

FORENSIC IMPLICATION OF HAND DIMENSIONS FOR GENDER ESTIMATION AMONG CHANDIGARH POPULATION

GURJEET KAUR, PRIYANKA VERMA AND GAURAV KR SINGH

ABSTRACT

Gender determination is an essential and prominent basis in initiating the identity of an individual for forensic purpose. Forensic anthropology plays very important role in the identification of unknown individuals. In forensic investigations it is routinely utilised to determine the identity through determination of stature, age, race and gender. In this study, an attempt has been made to determine the gender and individualise on the basis of hand anthropometry which has given significant results. Hence the results of the study have the potential to be used in case where identification is difficult in a situation where an isolated or dismembered part of body or in putrefied state is encountered at the crime scene.

Keywords: Anthropometry, Sexual dimorphism, Hand Length, Hand Breadth, Index Finger Length, Ring Finger Length,

INTRODUCTION

In forensic science investigation, identification of unknown individual is the most essential feature. In recent times, the identification of an unknown individual is very useful, because of the frequency of mass disasters such as floods, bomb-blasts, earthquakes, cyclones, tsunamis, plane crashes, forest fires, etc. In current scenarios, for social and legal reasons, identification of human remains is very important. Identification of individuals can be done using different methods. In some cases, mutilated, dismembered, isolated mutilated, dismembered, fragmented or decomposed remains are recovered and the forensic anthropological examination of remains can lead to reliable confirmation of gender, age, stature and race of the remains. Identification is difficult when an isolated or dismembered part of body is encountered at the crime scene. These isolated or dismembered parts are used for the stature, age, and gender confirmation and are very helpful in the identification of unknown individual.

Gurjeet Kaur, Department of Forensic Science and Toxicology, University Institute of Applied and Health Sciences, Chandigarh University Gharuan, Mohali, Punjab; **Priyanka Verma**, Assistant Professor, Department of Forensic Science and Toxicology, University Institute of Applied and Health Sciences, Chandigarh University Gharuan, Mohali, Punjab; **Gaurav kr Singh**, Research Scholar, Department of Forensic Science and Toxicology, University Institute of Applied and Health Sciences, Chandigarh University Gharuan, Mohali, Punjab.

Forensic anthropology is a branch of physical anthropology. This plays very essential role in the identification of unknown individual. Parameters such as stature, age estimation, race and gender determination is very helpful in the formation of biological profile of the individuals or victims. Forensic anthropologist operates with the pathologists and odontologists for the identification of the individual and to find out the cause, manner and time since death.

Gender determination is very essential feature for the identification of an individual in forensic investigation. It helps the forensic scientist and anthropologists in legal investigation. If isolated hand is encountered at the place of offence, it is used as evidences for the identification of the individual. Human hand is a flexible part of the body. Therefore, anthropometric measurements of hand can helps in estimation of the stature or gender of an individual. Anthropometry (a scientific study of the anthropometric measurements of the different parts of the body) has been a technique of identification in the past that is also known as the Bertillon system for identification. The sex of the individual can be determined from the size and shape of skeleton; in general the female skeleton is smaller than male skeleton.

Considerable efforts have been brought out by different researcher to determine the gender from various anthropometrics measurements of hand dimensions (Williams *et al.*, 2000; Kanchan and Rastogi, 2009) and also from metacarpals and phalanges (Scheuer and Elkington, 1993). In this study, an attempt has been made to determine the gender and individualise on the basis of hand anthropometry.

MATERIALS AND METHODS

In the present study, total of 100 subjects (50 males and 50 females) were selected from the colleges and urban area of Chandigarh within the age range of 20 to 40 years. The samples were collected randomly from the subjects (both male and female) of both hands (right and left). A data of hand measurements of both right and left hand were collected with the help of vernier calipers. All the measurement of hand dimensions were measured in centimeters.

