SEXUAL DIMORPHISM IN HAND DIMENSIONS: AN ANTHROPOMETRIC STUDY IN NORTH INDIAN HARYANVI ADOLESCENTS

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ABSTRACT

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Introduction: The human hand which is the most used and versatile part of the body is of great scientific importance. Studies have established racial identification, sexual dimorphism and height and age estimation from hand dimensions for forensic applications.

Materials and Methods: The present in study was conducted to observe the sex differences in hand dimensions among North Indian Haryanvi adolescent population. The study was carried out in the Department of Anatomy at MM Institute of Medical Science & Research, Mullana, Ambala (Haryana), India. Data for the study were obtained from 400 Haryanvi Adults (200 males and 200 females) aged between 21-25 years randomly selected from population of Haryana. Diseased and/or disabled hands were excluded from the study. Hand length, Hand breadth, Palm Length were measured using sliding vernier’s callipers, Hand index was calculated using formula following standard protocols. Statistical analysis of the obtained data was done in relation with gender and side. The dimensions of both hands showed significant relation with sexual dimorphism.

Results: Results of our study may be useful to identify sex in medico-legal investigations and to decide man-machine compatibility in designing hand tools.

KEY WORDS: Sexual Dimorphism, Hand Length (HL), Hand Breadth (HB), Palm Length (PL), Hand Index (HI), Hand Dimensions, Anthropometry.

INTRODUCTION

Person identification, ascertaining sex and estimation of stature from incomplete skeletal and decomposing bodies is a recurring theme in physical anthropology and forensic science [1-5]. This has become useful in recent times due to mass disasters like terrorist attacks, plane crash, mass suicide, tsunamis, forest fires, earth quakes [6]. Relationship between different body parts especially the limbs is being used to establish sex and stature [5-8], which is a prerequisite to identification in forensic investigation. Specifically hand and foot have been used by many investigators to determine sex and estimate stature [2,5,7,9,10].

Sex, age, stature and ethnicity are big fours of person identification.
anthropometry. Among these ‘big fours’ of anthropometry, determination of sex is one of the foremost criteria in establishing the identity of an individual to Anthropologist, Anatomist, Ergonomist, Obstetrician and in medico-legal practice. Accurate sexing of the remains primarily narrows down the pool of possible victim matches [10-17]. Many human features have been used to estimate sex from skeletal remains and body parts owing to the established relationship between sex and different parts of the body [18].

Sex difference in hand dimensions is a common phenomenon in human population. But the magnitude of sex difference is found to be varying from population to population. So, many authors have been working on body anthropology to find out sex differences [19-21]. Dimensions are more in males compared to females [22,23]. Differences in the morphological characters among inter and intra population is quiet interesting. India is known to be quite unique for human diversity in anthropometry. Variations in the hand dimensions are influenced by various factors like nutritional status [24], socio-economic status [25] and climate [26]. Hence the human population tends to have certain specific characters which stamp them as residents of a particular place in the world [27] the hand dimensions have been found to show high accuracy in sex determination when compared to indices. Of all hand dimensions, hand breadth has been reported to have the highest accuracy in sex determination [28].

When a dismembered upper limb is encountered, the dimensions of hand can help to determine the sex of the individual. The dimensions of hand may also provide guidance in planning for the selection of free skin graft in plastic surgeries [19].

The aim of this study is to provide the authentic database for forensic investigators in the hand length, hand breadth, palm length and hand index, and to determine the relationship between sex and both hands in a sample of Haryanvi adolescent population.

MATERIALS AND METHODS

The study was conducted for period of one year from Feb 2013 to Jan 2014. This study was carried out on a cross sectional sample of adolescent population (200 males and 200 females) aged between 21-25 years of the Haryana state, India. Samples were drawn randomly across the permanent resident of Haryana state of India, after giving informed consent both in English and Vernacular to participate in the study. Those with genetic, psychological, neurological or any chronic diseases affecting hand dimensions were excluded.

Recording of Hand Dimensions: Precautions were taken by asking the subject to clean the hands by washing with soap and water. After cleaning and drying following hand dimensions were measured. The subject was asked to place their hands in supine position on a table with fingers extended.

The hand dimensions in the categories given below were taken by sliding vernier’s callipers in centimetres [29].

