14	1.54±0.08	1.59±0.10	1.57±0.12	1.49±0.10	0.000
HSA (cm^2)	126.10±8.58	127.03±9.04	131.37±9.52	129.22±9.00	142.97±10.41	139.07±10.96	125.71±9.12	0.000

(p<0.05) (HL: Hand length, 2DFW: Distance of the 2nd finger from the wrist, 3DFW: Distance of the 3rd finger to wrist, 4DFW: Distance of the 4th finger from the wrist, 5DFW: Distance of the 5th finger from the wrist, 2FL: 2nd finger length, 3FL: 3rd finger length, 4FL: 4th finger length, 5FL: 5th finger length, HW: Hand width, 2PIP: 2nd proximal interphalangeal joint width, 3PIP: 3rd proximal interphalangeal joint width, 4PIP: 4th proximal interphalangeal joint width, 5PIP: 5th proximal interphalangeal joint width)

Table III. Results of non-normally distributed parameters in females by country.

Parameters	Türkiye	Morocco	Chad	Syria	Senegal	Gabon	Kazakhstan	P
3FL	7.58	7.52	7.89	7.70	8.26	7.90	7.46	0.000
(cm)	(6.82-8.26)	(6.91-8.43)	(7.11-9.16)	(6.79-8.45)	(7.47-9.99)	(6.97-9.22)	(6.56-8.49)	
PA	70.19	72.89	74.83	74.19	80.25	79.77	72.76	0.000
(cm^2)	(63.32-78.76)	(61.43-87.79)	(64.44-134.95)	(59.55-93.84)	(69.04-96.39)	(67.46-89.43)	(60.48-84.47)	

($p<0.05$) (3FL: 3rd finger length, PA: Palmar area)

Morocco, Syria, and Kazakhstan. Turkey had significantly shorter 5FL compared to Senegal and Gabon, and shorter than Kazakhstan compared to Chad, Senegal, and Gabon, and shorter than Morocco compared to Gabon. HW was significantly longer only in Gabon compared to Chad. Senegal had significantly higher 2PIP compared to Kazakhstan. Morocco and Kazakhstan had significantly narrower 3PIP compared to Senegal and Gabon. Kazakhstan had significantly narrower 4PIP compared to other countries except Morocco, and Turkey had higher 4PIP compared to Kazakhstan. Kazakhstan had significantly narrower 5PIP compared to other countries except Morocco. HSA was significantly higher in Chad compared to Kazakhstan and higher in Senegal and Gabon compared to Turkey, Morocco, and Kazakhstan. PA was significantly lower in Turkey compared to Chad, Senegal, and Gabon, and higher in Gabon compared to Morocco and Kazakhstan ($p<0.05$). The detailed results for males are shown in Tables IV and V.

Table IV. Distribution of normally distributed parameters in males according to countries.

Parameters	Türkiye	Morocco	Chad	Syria	Senegal	Gabon	Kazakhstan	P
HL (cm)	18.81±0.86	19.18±0.80	19.61±2.53	20.03±0.72	20.14±0.75	19.01±0.65	19.40±0.65	0.000
2DFW (cm)	10.69±0.50	11.01±0.47	11.37±0.39	10.88±0.48	11.39±0.44	11.33±0.45	10.85±0.46	0.000
3DFW (cm)	10.68±0.49	10.94±0.46	11.43±0.39	10.96±0.47	11.36±0.47	11.38±0.43	10.87±0.46	0.000
4DFW (cm)	10.22±0.50	10.52±0.46	11.02±0.41	10.56±0.48	10.92±0.50	10.98±0.46	10.44±0.43	0.000
2FL (cm)	7.41±0.46	7.47±0.42	7.53±0.41	7.58±0.49	7.72±0.48	7.78±0.54	7.26±0.40	0.000
3FL (cm)	8.18±0.47	8.28±0.44	8.57±0.47	8.38±0.52	8.69±0.47	8.81±0.60	8.20±0.41	0.000
4FL (cm)	7.67±0.51	7.82±0.41	8.08±0.44	7.88±0.50	8.20±0.56	8.29±0.55	8.29±0.55	0.000
2PIP (cm)	2.05±0.13	2.03±0.10	2.07±0.09	2.08±0.14	2.10±0.11	2.06±0.13	2.00±0.11	0.016
3PIP (cm)	2.06±0.13	2.00±012	2.08±0.09	2.09±0.14	2.11±0.12	2.10±0.12	2.01±0.10	0.000
4PIP (cm)	1.95±0.13	1.89±0.13	1.99±0.10	1.98±0.12	1.98±0.11	1.99±0.10	1.85±0.10	0.000
5PIP (cm)	1.73±0.11	1.67±0.12	1.74±0.12	1.76±0.13	1.73±0.15	1.74±0.14	1.63±0.11	0.000
HSA (cm^2)	155.98±13.10	154.28±10.26	161.49±9.09	160.80±15.66	163.54±11.80	167.31±11.86	153.59±9.32	0.000
PA (cm^2)	88.51±7.39	89.42±5.73	93.68±6.14	91.65±9.05	93.68±6.69	95.64±7.08	90.23±5.75	0.000