Hand Dimensions: Following four anthropometric measurements of both hands of each subject were taken:

- 1) **Hand Length (HL):** Straight distance between the mid -point of the distal transverse crease of the wrist to the most anterior projection of the skin of the middle finger i.e. tip of the middle finger (Kanchan and Kumar, 2011).
- 2) **Hand Breadth (HB):** Straight distance between the most laterally projected parts of the palm at the second metacarpal to the most medially projected part of the palm at the fifth metacarpal.
- 3) **Index Finger Length (IL):** Straight distance between the proximal flexion creases of the finger to the tip of the respective finger.

- 4) **Ring Finger Lenth (RL):** Straight distance between the proximal flexion creases of the finger to the tip of the respective finger (Agnihotri *et al.*, (2015).

Before taking measurements, some subjects were asked to wash their hands properly and clean and dry it. While taking the measurements of hand dimensions, subjects were asked to place their hand on a flat surface and stretch it to its maximum with fingers together. In addition, hand outlines of both hands were taken on a white A4 sheet. For this, the subjects were asked to place their hand on the white A4 sheet, then with outline of the hand was drawn with a pencil.

Statistical Analysis: MS Office Excel worksheet was used to carry out the entry of the data. The collected data was statistically analyzed and mean, median, mode, maximum, minimum, and standard deviation were calculated. An independent or unpaired t-Test was used to evaluate the level of significance of differences.

RESULTS AND DISCUSSION

Hand Length (HL): As can be seen in seen Table-1, in males, the hand length of left hand in males varies from 17.73 to 21.23 cm with a mean of 19.01 while in right hand it varies from 17.43 to 21.03 cm (mean18.95). In females, the length of left hand varies from 16.24 to 19.35 cm (17.42± SD 0.77) and for right hand it ranges from 16.23 to 19.33 cm (mean17.45±SD0.72).

In the present study, the left hand side in males were relatively longer than the right hand, while in females the length of the left hand was shorter than the right hand, as shown in Table-1. Males were having greater hand length as compared to the females. The result of hand dimension (hand length) is nearly similar to the study of Hagag *et al.* (2011) and Dhawan *et al.* (2016). The result of Dhawan *et.al* study shows that the male has significantly greater hand dimensions than females. The gender differences in hand length of both hands were statistically significant($p < 0.001$), as can be seen in Table-3.

Table-1: Hand Length and Hand Breadth (cm) of left and right hands of male and female subjects

| Hand Dimensions | Mean | Maximum | Minimum | Standard Deviation |
|-----------------|---------------|-------------|--------------|--------------------|
| MALE (n=50) | | | | |
| RHL | 18.95222 | 21.032 | 17.432 | 0.810188572 |
| LHL | 19.01718 | 21.238 | 17.738 | 0.820894775 |
| RHB | 8.47952 | 9.608 | 6.91 | 0.52590378 |
| LHB | 8.3748 | 9.702 | 6.102 | 0.739518762 |
| FEMALE (n=50) | | | | |
| RHL | 17.45356 | 19.332 | 16.232 | 0.721040098 |
| LHL | 17.42868 | 19.358 | 16.24 | 0.77225634 |
| RHB | 7.38878 | 8.306 | 6.65 | 0.35741734 |
| LHB | 7.2872 | 8.21 | 6.648 | 0.361116636 |

RHL-right hand length, RHB-right hand breadth, LHL-left hand length, LHB-right hand.

Hand Breadth (HB): As can be seen in Table-1, in males, the left hand breadth ranges from 6.102 to 9.702 cm (mean 8.37 ± 0.73) and for right hand it varies from 6.91 to 9.608 cm (mean 8.47 ± 0.52). In females, the left hand breadth varies from 6.64 to 8.21 cm (mean 7.28 ± 0.36) and for right hand it varies from 6.65 to 8.306 cm (mean 7.38 ± 0.35).

In the present study, males show greater hand dimensions as compared to the females. These results are similar to the results of the study of Dey and Kapoor (2015) which also reported significant sex differences in hand dimensions between males and females. Hand breadth shows greater accuracy for the determination of the gender. The statistical comparison of breadth of both hands of males with the females shows less significant value) as compare to the hand length, as shown in Table-3.

