

# Correlation of Hand Preference with Hand Anthropometric Measurements in University Students

Correlación de la Preferencia de Mano con las Medidas Antropométricas de la Mano en Estudiantes Universitarios

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**SUMMARY:** The hand is a critical organ for both personal and professional activities such as grasping, holding, touching and fine motor activities in daily life. In addition, with its complex structure consisting of twenty-seven bones and fifteen joints, it allows us to perform movements that require fine motor coordination. In the literature, there are studies showing that hand morphology varies according to factors such as race, sex and dominant hand. These studies constitute important data in forensic anthropology and even in the design of ergonomic tools. With the developing technology, more studies are needed in this field. In our study, we aim to contribute to the literature by comparing the hand morphometry of the Turkish population in terms of parameters such as sex, ethnicity and hand preference. The results of our study will be an important source of data for future morphological hand comparison studies. A total of 152 volunteer young university students, 128 of whom were Turkish and 24 of whom were from different ethnic backgrounds, participated in our study. Both hand parameters of the participants were measured and compared according to variables such as sex, ethnicity and dominant hand. Orfield hand preference test and 2D:4D ratio evaluations were also included. Although the results obtained were consistent with the literature, it was found that the right hand length was significantly higher in groups other than Turkish participants. In addition, it was found that the right hand width, height and fifth finger length were larger in Turkish girls compared to other races. The 2D:4D ratio did not yield significant results in any group. Our study provides new data for the literature and strengthens our understanding of hand morphology according to sex, especially in Turkish society.

**KEY WORDS:** Hand; Hand Preference; Hand Morphometry; Orfield; Finger Ratios.

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## INTRODUCTION

The hand is one of the most important organs we use in our daily life. It is an organ that fulfils many important tasks such as touching, holding, grasping and especially expressing ourselves (Arifoglu, 2021). It is the most frequently used structure for professional and work-related as well as daily living activities. It is involved in functional activities in a harmonious combination of motor, sensory and biomechanical parameters and participates in important and effective movements used in activities of daily living (Tonak *et al.*, 2021). Its complex structure provides the precise activity required for various tasks, including artistic work (Barut *et al.*, 2014).

The skeleton of the hand is analysed in 3 groups. It consists of 27 bones and 15 joints in total (Ozan, 2014; Jee *et al.*, 2015; Jee & Yun 2015; Arıncı & Elhan, 2020).

Eight of these bones are carpal (wrist), five are metacarpal (metacarpal bones) and 14 are phalanx bones. They have two faces, dorsal and ventral (Ozan, 2014; Arifoglu, 2021).

Anthropometry is a branch of ergonomics that analyses human body measurements and their relationship with the technical system (Bhattacharya & McGlothlin, 2011; Oviedo-Trespalacios *et al.*, 2017). There are many anthropometric studies in the literature related with the hand. These include studies investigating racial differences in hand morphology (Mirmohammadi *et al.*, 2016; Asadujaman *et al.*, 2019), the effects of hand anthropometry on different diseases (Arslan *et al.*, 2017; Avsaroglu & Ozcaker, 2018; Sahebalam *et al.*, 2021), differences in hand measurements between men and women (Barut *et al.*, 2014), and studies conducted to

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provide solutions to forensic cases (Jee *et al.*, 2015; Gupta *et al.*, 2022), the link between hand and body mass index, the relationship between hand and strength (Pizzigalli *et al.*, 2017; Alahmari *et al.*, 2017; Tonak *et al.*, 2021; Rostamzadeh *et al.*, 2021; Hossain Parash *et al.*, 2022), the effect of hand preference on hand morphometry (Kulaksız & Gözil, 2002).

Hand preference is a reflection of the brain itself as an indirect indicator of brain asymmetry (Kulaksız & Gözil, 2002). It reflects a functional asymmetry that is evident in almost every aspect of daily life in humans (Dexheimer *et al.*, 2022). Approximately 90 % of the population is right-handed (Przybyla *et al.*, 2013; Dexheimer *et al.*, 2022). For this reason, hand preference is often defined as a preference for using a particular hand. In simple reaching tasks, right-handed people often use their left hand for objects that are well to the left of the midline. However, for objects in the midline or to the right of the midline, they use their dominant right hand. Reaching for objects close to the midline of the body with the right hand is less efficient in terms of kinematics, energy and time, but it is still present (Dexheimer *et al.*, 2022). Hand preference is measured by questionnaires assessing the individual's preference for using a particular hand to perform various tasks, which have been proven to be reliable by previous studies (Przybyla *et al.*, 2013). In this study, 'Oldfield Hand Preference Test' was applied to the participants to determine hand preferences (Oldfield, 1971).

Anthropometric studies have emphasised that the data of the right half are different from the left half when comparing the two halves of the body. This difference is thought to be due to hand preference (Kulaksız & Gözil, 2002). The possible anthropometric variation between the two hands was the subject of investigation in this study, rather than the difference between the limbs caused by hand preference, which is a functional feature of the hand.

Researchers were curious about the effect of sex on hand size as well as the morphometric difference between the two hands. In the literature, it is emphasized that sex also has an effect on the morphological characteristics of the hands. The genetic structure of the individual plays an important role in the development and differentiation of the hands (Barut *et al.*, 2014). This morphological difference is very important ergonomically in the daily life of the individual, especially in business life. The connection between the worker and the hand tools is a parameter that has a direct impact on healthy productivity results. According to a study, fingers, hands and wrists account for 32 % of injuries. Inappropriate relationship with the vehicle used or improper use increases the likelihood of injuries on the musculoskeletal system (8,10).

The difference of the hand on sex is not only ergonomically important but also of great importance for forensic cases. Nowadays, dismembered body parts are frequently found in natural and man-made disasters or increased cases of assassination (Jee *et al.* 2015; Gupta, 2022). Although sex determination is an easy task in the presence of the whole body or genital organs, the situation can be different in the absence of these structures. Until recently, anthropologists have used the skeleton of the head and pelvis in such cases, but today there is a tendency to use structures such as long bones and hands (Gupta *et al.*, 2022). It has also been found that there is a significant correlation between hand size and a person's height and weight. For this reason, a dismembered or fragmented hand is often used in such cases to confirm the identity of the victim (Jee *et al.* 2015; Gupta *et al.*, 2022).

This study includes detailed anthropometric measurements of twenty-six parameters including the circumference, width and length of both wrists, including various reference points of the hand, using a digital caliper and tape measure, to students studying at Sakarya University Faculty of Dentistry. The aim of our study was to determine the sex-related changes in hand morphometry and anthropometric differences between the two hands depending on the dominant hand preference.

