*Original Article*

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# Determination of Sex from Index and Ring Finger Ratio

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**Abstract**

**Background**: Establishment of sex has considerable forensic implication. Earlier studies have shown that differences exist between male and female index and ring finger ratios. **Aim**: The purpose of present study is to evaluate sexual dimorphism of index and ring finger in western part of the Indian population. **Material and Method**: The study was carried out on a cross sectional sample of 195 adult students out of which 100 of the respondents were males and the remaining 95 were females. Data on age, sex, height and weight were collected through structured paper questionnaire as primary data collection and the anthropometric measurements as secondary data collection. **Result**: The result of present study shows that the mean age of male population is 21.52 years while the mean age of female population is 20.08 years. Statistically significant difference ($p < 0.05$) between index and ring finger ratios in male and female are observed. **Conclusion:** The present study suggests that the ratio of less than 0.97 suggests male sex while a ratio of 0.97 or more suggests female sex. The findings of present study can be utilized to establish sex especially in circumstances where body was mutilated or only remains were brought or in cases of mass disaster

**Keywords:** Identification; Sex difference; Index finger, Ring finger, Anthropometry.

## Introduction

Establishment of sex has considerable forensic implication. It assumes greater importance when the bodies are mutilated or only remains are brought for medical examination. Previous studies have shown that hand exhibits sexual dimorphism and the dimensions can be utilized to establish sex of a person.[1-3] Earlier studies have shown that differences exist between male and female index (2D) and ring finger (4D) ratios (2D:4D). [4-10] It was observed that digit ratios vary according to the ethnicity and population groups.[11,12] Ethnic differences in digit ratio could result from ethnic differences in prenatal and rogenization, but this has not been empirically tested.

In India, index and ring finger ratio had been studied in South Indian population and it was noted that the ratio can be a useful sex indicator to differentiate between male and female.[13-15] However, such studies are not available for the other part of country and therefore the purpose of present study is to evaluate sexual dimorphism of index and ring finger in western part of the Indian population.

## Material and Method

*Sample size and sampling techniques*

The present prospective study consists of adult students of Government Medical College, Miraj, District Sangli, Maharashtra who were randomly selected from the 5 year batches. The study was carried out on a cross sectional sample of 195 adult students out of which 100 of the respondents were males and

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the remaining 95 were females. Data on age, sex, height and weight were collected through structured paper questionnaire as primary data collection and the anthropometric measurements as secondary data collection. The length of the second digits (2D) and fourth digits (4D) of the left and right hand of each subject were measured with the aid of manual vernier calipers, from the tip of the digit to the ventral proximal crease, where there was a band of crease at the base of the digit, the most proximal crease was used. Subjects with injuries or deformities in any of the hands were excluded from the study. All measurements were made in centimeters to the nearest millimeter with digits fully extended.

*Instrumental design*

The instrument used for the study was a structured questionnaire titled ''determination of sex on the basis of measurement of the index and the ring finger''. The questionnaires consist of personal demographic information with questions on the age, weight, height and handedness of the volunteer, while part two contained information on anthropometric measurements.

*Method of validation of instrument*

Three parameters were investigated which includes height, weight and the length of index (2D) and ring (4D) of both hands. Careful and appropriate steps were taken to protect the rights of the respondents. Potential respondents were informed that the survey was completely voluntary and all participation was confidential.

*Statistical analysis*

Data was expressed as mean ± Standard deviation (± SD). Descriptive statistics and Students'-test were used to analyze and determine the parameters studied in both males and females. 2D:4D ratio was calculated on both hands of each individual. The relationship between the parameters studied was established using Pearson correlation to establish the strength of the relationship between the lengths of second and fourth digits (2D&4D), the digit ratios and the other anthropometric variables in both sexes. Statistical significance was accepted at P value less than or equal to <0.05 ($P<0.05$). The sectioning point was calculated for sex differentiation from the index and ring finger ratios as – mean male ratio + mean female ratio ÷ 2.