($p<0.05$) (HL: Hand length, 2DFW: Distance of the 2nd finger from the wrist, 3DFW: Distance of the 3rd finger to wrist, 4DFW: Distance of the 4th finger from the wrist, 2FL: 2nd finger length, 3FL: 3rd finger length, 4FL: 4th finger length, 2PIP: 2nd proximal interphalangeal joint width, 3PIP: 3rd proximal interphalangeal joint width, 4PIP: 4th proximal interphalangeal joint width, 5PIP: 5th proximal interphalangeal joint width)

Table V. Distribution of non-normally distributed parameters in males according to countries.

Parameters (cm)	Türkiye	Morocco	Chad	Syria	Senegal	Gabon	Kazakhstan	P
5DFW	9.48	9.64	10.12	9.77	10.08	10.16	9.75	0.000
	(7.51-10.47)	(8.46-10.56)	(9.34-11.28)	(8.91-10.72)	(8.11-10.79)	(8.95-11.40)	(8.64-10.25)	
5FL	6.30	6.41	6.43	6.49	6.58	6.86	6.26	0.000
	(5.46-7.52)	(5.74-6.96)	(5.50-9.59)	(5.73-7.98)	(5.67-7.47)	(5.35-7.51)	(4.94-6.95)	
HW	8.84	8.85	8.84	9.01	8.98	9.05	8.81	0.039
	(7.61-10.0)	(8.00-9.47)	(8.05-9.87)	(7.88-9.92)	(8.09-9.92)	(8.10-10.15)	(7.89-9.57)	

($p<0.05$) (5DFW: Distance of the 5th finger from the wrist, 5FL 5th finger length, HW: Hand width).

Factor analysis. Kaiser-Meyer-Olkin value was .943. When Barlett's test of sphericity was analyzed (x^2=17104,153; p=0.000), the data obtained were significant ($p<0.001$). As a rotation technique, it was separated by the Direct Oblimin method. The number of factors was decided according to the Kaiser rule. As a result of the factoranalysis, a structure with three sub-dimensions emerged. The values of the factors are given in the table below. The total explanatory power of the factors is 85.01 %. Factor 1 was named finger length, factor 2 was hand width, and factor 3 was palm length. Height and weight were included in the factor parameters so as not to affect the result.

As a result of the ANOVA test with factor scores in females, factor 1 (finger length) was significantly different in Senegal compared to other countries. Gabon was significantly different from Morocco and Kazakhstan (F1=13.494; sd=6,243; p=0.000). Factor 2 (hand width) was significantly different between Senegal and Gabon and Turkey, Morocco, Chad and Kazakhstan (F2=9.851; sd=6,243; p=0.000). Factor 3 (palm length) showed a significant difference between Senegal, Gabon and Chad and Turkey, Morocco, Syria and Kazakhstan (F3=22.933; sd=6,243; p=0.000) (Fig. 2).