Although the data obtained from our study is cross-sectional, it is important in terms of accumulation of morphometric data of the hand in the Turkish population.

## MATERIAL AND METHOD

This study was carried out on students aged 17-24 years studying at the Faculty of Dentistry. The study was carried out on students who did not have any health problems, did not have congenital or traumatic deformity in the hand area and did not have a history of hand surgery. Anthropometric measurements were carried out on 164 students in total. However, 12 students who did not complete the Oldfield Hand Preference Test questionnaire were excluded from the study and the data of 152 students were analyzed. Data were taken in laboratory environment. After the age and sex information of the participants were recorded on the data recording form, the 'Oldfield Hand Preference Test' was applied to determine their hand preferences. Finally, detailed anthropometric measurements of both hands of the participants were made with a digital caliper. Ethical approval was granted by the 'Sakarya University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee'. Informed consent form was obtained from the participants before starting the study.

‘Olfield Hand Preference Test’ which evaluates the direction and degree of hand preference was used to determine the hand preferences of the participants (Cakit *et al.*, 2014). With the test, participants were asked 10 questions including hand preferences such as writing, drawing, throwing a ball, using various tools, lighting matches and opening a lid. The subjects were asked to write the ‘+’ sign in the relevant column if they have a hand that they use continuously, right or left, while performing the activity, and the ‘+’ sign in the relevant column if they have a hand that they usually use, although not continuously. Participants who used both hands equally were asked to put a ‘+’ sign in the column with both hand options. Participants were asked to tick only one column for each question. The result was summed by giving +10 points for the ‘+’ sign for the right hand used continuously, +5 points for the sign placed in the relevant column for the right hand they usually use, 0 points for the ‘+’ sign placed in both hand columns, -10 points for the ‘+’ sign placed in the column for the left hand used continuously, and -5 points for the sign placed in the relevant column for the left hand they usually use. With the sum of these scores, the ‘Geschwind score’ was obtained, which allows us to determine the direction and degree of hand preference. An indicator of  $-100 \leq \text{Geschwind score} \leq +100$  is an indication of decreasing right hand preference from +100 to -100. The score is characterized as strong left-handedness between -80 and -100, weak left-handedness between -20 and -75, two-handedness between -15 and +15, weak right-handedness between +20 and +75, and strong right-handedness between +80 and +100.

Wrist circumference, which is one of the 26 hand anthropometric parameters of the participants, was measured with a tape measure and the other anthropometric structures

were measured using an electronic digital caliper, which is a direct anatomical and anthropometric measurement technique with a precision of 0.01mm/0.0005. The points of 26 parameters on the hand are indicated in Table I and the schematized image is shown in Figure 1.

Table I. The points expressed by the parameters.

| Parameters | Place of Expression                |
|------------|------------------------------------|
| 1          | I.finger length (root to tip)      |
| 2          | II.finger length (root-to-end)     |
| 3          | III.finger length (root-to-end)    |
| 4          | IV.finger length (root-to-end)     |
| 5          | V.finger length (root-to-end)      |
| 6          | I.finger DIP joint width           |
| 7          | II.finger DIP joint width          |
| 8          | III.finger DIP joint width         |
| 9          | IV.finger DIP joint width          |
| 10         | V.finger DIP joint width           |
| 11         | I.finger PIP joint width           |
| 12         | II. finger PIP joint width         |
| 13         | III. finger PIP joint width        |
| 14         | IV. finger PIP joint width         |
| 15         | V. finger PIP joint width          |
| 16         | Hand width along the first finger  |
| 17         | Palm width                         |
| 18         | Hand width at the metacarpal bones |
| 19         | Hand length                        |
| 20         | Hand height                        |
| 21         | Wrist circumference                |
| 22         | Wrist width                        |
| 23         | II.finger MCP joint width          |
| 24         | III. finger MCP joint width        |
| 25         | IV. finger MCP joint width         |
| 26         | V. finger MCP joint width          |

\*DIP: distal interphalangeal joint, PIP: proximal interphalangeal joint, MCP: metacarpophalangeal joint

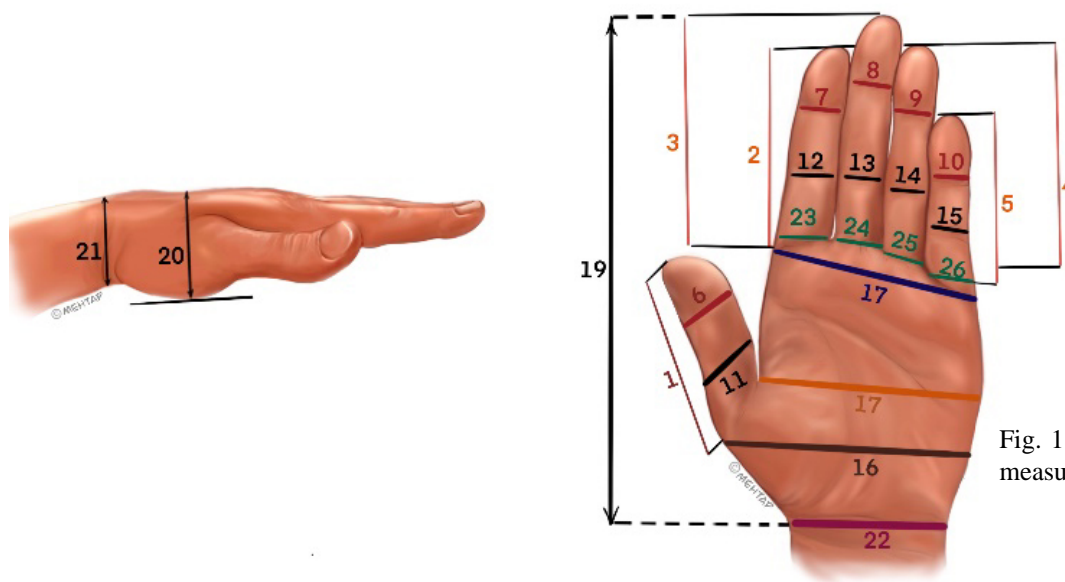


Fig. 1. Landmarks for hand measurement.

During the measurement, the participants were asked to keep their elbows resting on the side of their body on the table, forearms and hands fixed on the table in supine position, thumbs in abduction and 2nd-5th fingers in adduction.