All the measurements were taken from the palmer aspect of hand with fingers fully extended, adducted on the flat surface and thumb extended. The hand length, hand breadth and palm length were measured [29] (Figure 1) and hand index was calculated using formula following standard protocols.

Hand Breadth (HB): Distance between the most lateral point on the head of 2nd metacarpal to the most medial point on the head of 5th metacarpal.

Hand Length (HL): Distance between mid-point of the distal transverse crease of the wrist to the most anterior projection of the skin of the middle finger.

Palm Length (PL): Distance from the mid-point...
of the distal transverse crease of the wrist to the midpoint of proximal flexion crease of the middle finger.

**Hand Index (HI):** Hand breadth / Hand length x 100

**Statistical Analysis:** During data collection completed questionnaires were checked regularly to rectify any discrepancy, logical errors or missing information. The data entry was carried using Microsoft Office Excel Worksheet and then exported to statistical software and analyzed using statistical tests by using Statistical Package for Social Services (SPSS vs. 21 Mac.IBM Inc. Chicago).

Data was analyzed statistically by Minimum, maximum, mean, standard deviation, independent t-test was used to calculate significant level, pearson correlation were used to evolve regression analysis and other appropriate statistical tests which were applied depending upon the data collected.

**RESULTS**

The study was conducted with 400 adolescent population of Haryana state of India (males- 200; females- 200) aged between 21 – 25 years. Of 800 hands studied, the values of HL, HB, PL and hand index shown in Tables: 1 and 2 and were found to be significantly greater in males than females. The dimensions of hand were more on the left side than right side in both sexes except HL of females where RHL_F>LHL_F. Out of the parameters studied, the measurements of HL, HB, and PL were significant as compared with the indices (p<0.05).

**Hand Length (HL):** The hand length in males on right side varied from 16.90 cm to 21.70cm (Mean 19.36 ± SD 0.826) but the left side varied from16.60 cm to 21.40 cm (mean 19.42 ± SD 0.787).In females, the right hand length measured from 15.50 cm to 19.30 cm (mean 17.73 ± 0.686) and the left hand length varied from 15.60 cm to 19.40 cm (mean 17.72 ± SD 0.727).

**Hand Breadth (HB):** In males, the right hand breadth varied from 7.40 cm to 10.00 cm (mean 8.77 ± SD 0.486), and the left hand breadth varied from 7.80 cm to 10.70 cm (mean 8.81 ± SD 0.470). In females, the HB on right side varied from 6.90 cm to 9.00 cm (mean 7.80 ± SD 0.408), and that on left side hand breadth varied from 6.80 cm to 8.80 cm (mean 7.92 ± SD 0.802).

**Palm Length (PL):** In males, the right palm length varied from 9.30 cm to 11.80 cm (mean 10.54 ± SD 0.553), and the left palm length varied from 8.90 cm to 11.70 cm (mean 10.61 ± SD 0.488). In females, the right palm length varied from 8.30 cm to 10.80 cm (mean 9.72 ± SD 0.461), and that on left side left palm length varied from 8.40 cm to 11.10 cm (mean 9.79 ± SD 0.462).

**Hand Index (HI):** In males, right hand index varied from 37.19 cm to 52.91 cm (mean 45.34 and SD 2.633), and the left hand index varied from 39.50 cm to 52.20 cm (mean 45.41 and SD 2.319). In females, the right hand index varied from 38.50 cm to 49.03 cm (mean 43.99 and SD 4.299), and left hand index varied from 36.08 cm to 50.00 cm (mean 44.72 and SD 4.299). There was a statistically highly significant
difference in these two groups of males and females for right hand length (RHL), right hand breadth (RHB), right palm length (RPL), right hand index (RHI), left hand length (LHL), left hand breadth (LHB), left palm length (LPL), left hand index (LHI) (p=0.000).

**DISCUSSION**

Our present study strongly denotes sexual dimorphism in the hand dimensions as stated earlier (Table 3). Regarding sexual differences, men presented greater dimensions than women similar to other studies. Hand length can be a good predictor of body surface area independent of the sex of an individual [30].

The hand dimensions were significantly greater in males than females and the left hand showed higher dimensions than left side. The findings regarding the hand dimensions were very near with that of Khaled et al [12].

Kanchan et al [28] noted that in all hand dimensions, the hand breadth had highest accuracy for sex differences but our study found all dimensions were significant.