As a result of the ANOVA test with factor scores in males, factor 1 (finger length) showed that the difference between Senegal, Turkey and Kazakhstan was significant. Gabon was significantly different from Turkey, Morocco, Syria and Kazakhstan (F1=8.292; sd=6,322; p=0.000). Factor 2 (hand width) was significantly different between Kazakhstan and Turkey, Syria and Gabon (F2=4.036; sd=6,322; p=0.001). In factor 3 (palm length), the difference between Senegal, Gabon, Chad, Morocco, Syria and Kazakhstan was significant. Turkey was significantly different from the other countries except for Kazakhstan (F3=21.784; 6,322; p=0.000) (Fig. 3).

Factor scores were used to group participants with similar hand measurements through cluster analysis. The appropriate amount of groups was calculated by deriving a dendrogram and selecting four clusters by applying Ward's method of using Euclidean distance. ANOVA was used to confirm that these four groups were significantly different from each other ($p<0.05$) (Table VI). According to the analysis, four different hand types were found (Fig. 4).

As a result of the distribution of hand types between countries, there was a difference between the groups of females. In females, type 1 was found only in Gabon; type 2 only in Senegal; type 3 in Turkey, Morocco and Kazakhstan; and type 4 in Senegal and Gabon (X^2 =104.62; df=18, $p<0.05$). In males, type 1 was significant in Turkey, type 2 in Senegal and Gabon, type 3 in Turkey, and type 4 in Morocco and Kazakhstan (X^2 =76.964; df=18, $p<0.05$) (Table VII).

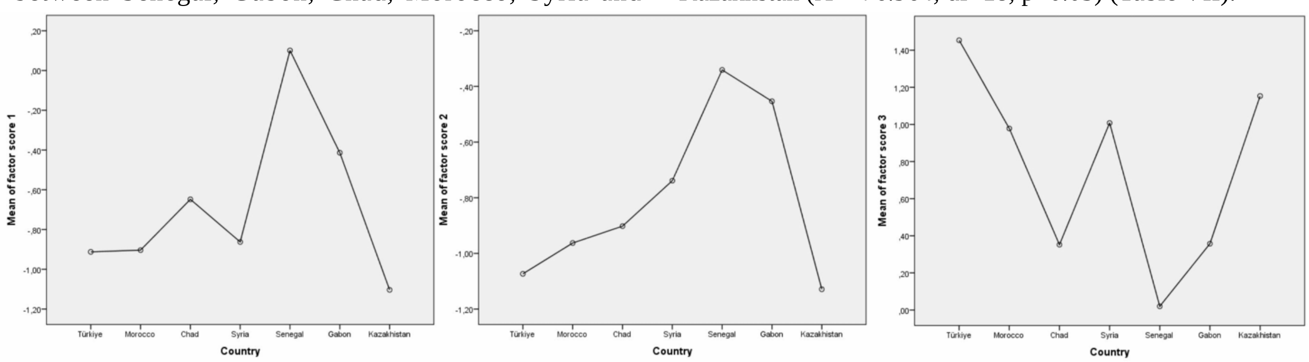

Fig. 2. Graphs of ANOVA test with factor scores in females.

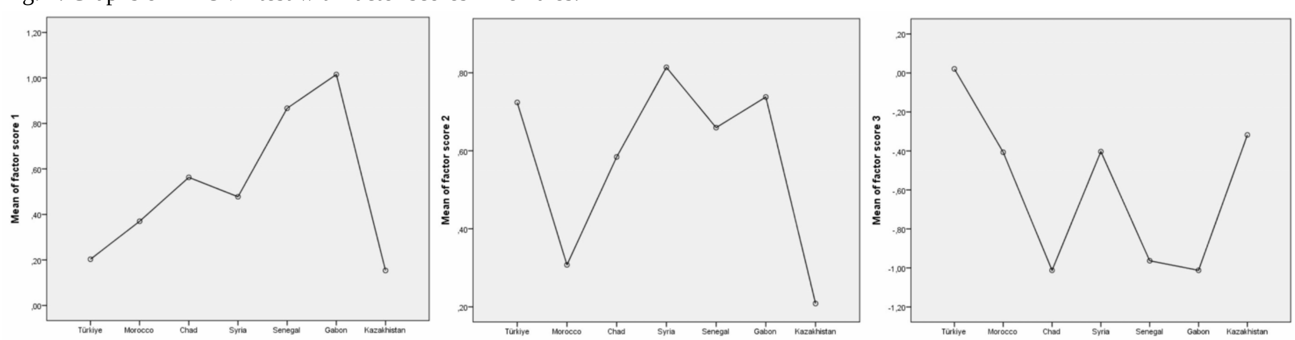

Fig. 3. ANOVA test plots with factor scores in males.