All parameters were measured twice for each participant and the mean value was used to eliminate measurement error. If there was a difference of more than 0.5cm between the two measurements, both data were rejected and two measurements were taken again. The measurements were performed in Sakarya University anatomy laboratory and by a single observer in order not to affect the results.

**Statistical Analysis.** Statistical analyses were performed using IBM SPSS Statistics v25 software (IBM Corporation, New York, USA). Compliance with normal distribution was evaluated by Shapiro-Wilk test. Mean, standard deviation and percentage calculations were made for descriptive statistics. Comparisons between the groups were performed by independent samples t-test for normally distributed data and Mann-Whitney U and Kruskal-Wallis tests for non-normally distributed data. Pairwise post-hoc test was performed in the groups with significant difference. Correlation analyses were performed using Pearson's correlation test for normally distributed data and Spearman's correlation test for non-normally distributed data.

**RESULTS**

In this study, 164 students of the Faculty of Dentistry were subjected to anthropometric measurements. However,

12 students who did not complete the Orfield Hand Preference Test questionnaire were excluded from the study and the data of a total of 152 students were analyzed. According to the Orfield test results, 5 of the 152 students included in the study were left-handed, only 2 were ambidextrous (two-handed) and 147 were right-handed.

In our study, 35.8 % (n=19) of 1st grade students were male and 64.2 % (n=34) were female; 38.7 % (n=29) of 2nd grade students were male and 61.3 % (n=46) were female; and 30.6 % (n=11) of 4th grade students were male and 69.4 % (n=25) were female. In general, 36 % (n=59) of the total 164 students participating in the study were male and 64 % (n=105) were female. While 42 of the Turkish participants were male (27.6 %) and 86 were female (56.6 %), 16 of the foreign students were male (10.5 %) and 8 were female (5.3 %).

As a result of the statistical analysis, a significant difference was found in favor of foreign participants in the right hand length parameter (p<0.05). The mean hand length of foreign participants (18.32 ± 1.23 cm) was statistically significantly higher than that of Turkish participants (17.66 ± 1.19 cm). No statistically significant difference was found between the groups in other right hand parameters (p > 0.05) (Table II).

It was observed that the measurements of Turkish girls were higher than the measurements of foreign girls in the parameters of V. finger length, I. and II. DIP joint width, I. finger PIP joint width, III. finger MCP joint width and wrist circumference in the right hand. (p < 0,05). It was observed that the measurements of Turkish girls were higher

Table II. Comparison of right hand anthropometric measurements in terms of nationality.

| Parameter | Turkish students<br>(Mean ± SS) | Foreign students<br>(Mean ± SS) | p Value | Parameter | Turkish students<br>(Mean ± SS) | Foreign students<br>(Mean ± SS) | p Value |
|-----------|---------------------------------|---------------------------------|---------|-----------|---------------------------------|---------------------------------|---------|
| R1        | 52.33 ± 7.27                    | 54.85 ± 9.01                    | p>0,05  | R14       | 18.20 ± 4.47                    | 18.45 ± 5.25                    | p>0,05  |
| R2        | 69.44 ± 8.27                    | 70.68 ± 8.96                    | p>0,05  | R15       | 16.14 ± 4.71                    | 16.25 ± 5.18                    | p>0,05  |
| R3        | 74.88 ± 11.66                   | 77.67 ± 17.10                   | p>0,05  | R16       | 92.39 ± 12.32                   | 94.58 ± 12.47                   | p>0,05  |
| R4        | 69.31 ± 10.14                   | 71.20 ± 12.77                   | p>0,05  | R17       | 78.05 ± 9.40                    | 79.16 ± 11.66                   | p>0,05  |
| R5        | 52.97 ± 9.33                    | 52.92 ± 11.63                   | p>0,05  | R18       | 75.11 ± 7.73                    | 76.05 ± 10.26                   | p>0,05  |
| R6        | 19.56 ± 4.74                    | 19.51 ± 5.19                    | p>0,05  | R19       | 17.66 ± 1.19                    | 18.32 ± 1.23                    | p<0,05  |
| R7        | 16.73 ± 4.38                    | 17.14 ± 5.04                    | p>0,05  | R20       | 36.36 ± 6.20                    | 38.03 ± 12.55                   | p>0,05  |
| R8        | 16.90 ± 4.47                    | 17.20 ± 5.16                    | p>0,05  | R21       | 35.98 ± 5.13                    | 35.41 ± 4.77                    | p>0,05  |
| R9        | 16.08 ± 4.45                    | 16.14 ± 5.00                    | p>0,05  | R22       | 52.24 ± 6.74                    | 51.13 ± 10.93                   | p>0,05  |
| R10       | 14.33 ± 4.27                    | 14.85 ± 5.14                    | p>0,05  | R23       | 19.71 ± 4.93                    | 19.53 ± 5.97                    | p>0,05  |
| R11       | 22.10 ± 5.41                    | 22.59 ± 5.18                    | p>0,05  | R24       | 18.15 ± 4.94                    | 18.06 ± 5.21                    | p>0,05  |
| R12       | 19.02 ± 4.64                    | 19.19 ± 4.79                    | p>0,05  | R25       | 17.01 ± 4.96                    | 17.08 ± 5.23                    | p>0,05  |
| R13       | 19.18 ± 4.56                    | 18.80 ± 4.89                    | p>0,05  | R26       | 16.34 ± 5.09                    | 16.07 ± 5.84                    | p>0,05  |
| 2D:4D     | 1.02 ± 0.17                     | 1.02 ± 0.24                     | p>0,05  |           |                                 |                                 |         |

\*R:right hand \*2D:4D: Digit ratio

than those of foreign girls in the parameters of right hand IV. finger DIP and PIP joint width, V. finger PIP and MCP joint width, palm width, II. finger MCP joint width, hand width at metacarpal bones. ( $p < 0,01$ ). In the right hand V. finger DIP joint width parameter, it was observed that the measurements of Turkish girls were higher than those of foreign girls ( $p < 0.001$ ). With these data, it can be said that the right hand width, right hand height, 5th finger length, mostly finger widths of Turkish girls are larger than foreign girls. However, no significant difference was observed between the two groups in terms of right hand 2D:4D ratio (Table III).

When the right hand anthropometric measurements and 2D:4D ratio differences were analyzed according to nationality difference among male students, no significant difference was observed ( $p > 0.05$ ) (Table IV).