Index (2D) and Ring (4D) Finger Length (FL): The values of mean, maximum, minimum and standard deviation of index finger length (2D) and ring finger length (4D) are given in Table-2. In males, the length of index finger of right hand varies from 6.702 to 8.802 cm (mean 7.40 ± 0.440) and for left hand it ranges from 6.53 to 8.902 cm (mean 7.44 ± 0.441). In females, the length of index finger of right hand varies from the 6.302 to 8.002 cm (mean 6.89 ± 0.36) and for left hand it ranges from 6.202 to 8.002 cm (mean 6.91 ± 0.37).

TABLE 2: Index Finger Length and Ring Finger Length (cm) of both Hands in Male and Females of the present sample

| Hand Dimensions | Mean | Maximum | Minimum | Standard Deviation |
|-----------------|----------------|-------------|--------------|--------------------|
| MALE (n=50) | | | | |
| RHIL | 7.40676 | 8.802 | 6.702 | 0.440138362 |
| LHIL | 7.44636 | 8.902 | 6.53 | 0.44135241 |
| RHRL | 7.56552 | 8.402 | 6.502 | 0.426522064 |
| LHRL | 7.5332 | 8.702 | 6.608 | 0.428046726 |
| FEMALE (n=50) | | | | |
| RHIL | 6.8994 | 8.002 | 6.302 | 0.367541251 |
| LHIL | 6.91424 | 8.002 | 6.202 | 0.374343647 |
| RHRL | 6.96252 | 7.902 | 6.11 | 0.367435417 |
| LHRL | 6.96504 | 8.01 | 6.402 | 0.375692067 |

RHIL- right hand index length, RHRL-right hand ring length,
LHIL-left hand index length, LHRL-left hand ring length.

In males, the length of ring finger of right hand varies from 6.502 to 8.402 cm (mean 7.56 ± 0.426) and for left hand it ranges from 6.608 to 8.702 (mean 7.53 ± 0.428). In females, the length of ring finger of right hand varies from 6.11 to 7.902 cm (mean 6.962 ± 0.36) and for left hand it ranges from 6.402 to 8.01cm (6.965 ± 0.37), as shown in Table-2.

The result of present study shows that, males have greater lengths of index and ring fingers as compared to the females (Table-2). The results of the present study are comparable to the results of the study of Dey and Kapoor (2016) in which they found that the lengths of index and ring fingers was relatively significantly larger in males than females.

In the present study, the mean length of index finger was smaller than that of the ring finger. The statistical result of comparison of length of index and ring finger of both hands of males with the females shows less significant value ($p < 0.001$) as compare to the hand length and more significant than hand breadth. The statistical results of comparison the length of index finger shows greater significant ($p=0.018$) results as compare to the length of the ring finger ($p=0.0023$) as shown in table 3.

In the present study, the bilateral differences in hand dimensions shows stronger significance in males as compared to the females. The hand length shows higher values of significance for sex differences as compared to the hand breadth, index finger length and ring finger length. In males hand dimensions were larger than females and left hand shows greater accuracy.

Table-3: Results of t-test of right and left hand dimensions of males and females.

| S.NO. | Hand Dimensions | P Value* | 95% Confidence Interval |
|-------|------------------------|-----------------|-------------------------|
| 1 | RHL & LHL | 0.0005*** | 1.401-1.689 |
| 2 | RHB & LHB | 0.0034** | 0.8245-1.376 |
| 3 | RHIL & LHIL | 0.0018** | 0.4238-0.6162 |
| 4 | RHRL & LHRL | 0.0023** | 0.4845-0.7355 |

*** Highly Significant Value

** Significant Value Unpaired T-Test used to calculate significant level,

*p value has been considered to be statistically significant

CONCLUSIONS

Gender determination is one of the most important parameters for the identification of an individual. The results of the study show that hand dimensions are useful for criminal investigation and an important forensic tool for medico-legal cases. From the results of this study it can be concluded that human hand dimensions, viz., length of hand, hand breadth, and length of the index finger and ring finger, show sexual dimorphism. Therefore, the anthropometric measurements of hand dimensions can be used for the determination of gender and identification of an individual, if dismembered or isolated or individual hand is encountered at a place of crime.

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