Table VI. Cluster mean factor scores for the four hand types.

Hand types	Cluster mean factor scores			
	Factor 1: finger lenght	Factor 2: hand breath	Factor 3: palm lenght	Relative frekans (%)
Type 1: Wide hand long finger	0.119	1.070	-0.343	18.3
Type 2: Long palm and finger	1.177	0.714	-1.067	26.1
Type 3: Narrow hand and short finger	-1.136	-1.079	1.249	24.9
Type 4: Short palm short finger	-0.150	-0.369	0.099	30.7

Fig. 4. Hand types resulting from cluster analysis. Type 1: Wide hand, long finger; Type 2: Long palm and finger; Type 3: Narrow hand and short finger; and Type 4: Short palm, short finger.

Table VII. Distribution of countries in hand types.

Country	Type 1		Type 2		Type 3		Type 4		Total
	Female	Male	Female	Male	Female	Male	Female	Male	
Türkiye	0	31*	0	13	21*	5*	4	20	94
Morocco	0	8	1	11	29*	0	8	12*	69
Chad	1	14	0	28	13	0	17	9	82
Syria	1	18	0	13	22	2	9	11	76
Senegal	1	6	6*	31*	3	0	31*	5	83
Gabon	3*	9	2	33*	10	0	24*	4	85
Kazakhstan	0	14	0	13	39*	0	5	19*	90
Total	6	100	9	142	137	7	98	80	579

Type 1: Wide hand long finger, Type 2: Long palm and finger, Type 3: Narrow hand and short finger, Type 4: Short palm short finger.

DISCUSSION

This study aimed to systematically evaluate the right hand morphometric measurements of healthy young individuals from various geographical regions and the distribution of hand types according to countries. In the study, 16 different parameters, including two surface areas and 14 lengths, were measured in the right hand of 579 individuals from 7 different countries. All parameters showed significant differences between countries in both sexes. In the study, it was determined that the three-dimensional hand structure emerging from the factor analysis of the measured parameters explained 85.01 % of the total variation, and there were significant differences in hand parameters between countries. Finger length, hand width and palm length were identified as the primary factors in the three-dimensional hand structure. Cluster analysis revealed four significantly different hand types. Specifically, different hand types were common in different countries, and there were significant differences between these hand types by sex. All our findings indicated that environmental factors and sex may contribute to variation in hand morphology and morphometry. These differences may shed light on the sociological characteristics of societies through hand morphometry variation. It may also provide information about the racial characteristics of individuals, not only limited to sex but also based on the hands of dismembered corpses.

As Kovacs *et al*. (2002) stated, tailoring gloves to the range of motion of different hand joints can affect the comfort and performance of users. The hand types mentioned in our study indicate that many different dimensions need to be considered in glove design. Previous studies in the literature show that glove sizing systems usually focus only on hand length and width (Kwon *et al*., 2009; Lee *et al*., 2015). In this context, the different hand types revealed by our study emphasize the necessity of a more specific and user-oriented approach according to countries and sexes, not only in glove design but also in all product designs used with the hand and all medical interventions on the hand.

Many studies in the literature have reported differences in hand morphometry between populations by comparing and interpreting hand anthropometric analysis data of individuals in their geographical regions with the results of similar studies (Barut *et al*., 2014; Bures *et al*., 2015; Jee & Yun, 2016). Within the scope of this research, data from 7 different countries, consisting of individuals of the same age range and using the same measurement methodology, provide more precise results in the population comparison process. This study shows that hand morphometry includes a number of important parameters that vary across geographical regions.