According to the results obtained in the study, hand anthropometric measurements were significantly longer in boys than in girls ( $P < 0.001$ ). However, no statistically significant difference was found between sexes in the Orfield hand test score ( $P > 0.05$ ) (Tables V and VI).

According to the results of Orfield hand preference test, right hand height and left hand 4th finger length parameters showed a significant difference between right hand dominant, left hand dominant and ambidextrous individuals ( $p < 0.05$ ). According to post-hoc analyses, right hand height was higher in ambidextrous individuals ( $42.08 \pm 4.64$ ) than in left hand dominant individuals ( $33.08 \pm 6.03$ ). Similarly, higher values were found for left hand 4th finger length in ambidextrous individuals ( $76.81 \pm 10.19$ ) than in right hand dominant individuals ( $66.40 \pm 6.32$ ). The data are shown in Tables VII and VIII.

Table III. Comparison of right hand anthropometric measurements in female students in terms of nationality.

| Parameter | Turkish students<br>(Mean ± SS) | Foreign students<br>(Mean ± SS) | p Value | Parameter | Turkish students<br>(Mean ± SS) | Foreign students<br>(Mean ± SS) | p Value |
|-----------|---------------------------------|---------------------------------|---------|-----------|---------------------------------|---------------------------------|---------|
| R1        | 51.02 ± 7.22                    | 48.05 ± 6.96                    | p>0,05  | R14       | 17.23 ± 4.10                    | 14.09 ± 0.82                    | p<0,01  |
| R2        | 67.22 ± 6.66                    | 65.16 ± 7.48                    | p>0,05  | R15       | 15.24 ± 4.49                    | 11.89 ± 0.51                    | p<0,01  |
| R3        | 72.67 ± 10.50                   | 71.03 ± 7.56                    | p>0,05  | R16       | 87.59 ± 10.71                   | 83.92 ± 5.25                    | p>0,05  |
| R4        | 66.53 ± 9.50                    | 63.48 ± 6.77                    | p>0,05  | R17       | 74.54 ± 6.65                    | 67.33 ± 3.67                    | p<0,05  |
| R5        | 50.72 ± 8.54                    | 44.18 ± 6.03                    | p<0,05  | R18       | 72.19 ± 6.76                    | 64.85 ± 3.39                    | p<0,01  |
| R6        | 18.50 ± 4.48                    | 15.13 ± 1.16                    | p<0,05  | R19       | 17.15 ± 0.98                    | 17.09 ± 0.86                    | p>0,05  |
| R7        | 15.86 ± 4.09                    | 12.94 ± 1.01                    | p<0,05  | R20       | 34.91 ± 5.69                    | 36.99 ± 18.16                   | p>0,05  |
| R8        | 15.96 ± 4.20                    | 12.93 ± 1.08                    | p>0,05  | R21       | 34.52 ± 4.98                    | 31.39 ± 1.62                    | p<0,05  |
| R9        | 15.15 ± 4.19                    | 11.64 ± 0.53                    | p<0,01  | R22       | 49.98 ± 5.99                    | 46.13 ± 2.79                    | p>0,05  |
| R10       | 13.49 ± 4.01                    | 10.09 ± 0.50                    | p<0,001 | R23       | 18.61 ± 4.46                    | 14.85 ± 1.37                    | p<0,01  |
| R11       | 21.18 ± 4.78                    | 18.58 ± 1.47                    | p>0,05  | R24       | 17.36 ± 4.71                    | 13.73 ± 1.07                    | p<0,05  |
| R12       | 18.16 ± 4.20                    | 15.18 ± 0.93                    | p<0,05  | R25       | 16.08 ± 4.57                    | 13.49 ± 1.52                    | p>0,05  |
| R13       | 18.08 ± 4.11                    | 14.80 ± 1.21                    | p<0,05  | R26       | 15.45 ± 4.65                    | 11.22 ± 1.02                    | p<0,01  |
| 2D:4D     | 1.03 ± 0.19                     | 1.03 ± 0.09                     | p>0,05  |           |                                 |                                 |         |

\*R:right hand. \*2D:4D: Digit ratio.

Table IV. Comparison of right hand anthropometric measurements of male students in terms of nationality.

| Parameter | Turkish students<br>(Mean ± SS) | Foreign students<br>(Mean ± SS) | p Value | Parameter | Turkish students<br>(Mean ± SS) | Foreign students<br>(Mean ± SS) | p Value |
|-----------|---------------------------------|---------------------------------|---------|-----------|---------------------------------|---------------------------------|---------|
| R1        | 55.01 ± 6.68                    | 57.82 ± 8.29                    | p>0,05  | R14       | 20.19 ± 4.59                    | 20.36 ± 5.23                    | p>0,05  |
| R2        | 74.01 ± 9.39                    | 73.09 ± 8.66                    | p>0,05  | R15       | 17.99 ± 4.64                    | 18.16 ± 5.14                    | p>0,05  |
| R3        | 79.39 ± 12.72                   | 80.58 ± 19.40                   | p>0,05  | R16       | 102.22 ± 9.21                   | 99.24 ± 11.87                   | p>0,05  |
| R4        | 75.01 ± 9.05                    | 74.58 ± 13.44                   | p>0,05  | R17       | 85.24 ± 10.15                   | 84.34 ± 10.02                   | p>0,05  |
| R5        | 57.58 ± 9.26                    | 56.74 ± 11.52                   | p>0,05  | R18       | 80.95 ± 6.10                    | 80.95 ± 8.09                    | p>0,05  |
| R6        | 21.74 ± 4.55                    | 21.43 ± 5.11                    | p>0,05  | R19       | 18.72 ± 0.82                    | 18.85 ± 0.95                    | p>0,05  |
| R7        | 18.50 ± 4.46                    | 18.97 ± 5.01                    | p>0,05  | R20       | 39.42 ± 6.18                    | 38.49 ± 9.92                    | p>0,05  |
| R8        | 18.82 ± 4.43                    | 19.06 ± 5.13                    | p>0,05  | R21       | 39.02 ± 3.99                    | 37.16 ± 4.64                    | p>0,05  |
| R9        | 18.00 ± 4.40                    | 18.10 ± 4.79                    | p>0,05  | R22       | 56.92 ± 5.76                    | 53.32 ± 12.47                   | p>0,05  |
| R10       | 16.04 ± 4.33                    | 16.94 ± 4.84                    | p>0,05  | R23       | 21.97 ± 5.12                    | 21.87 ± 6.02                    | p>0,05  |
| R11       | 23.99 ± 6.16                    | 24.34 ± 5.26                    | p>0,05  | R24       | 19.77 ± 5.05                    | 20.22 ± 5.11                    | p>0,05  |
| R12       | 20.77 ± 5.03                    | 20.94 ± 4.75                    | p>0,05  | R25       | 18.93 ± 5.24                    | 18.88 ± 5.53                    | p>0,05  |
| R13       | 21.43 ± 4.67                    | 20.56 ± 4.86                    | p>0,05  | R26       | 18.18 ± 5.49                    | 18.50 ± 5.74                    | p>0,05  |
| 2D:4D     | 0.99 ± 0.10                     | 1.02 ± 0.28                     | p>0,05  |           |                                 |                                 |         |