In present study, the hand length of north Indians was found to be more than that of south Indians [9,19], Mauritius [32] and Port Harcourt, Nigeria [1] but less than with that of Jat sikh, Punjabi [16], Delhi [31] and Nigerian [1] population. The hand length of women of Delhi [31], Nigeria [1], Upper Egypt [12] and Istanbul [15] were found to be more than Haryanvi Indian females (our study).

The hand breadth in Haryanvi Indian males in our study was found to be more compared to all studies shown in table 3 except RHB of Nigerians [1]. But the female HB in the present study was found to be more compared to all studies shown in Table 3.

The palm length in our study showed a statistically significant higher value in males as compared to females but this was lesser in values as compared to south Indians [19].

The Hand Index in our study showed a statistically significant higher value in males as compared to females and this was also greater in values as compared to all tabulated studies.

The key features found in present study were:

1. All hand measurements are sexually dimorphic.
2. The length, breadth and index of the hand contribute most significantly to sex discrimination.
3. All dimensions of right hand of males were greater than right hand dimensions of females, difference were statistically highly significant (p=0.000).

**Table 3:** Comparison of mean hand dimensions of males and females of present study group with some accessible previous studies.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Authors</th>
<th>Population and Country</th>
<th>Age Group</th>
<th>Sex and No. of subjects</th>
<th>Mean Hand Length RHL</th>
<th>Mean Hand Breadth RHB</th>
<th>Mean Palm Length LPL</th>
<th>Mean Hand Index LHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jasuja OP et al. (2004) [16]</td>
<td>Jat sikh, Punjab, India</td>
<td>18-60</td>
<td>M (30)</td>
<td>19.8</td>
<td>19.79</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>Oommen A et al. (2005) [9]</td>
<td>Manglore, Karnataka, India</td>
<td>19-25</td>
<td>M (50)</td>
<td>19.06</td>
<td>19.06</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>Suli et al. (2005) [31]</td>
<td>Delhi, India</td>
<td>18-22</td>
<td>M (75)</td>
<td>19.6</td>
<td>19.5</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>5</td>
<td>Danborno B et al. (2000) [1]</td>
<td>Nigeria</td>
<td>18+</td>
<td>M (250)</td>
<td>19.85</td>
<td>19.93</td>
<td>8.9</td>
<td>8.68</td>
</tr>
<tr>
<td>6</td>
<td>Devi KVS et al. (2011) [19]</td>
<td>South Indian</td>
<td>17-20</td>
<td>M (99)</td>
<td>19.01</td>
<td>19.07</td>
<td>8.46</td>
<td>8.28</td>
</tr>
<tr>
<td>7</td>
<td>Ibeachu PC et al. (2011) [19]</td>
<td>Port Harcourt, Nigeria</td>
<td>18-30</td>
<td>M (150)</td>
<td>19.02</td>
<td>19.09</td>
<td>8.58</td>
<td>9.63</td>
</tr>
<tr>
<td>9</td>
<td>Ozaslan A et al. (2012) [15]</td>
<td>Istanbul, Turkey</td>
<td>20-51</td>
<td>M (224)</td>
<td>19.23</td>
<td>--</td>
<td>8.29</td>
<td>--</td>
</tr>
<tr>
<td>10</td>
<td>Present study</td>
<td>Haryana, India</td>
<td>21-25</td>
<td>M (200)</td>
<td>19.36</td>
<td>19.42</td>
<td>8.77</td>
<td>8.81</td>
</tr>
</tbody>
</table>

4. All dimensions of left hand of males were greater than left hand dimensions of females, difference were statistically highly significant (p=0.000).

The present study revealed that in males, the hand length was more than 16.60 cm, the hand breadth was more than 7.40 cm and the palm length was more than 8.90 cm but in the females, these values were found to be lower than males. Hence 16.60 cm for hand length, 7.40 cm for hand breadth and 8.90 cm for palm length can be considered as a deviation point for determination of sex.

The present study has taken into consideration only the age group between 21 and 25 years in north Indian Haryanvi adolescent population. In future, the authors recommend a study including different age groups and in different populations for better interpretation of results.

CONCLUSION

The measurements of hands in our study demonstrated a significant impact in deciding the sex with a high degree of expected accuracy in Haryanvi adolescent population; they can be utilized in identification of sex in forensic science, in planning plastic surgeries, in designing hand tools and appliances, products, machines and devices for this specific population.

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REFERENCES


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