In recent years, studies on hand morphometry in the literature have adopted a classification-based evaluation approach instead of considering anthropometric parameters individually (Jee & Yun, 2016; Vergara *et al*., 2019; Ermolenko & Khayrullin, 2021). Some studies in the literature indicate that the ratios between different anatomical regions of the hand vary, and these ratios can be used to classify different hand types in various populations (Clerke *et al*., 2005; Chandra *et al*., 2013; Jee *et al*., 2016). In our study, we evaluated the right hand morphometric measurements of healthy young individuals from 7 different countries. The measurements were analyzed using factor analysis and cluster analysis, which revealed significant morphometric differences in typing of hand between countries.

The strengths of the study include the fact that it was an original study, it was conducted with a wide range of participants, it used statistical methods such as factor analysis and cluster analysis, and it showed that sex and geographical factors affect hand types. Weaknesses of the study include the fact that it was conducted only on healthy young individuals and did not examine the effects of hand anthropometry on job performance or health. Future studies could be replicated using artificial intelligence, which is one of the current methods to validate the findings and help us better understand the importance of hand anthropometry or examine the effects of hand anthropometry on job performance and occupational health in specific occupational groups.

Our study showed that there are significant differences in hand parameters between 7 different underdeveloped and developing countries, and different hand types are common in different countries. These findings suggest that geographical factors may play an important role in the formation of hand types, and hand morphology and morphometry are shaped by environmental, ethnicity and genetic factors in different geographies. Thus, it may increase the risk that equipment imported in developed or developing countries may lead to ergonomic problems in health, safety and task performance due to the lack of conformity with the anthropometric data of the local population.

In conclusion, this study provides valuable information on the geographical distribution of hand morphometric measurements and types, highlighting significant differences between countries and sexes. Our findings will contribute to a broader understanding of morphological diversity influenced by geographical and sex-specific factors.

Ethics Approval Statement. This study was approved by 2022/751 protocol numbered permission of Karabük University non-interventional ethics board.

ACKNOWLEDGEMENTS. We extend our gratitude to all volunteer participants who contributed to this study and the academic staff of Karabük University Turkish Language Teaching Application and Research Center (TÖMER).

SAHIN, N. E.; BAKICI, R. S.; TOY, S. & ONER, Z. Evaluación de la morfometría de la mano en individuos jóvenes sanos de diferentes países. *Int. J. Morphol., 42(4)*:991-998, 2024.

RESUMEN: Este estudio tuvo como objetivo examinar la morfometría de la mano de individuos jóvenes sanos de diferentes países e investigar las diferencias en la mecanografía de la mano entre países en función de los valores morfométricos obtenidos. En el estudio, se midieron 16 parámetros diferentes, incluidas dos superficies y 14 longitudes, de la mano derecha de 579 voluntarios (250 mujeres, 329 hombres) de 7 países diferentes (Turquía, Chad, Marruecos, Gabón, Kazajstán, Senegal y Siria). Se realizó un análisis factorial de los parámetros, un análisis de conglomerados según la puntuación factorial obtenida y se determinaron los tipos de manos en el estudio. Como resultado, se definieron cuatro tipos diferentes de manos y se analizó la distribución de estos tipos según países. Todos los parámetros mostraron diferencias significativas entre países en ambos sexos ($p<0,05$). Según los resultados del estudio, hubo una diferencia entre los tipos de manos de los hombres y de las mujeres entre países. En las mujeres, el tipo de mano tipo 1 se encontró solo en Gabón, el tipo de mano tipo 2 se encontró solo en Senegal, el tipo de mano tipo 3 se encontró en Turquía, Marruecos y Kazajstán, mientras que la mano tipo 4 se distribuyó significativamente en Senegal y Gabón ($X^2=104,62$; gl=18, $p<0,05$). En los hombres, el tipo de mano tipo 1 se encontró en Turquía, el tipo de mano tipo 2 en Senegal y Gabón, el tipo de mano tipo 3 en Turquía, mientras que la mano tipo 4 se distribuyó significativamente en Marruecos y Kazajstán ($X^2=76,964$; gl=18, $p <0,05$).

PALABRAS CLAVE: Morfometría de la mano; Mecanografía manual; Antropología; Variación geográfica; Análisis de conglomerados.

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