\*R:right hand. \*2D:4D: Digit ratio

Table V. Comparison of right hand anthropometric measurements according to sex.

| Parameter     | Male<br>(Mean ± SS) | Female<br>(Mean ± SS) | p Value | Parameter | Male<br>(Mean ± SS) | Female<br>(Mean ± SS) | p Value |
|---------------|---------------------|-----------------------|---------|-----------|---------------------|-----------------------|---------|
| L1            | 52,47 ± 10,55       | 47,09 ± 8,88          | p<0,001 | L14       | 19,71 ± 4,79        | 16,94 ± 4,02          | p<0,001 |
| L2            | 72,85 ± 8,79        | 66,30 ± 6,98          | p<0,001 | L15       | 17,95 ± 5,66        | 14,67 ± 4,00          | p<0,001 |
| L3            | 82,16 ± 8,34        | 73,84 ± 6,53          | p<0,001 | L16       | 100,12 ± 13,34      | 87,56 ± 10,19         | p<0,001 |
| L4            | 75,90 ± 8,17        | 66,79 ± 6,61          | p<0,001 | L17       | 84,84 ± 11,62       | 74,15 ± 6,48          | p<0,001 |
| L5            | 60,29 ± 7,94        | 53,69 ± 5,35          | p<0,001 | L18       | 79,20 ± 10,04       | 70,88 ± 6,65          | p<0,001 |
| L6            | 21,33 ± 4,59        | 18,04 ± 3,89          | p<0,001 | L19       | 19,08 ± 2,22        | 17,25 ± 0,99          | p<0,001 |
| L7            | 17,82 ± 4,61        | 15,24 ± 3,97          | p<0,001 | L20       | 40,09 ± 26,94       | 33,00 ± 6,75          | p<0,001 |
| L8            | 18,17 ± 4,51        | 15,22 ± 4,01          | p<0,001 | L21       | 37,53 ± 4,84        | 33,85 ± 4,65          | p<0,001 |
| L9            | 17,34 ± 4,40        | 14,81 ± 3,89          | p<0,001 | L22       | 56,62 ± 6,22        | 49,59 ± 5,37          | p<0,001 |
| L10           | 15,84 ± 4,51        | 13,14 ± 3,64          | p<0,001 | L23       | 21,12 ± 5,68        | 18,43 ± 5,64          | p<0,001 |
| L11           | 26,33 ± 14,44       | 21,27 ± 4,99          | p<0,001 | L24       | 19,49 ± 5,23        | 16,79 ± 4,60          | p<0,001 |
| L12           | 20,52 ± 4,74        | 18,04 ± 4,92          | p<0,001 | L25       | 18,11 ± 5,38        | 15,52 ± 4,66          | p<0,001 |
| L13           | 20,67 ± 4,72        | 17,63 ± 3,96          | p<0,001 | L26       | 18,96 ± 5,12        | 15,49 ± 4,38          | p<0,001 |
| Orfield Score | 68,28 ± 34,74       | 76,17 ± 29,70         | p>0,05  |           |                     |                       |         |

\*R:right hand.

Table VI. Comparison of left hand anthropometric measurements and orfield hand preference test score according to sex.

| Parameter | Male<br>(Mean ± SS) | Female<br>(Mean ± SS) | p Value | Parameter | Male<br>(Mean ± SS) | Female<br>(Mean ± SS) | p Value |
|-----------|---------------------|-----------------------|---------|-----------|---------------------|-----------------------|---------|
| R1        | 55,66 ± 7,20        | 50,59 ± 7,02          | p<0,001 | R14       | 20,18 ± 4,71        | 16,88 ± 4,04          | p<0,001 |
| R2        | 73,69 ± 9,06        | 67,10 ± 6,52          | p<0,001 | R15       | 17,98 ± 4,71        | 14,83 ± 4,34          | p<0,001 |
| R3        | 79,67 ± 14,56       | 72,52 ± 9,94          | p<0,001 | R16       | 101,18 ± 10,04      | 87,59 ± 10,15         | p<0,001 |
| R4        | 74,85 ± 10,23       | 66,34 ± 9,26          | p<0,001 | R17       | 84,86 ± 9,99        | 73,70 ± 6,85          | p<0,001 |
| R5        | 57,26 ± 9,77        | 50,19 ± 8,46          | p<0,001 | R18       | 80,83 ± 6,65        | 71,60 ± 6,84          | p<0,001 |
| R6        | 21,58 ± 4,66        | 18,14 ± 4,39          | p<0,001 | R19       | 18,75 ± 0,85        | 17,14 ± 0,93          | p<0,001 |
| R7        | 18,57 ± 4,56        | 15,52 ± 4,01          | p<0,001 | R20       | 39,10 ± 7,28        | 34,83 ± 7,11          | p<0,001 |
| R8        | 18,83 ± 4,57        | 15,64 ± 4,09          | p<0,001 | R21       | 38,51 ± 4,19        | 34,26 ± 4,78          | p<0,001 |
| R9        | 17,97 ± 4,45        | 14,79 ± 4,07          | p<0,001 | R22       | 55,85 ± 8,19        | 49,59 ± 5,87          | p<0,001 |
| R10       | 16,22 ± 4,44        | 13,24 ± 3,96          | p<0,001 | R23       | 21,84 ± 5,34        | 18,28 ± 4,40          | p<0,001 |
| R11       | 24,04 ± 5,85        | 20,85 ± 4,64          | p<0,001 | R24       | 19,82 ± 5,01        | 17,00 ± 4,61          | p<0,001 |
| R12       | 20,76 ± 4,90        | 17,80 ± 4,15          | p<0,001 | R25       | 18,83 ± 5,27        | 15,83 ± 4,56          | p<0,001 |
| R13       | 21,13 ± 4,67        | 17,74 ± 4,04          | p<0,001 | R26       | 18,18 ± 5,50        | 15,04 ± 4,64          | p<0,001 |

\*L: left hand.

Table VII. Comparison of right hand anthropometric measurement data according to hand preference.

| P   | Right         | Left         | A             | p      | P   | Right         | Left         | A             | p      |
|-----|---------------|--------------|---------------|--------|-----|---------------|--------------|---------------|--------|
| R1  | 55.12 ± 6.93  | 48.79 ± 4.80 | 53.68 ± 11.25 | p>0,05 | R14 | 19.04 ± 4.91  | 15.97 ± 3.97 | 18.73 ± 5.38  | p>0,05 |
| R2  | 73.41 ± 8.25  | 67.68 ± 4.81 | 72.54 ± 10.04 | p>0,05 | R15 | 16.17 ± 4.60  | 13.67 ± 3.44 | 16.78 ± 4.59  | p>0,05 |
| R3  | 75.30 ± 17.30 | 72.66 ± 6.44 | 80.71 ± 9.22  | p>0,05 | R16 | 90.09 ± 23.20 | 89.82 ± 6.95 | 96.98 ± 12.40 | p>0,05 |
| R4  | 71.15 ± 16.03 | 67.14 ± 8.80 | 71.51 ± 10.69 | p>0,05 | R17 | 76.24 ± 15.67 | 71.76 ± 7.53 | 80.30 ± 8.62  | p>0,05 |
| R5  | 57.28 ± 14.64 | 50.06 ± 7.86 | 54.65 ± 10.19 | p>0,05 | R18 | 78.84 ± 8.11  | 71.63 ± 6.86 | 78.26 ± 7.22  | p>0,05 |
| R6  | 19.46 ± 3.76  | 17.24 ± 4.07 | 19.39 ± 4.44  | p>0,05 | R19 | 18.11 ± 1.47  | 17.16 ± 0.67 | 18.55 ± 1.05  | p>0,05 |
| R7  | 17.36 ± 4.38  | 14.50 ± 3.79 | 16.34 ± 4.13  | p>0,05 | R20 | 32.87 ± 5.89  | 33.08 ± 6.03 | 42.08 ± 4.64  | p<0,05 |
| R8  | 17.24 ± 4.25  | 14.84 ± 3.64 | 17.43 ± 4.24  | p>0,05 | R21 | 34.91 ± 4.58  | 34.44 ± 4.04 | 36.54 ± 3.86  | p>0,05 |
| R9  | 16.63 ± 4.37  | 14.06 ± 3.42 | 16.64 ± 4.02  | p>0,05 | R22 | 55.18 ± 9.98  | 49.06 ± 5.78 | 53.46 ± 4.87  | p>0,05 |
| R10 | 14.65 ± 4.22  | 13.17 ± 4.01 | 14.12 ± 4.93  | p>0,05 | R23 | 20.33 ± 4.55  | 17.96 ± 4.35 | 19.84 ± 6.28  | p>0,05 |
| R11 | 21.76 ± 5.63  | 19.83 ± 4.35 | 22.10 ± 6.53  | p>0,05 | R24 | 18.78 ± 4.53  | 16.45 ± 4.40 | 17.52 ± 5.50  | p>0,05 |
| R12 | 18.89 ± 4.13  | 16.67 ± 4.20 | 13.95 ± 5.15  | p>0,05 | R25 | 17.15 ± 4.55  | 15.43 ± 5.41 | 16.36 ± 5.04  | p>0,05 |
| R13 | 19.26 ± 4.69  | 16.95 ± 3.81 | 19.45 ± 5.20  | p>0,05 | R26 | 16.35 ± 5.22  | 14.53 ± 4.89 | 15.79 ± 5.39  | p>0,05 |

\*R:right hand, P:parameter, A: ambidextrous

Table VIII. Comparison of left hand anthropometric measurement data according to hand preference.

| P   | Right        | Left          | A             | p      | P   | Right         | Left          | A             | p      |
|-----|--------------|---------------|---------------|--------|-----|---------------|---------------|---------------|--------|
| L1  | 44.15 ± 7.32 | 54.96 ± 16.49 | 56.41 ± 12.20 | p>0,05 | L14 | 16.61 ± 4.26  | 16.50 ± 1.38  | 19.58 ± 5.48  | p>0,05 |
| L2  | 66.27 ± 6.43 | 68.79 ± 9.63  | 74.28 ± 10.50 | p>0,05 | L15 | 14.18 ± 4.07  | 13.87 ± 1.40  | 17.86 ± 6.11  | p>0,05 |
| L3  | 74.36 ± 5.43 | 75.96 ± 7.49  | 81.56 ± 9.92  | p>0,05 | L16 | 91.40 ± 7.98  | 93.41 ± 10.68 | 94.02 ± 15.75 | p>0,05 |
| L4  | 66.40 ± 6.32 | 74.10 ± 5.81  | 76.81 ± 10.19 | p<0,05 | L17 | 73.68 ± 8.02  | 78.54 ± 10.74 | 82.25 ± 10.29 | p>0,05 |
| L5  | 53.40 ± 4.90 | 56.57 ± 7.88  | 60.99 ± 9.08  | p>0,05 | L18 | 69.69 ± 7.34  | 78.26 ± 7.09  | 78.06 ± 8.46  | p>0,05 |
| L6  | 17.75 ± 4.10 | 18.80 ± 2.17  | 20.80 ± 5.86  | p>0,05 | L19 | 17.26 ± 0.87  | 18.73 ± 1.15  | 19.50 ± 4.51  | p>0,05 |
| L7  | 14.82 ± 4.01 | 14.91 ± 1.84  | 17.92 ± 5.46  | p>0,05 | L20 | 31.26 ± 7.89  | 35.98 ± 3.93  | 33.71 ± 7.09  | p>0,05 |
| L8  | 14.92 ± 3.91 | 15.20 ± 1.24  | 17.86 ± 5.00  | p>0,05 | L21 | 34.15 ± 5.74  | 36.71 ± 4.14  | 34.92 ± 6.68  | p>0,05 |
| L9  | 14.80 ± 4.10 | 14.08 ± 0.90  | 17.37 ± 5.10  | p>0,05 | L22 | 47.20 ± 6.90  | 54.33 ± 7.03  | 55.10 ± 6.18  | p>0,05 |
| L10 | 12.80 ± 3.90 | 12.81 ± 1.43  | 16.08 ± 5.37  | p>0,05 | L23 | 19.56 ± 10.27 | 18.39 ± 6.13  | 20.19 ± 5.21  | p>0,05 |
| L11 | 21.12 ± 4.08 | 20.61 ± 2.65  | 24.03 ± 6.14  | p>0,05 | L24 | 15.99 ± 4.36  | 17.47 ± 5.48  | 18.65 ± 4.77  | p>0,05 |
| L12 | 17.48 ± 5.06 | 17.54 ± 1.91  | 20.12 ± 5.65  | p>0,05 | L25 | 14.21 ± 4.55  | 17.47 ± 6.02  | 17.07 ± 5.48  | p>0,05 |
| L13 | 17.62 ± 4.60 | 17.62 ± 1.86  | 20.47 ± 5.31  | p>0,05 | L26 | 14.92 ± 3.77  | 15.84 ± 6.00  | 17.63 ± 5.43  | p>0,05 |

\*R:right hand, P:parameter, A: ambidextrous.

The p value of right hand height between right hand dominant and ambidextrous individuals was 0.014; the p value of left hand 4th finger length between left hand dominant and ambidextrous individuals was 0.016.

A negative, low and statistically significant relationship was found between the Orfield hand preference test and right hand length and left hand 2nd-5th finger distance ( $r = -0.162$ ,  $p = 0.047$ ,  $r = -0.174$ ,  $p = 0.033$ ).

## DISCUSSION

In this study, 26 anthropometric hand measurements of male and female dental students were completed. These anthropometric measurements, which include the general dimensions of the hand, include hand width, hand length and joint widths. These measurements can be considered among the most important hand dimensions when designing an instrument (Oviedo-Trespalcios *et al.*, 2017). It is known that men generally have larger physical dimensions compared to women (Hallbeck, 1994; Barut *et al.*, 2014; Je *et al.*, 2015). The results of our study also support this theory. In all 26 anthropological measurements, it is shown that the hand length and width of male individuals are significantly greater than those of females.

Erman *et al.*, who conducted a study on dental students reported that the mean values of hand dimensions in both hands were larger in males than in females (Cakit *et al.*, 2014). In studies conducted in Bangladesh and Northern Colombia, anthropometric hand measurements of males were found to be larger than females (Oviedo-Trespalcios, 2017; Asadujjaman *et al.*, 2019). Zhang *et al.* (2017) in Chinese population and Krishan & Sharma (2007) in North Indian individuals reported that male participants had larger hand length and width than females. In 2015, in another study conducted on a Korean population, it was determined that male participants had larger hand length, hand width, palm length, thumb length, index finger length, middle finger

length, ring finger length and pinkie finger length than female participants (Jee *et al.*, 2025). In another study conducted by Ishak *et al.* (2012) in the Western Australian population, it was found that men had larger hand length, hand width, palm length, thumb length, index finger length, middle finger length and ring finger length than women. In a study conducted in a Korean population, it was emphasised that hand size was larger in men than in women and the biggest difference was found in maximum hand circumference. They also revealed that hand size difference can be used as a tool to estimate the height of the person (Jee *et al.*, 2015). The results given in the sample studies above are in parallel with the results of our study and our study contributes to the literature on female-male hand sizes.

Gupta *et al.* (2022), who investigated the usability of hand anthropometric measurements in sex estimation in forensic anthropology, found that the hand measurement parameters of males were larger compared to females and stated that this may be helpful in revealing sex differences in forensic cases. They also added that the left hand length had the highest accuracy rate (Gupta *et al.*, 2022). According to the results of another study conducted by Soo-Chan Jee *et al.* (2015) on Korean individuals, the rate of predicting the sex of the maximum hand circumference for males was 88.6 % and 89.6 % for females, contributing to the literature. In our study, significant results were found in favor of male individuals in all 26 parameters and the greatest difference was obtained from the measurement of hand width along the first finger (R16-L16).

Many important studies in the literature have accepted that the fact that hand size is higher in men than in women, is one of the reasons why men have more grip strength than women. In these studies, a high correlation was shown between palm length and grip strength (Sharifi-Mollayousefi *et al.*, 2008; Wu *et al.* 2009; Kong & Kim, 2015; Shahida *et al.*, 2015; Rostamzadeh *et al.* 2019, 2020). This link between hand size and grip strength is an important issue for future

ergonomic applications. Sex-related anthropometric differences in the hand should be taken into account in the design of industrial work systems and the preparation of working conditions, with a view to minimizing sex differences (Oviedo-Trespacios *et al.*, 2017). We think that the data on hand size of men and women obtained for our study can serve as a reference for future studies on hand size and grip strength.

Turkish and foreign students studying in dentistry were included in our study. Among 26 anthropometric hand measurements, only hand length was significantly different in foreign students. The mean hand length was found to be higher in foreign students than in Turkish students. When we compared the subjects as male and female, it was found that Turkish girls had larger right hand widths (R17 and R18), wrist circumference (R21), 5th finger length (R5), mostly finger widths (R6, R7, R9, R10, R14, R15, R23, R26) than foreign girls and these differences were statistically significant. When we compared the male participants as Turkish and foreign nationals, no significant difference was found between the results.

Erman *et al.*, compared Turkish-Thai, Turkish-Nigerian, Turkish-Indian, Turkish-Vietnamese, Turkish-Indian and Turkish-Vietnamese nationalities and found that Turkish girls had wider finger widths than girls from other populations, with the exception of Indian women. This data is in parallel with the data of our study. However, in contrast to our study, it was reported that Turkish women had shorter hand sizes than other populations and Turkish men had longer hand sizes than other nationalities (Cakit *et al.*, 2014).

In another study conducted by Mollayousefi *et al.*, on Turkish and Iranian individuals, it was reported that Iranians had thinner hands than Turks (34). Ibeachu *et al.*, compared the data collected from Nigerian men and women with the data collected from Turkish individuals by Barut *et al.* (2014) and found that the hand size of Nigerians was thinner than that of Turks. In our study, no significant difference was found between Turkish and foreign nationals. Mirmohammadi *et al.* (2016) reported that the longest hand length belonged to Iranian individuals among the populations of Iran, India, Jordan, Turkey, Vietnam and Bangladesh, all of which were male industrial workers, and that the hand width in the thumb region of Iranian individuals was larger than the populations of India, Vietnam and Bangladesh, but smaller than the individuals of Turkey and Jordan. In our study, no significant difference was found between Turkish and foreign nationals in the hand width parameter.

In our study, Orfield hand preference test was applied to the participants and graded according to Graskov scale.

When the hand measurements and hand preference test results of the participants were compared, only two parameters were found to be significantly different. In ambidextrous individuals, right hand height (R20) was significantly higher than left handed individuals and left fourth finger length (L4) was significantly higher than right handed individuals. In addition, according to the Orfield hand preference result, an opposite but significant result was found between right hand length and hand width at the left hand metacarpal joints. While the right hand length increased in right-handed individuals, the distance between the 2nd-5th fingers of the left hand decreased. In left-handed individuals, while the right hand length decreased, the distance between the 2nd-5th fingers of the left hand increased. The results of our study proved that the use of right or left hand caused a significant difference in hand anthropometry. In parallel with the results of our study, in a study conducted by Neumann (1992), it was found that the length, width and circumference measurements of the apparent right-handed preference were significantly asymmetric in favor of the right side in right-handers compared to left-handers. Similarly, in a study conducted by Kulaksız & Gözil (2002) in parallel with our study, it was reported that hand width and length were measurably larger in the right hand in right-handed individuals. As an example, both studies show that in the case of right hand dominance, hand width asymmetry in the right hand is prominent, but in the case of left hand dominance, the degree of asymmetry is lower and irregular. In a study conducted by Mirmohammadi *et al.* (2016) with 529 participants, possible differences between right and left hand were investigated and significant differences were recorded. In the study conducted by Cakit *et al.* (2014) the mean values of finger widths, finger circumferences and hand depths were found to be significantly larger in the right hand compared to the left hand between sexes. Considering that 92 % of the participants in this study were right-handed, it is thought that this difference may be related with laterality (Cakit *et al.*, 2014).

The 2nd and 4th finger length ratio (2D/4D), which has been the subject of many studies in the literature, continues to increase in popularity today. In terms of sex, a higher 2D:4D ratio (longer index finger) indicates prenatal estrogen hormone dominance, while a lower ratio (longer ring finger) indicates testosterone hormone dominance (Manning *et al.*, 2003; Lutchmaya *et al.* 2004). It has been shown that opposite rates are observed in homosexual women and men (James, 2001; Rahman, 2005). Apart from the effects of the ratio on the sexes, its links with diseases and its relationship with psychological and characteristic features are still being investigated. In our study, we wanted to draw attention to the 2D/4D ratio between Turkish race and different nationalities. The ratio (2D:4D) did not show



a significant result between Turkish and foreign nationals. When the results of the participants were analyzed on the basis of sex, firstly as male-female and then as Turkish and foreign nationals, no statistically significant difference was obtained in the 2D: 4D ratio of the right hand.

## CONCLUSIONS

Since the design of tasks and equipment is based on the concept of 'fitting the person to the task', and since the dentists in our study perform tasks that require precision, the instruments they use should be suitable for various anthropometric dimensions. The size, shape and design of the equipment used are usually produced taking into account the 26 anthropometric lengths measured in our study. This difference becomes even more important when sex differences are taken into account. Instruments that are too small or too large, or that do not conform to the contours of the hand, may require more muscle strength than well-fitting instruments, and the accumulation of musculotendinous strains in repetitive use may lead to cumulative trauma disorders of the hand. In addition to sex differences, nationality differences must also be taken into account in the design of hand tools.

Our study provides new data to the literature on female - male hand size and emphasized once again the rate and importance of hand size difference between the two sexes. In addition, since our research includes Turkish and foreign nationals, in the light of the data it presents, it aims to increase the efficiency of use of the equipment to be imported to our country and the people of our country and to reduce occupational accidents caused by the equipment. The findings of our study strengthen our understanding of the general hand morphology and shape by sex in a Turkish population. In addition, our study can be a reference for future research.

Our research has some limitations. Firstly, the sample size can be considered small and therefore not descriptive enough to reflect the whole population. For a more comprehensive assessment, additional studies with larger groups evaluating the above-mentioned factors are needed.

**Study Limitations:** Our study is valuable in contributing data to forensic anthropology, especially in terms of ethnic origin studies. However, there are some limitations. Firstly, it is a single-center study. To obtain a broader scope of results, the study could be expanded to include a larger number of participants, extended over several years, and conducted in multiple hospitals, cities, or even countries.

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**ERDOGAN, E.; KARACAN, K. & BILGIC, S.** Correlación de la preferencia de mano con las medidas antropométricas de la mano en estudiantes universitarios. *Int. J. Morphol.*, 43(2):554-563, 2025.

**RESUMEN:** En la vida diaria la mano es un órgano fundamental para las actividades personales y profesionales, como agarrar, sostener, tocar y realizar actividades motoras finas. Además, con su compleja estructura que consta de veintisiete huesos y quince articulaciones, nos permite realizar movimientos que requieren coordinación motora fina. En la literatura, existen estudios que muestran que la morfología de la mano varía según factores como la raza, el sexo y la mano dominante. Estos estudios constituyen datos importantes en la antropología forense e incluso en el diseño de herramientas ergonómicas. Con el desarrollo de la tecnología, se necesitan más estudios en este campo. En nuestro estudio, pretendemos contribuir a la literatura comparando la morfometría de la mano de la población turca en términos de parámetros como el sexo, la etnia y la preferencia manual. Los resultados de nuestro estudio serán una fuente importante de datos para estudios futuros de comparación morfológica de la mano. En nuestro estudio participaron un total de 152 jóvenes universitarios voluntarios, 128 de los cuales eran turcos y 24 eran de diferentes orígenes étnicos. Se midieron ambos parámetros de la mano de los participantes y se compararon según variables como sexo, etnia y mano dominante. También se incluyeron la prueba de preferencia de mano de Orfield y las evaluaciones de la relación 2D:4D. Aunque los resultados obtenidos fueron consistentes con la literatura, se encontró que la longitud de la mano derecha fue significativamente mayor en grupos distintos a los participantes turcos. Además, se encontró que el ancho, la altura y la longitud del quinto dedo de la mano derecha fueron mayores en las niñas turcas en comparación con otros grupos étnicos. La relación 2D:4D no arrojó resultados significativos en ningún grupo. Nuestro estudio proporciona nuevos datos a la literatura y fortalece nuestra comprensión de la morfología de la mano según el sexo, especialmente en la sociedad turca.

**PALABRAS CLAVE: Mano; Preferencia de mano; Morfometría de la mano; Orfield; Proporciones de los dedos.**

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