## Result

The result of present study shows that the mean age of male population is 21.52 years while the mean age of female population is 20.08 years. The mean height of (171.6 cm) men exceeds the mean height (157.3 cm) of women. Similarly the mean BMI of men (22.48) exceeds that of mean BMI (21.48) of women (Table1). It is observed that the index and ring finger shows significant difference between the lengths in both sexes ($P < 0.05$). The mean lengths of index and ring finger in male are 7.35 cm and 7.66 cm respectively in right hand and 7.34 cm and 7.67 cm in left hand respectively. The mean lengths of index and ring finger in female are 6.80cm and 6.93

**Table 1: Showing age and sex related descriptive data**

| Parameters | Male (n = 100) | | | | Female (n = 95) | | | |
|---|---|---|---|---|---|---|---|---|
| | Min | Max | Mean | SD | Min | Max | Mean | SD |
| Age | 19 | 26 | 21.52 | 1.41 | 18 | 23 | 20.81 | 0.97 |
| Weight (in KG) | 50 | 98 | 66.05 | 9.44 | 34 | 77 | 53.13 | 5.26 |
| Height (in cm) | 158 | 190 | 171.46 | 7.08 | 145 | 172 | 157.3 | 8.01 |
| BMI | 22.62 | 30.47 | 22.48 | 3.01 | 14.79 | 30.91 | 21.48 | 3.21 |

**Table 2: Showing the descriptive statistics of male and female index and ring finger measurements (in cm)**

| Sex | Parameters | Min | Max | Mean | SEM | SD | Significance |
|---|---|---|---|---|---|---|---|
| Male (n = 100) | R2D | 6.36 | 8.37 | 7.35 | 0.041 | 0.414 | P < 0.05 |
| | R4D | 6.76 | 8.78 | 7.66 | 0.046 | 0.462 | |
| | L2D | 6.40 | 8.30 | 7.34 | 0.042 | 0.423 | P < 0.05 |
| | L4D | 6.74 | 8.89 | 7.67 | 0.046 | 0.467 | |
| Female (n = 95) | R2D | 5.99 | 7.78 | 6.80 | 0.036 | 0.357 | P < 0.05 |
| | R4D | 6.11 | 7.84 | 6.93 | 0.036 | 0.357 | |
| | L2D | 5.98 | 7.53 | 6.76 | 0.034 | 0.334 | P < 0.05 |
| | L4D | 6.11 | 7.63 | 6.92 | 0.037 | 0.365 | |

**Table 3: Showing the difference between male and female index and ring fingers (in cm)**

| Parameters | Male | Female |
|---|---|---|
| | Mean ± SD | Mean ± SD |
| R2D – R4D | 0.28 ± 0.23 | 0.13 ± 0.15 |
| L2D – L4D | 0.33 ± 0.20 | 0.16 ± 0.18 |

cm respectively in right hand and 6.76 cm and 6.92 cm in left hand respectively (Table 2). However, no significant difference exists between the lengths of index and ring finger in right and left hand in both sexes (Table 2). In male, the mean difference between index and ring finger in right hand is 0.28 ± 0.23 cm and in left hand it is 0.33 ± 0.20 cm. In female, the mean difference between index and ring finger in right hand is 0.13 ± 0.15cm and in left hand it is 0.16 ± 0.18 cm (Table 3). Statistically significant difference ($p < 0.05$) between 2D:4D ratios in male and female are observed (Table 4). In male, the mean 2D:4D ratio in right and left hand is 0.960 and 0.957 respectively while in female the mean 2D:4D ratio in right and left hand is 0.981and 0.978 respectively (Fig 1 and 2).

A sectioning point was calculated for the index and ring finger ratios (2D:4D) to differentiate between male and females and the value is 0.97. A ratio of 0.97 or more is suggestive of female while ratio less than 0.97 suggest male sex. With this sectioning point we could predict 69% males from right hand and 77% males from left hand. Similarly with a value of 0.97 or more we could predict 62.5% females from right hand and 59.85% females from left hand.

## Discussion

In human hand the second and fourth digit presents a pattern of approximate symmetry around the central axis of third digit. However, there is considerable variation in the ratio of length of second digit to fourth digit. The ratio between the length of the index and ring finger (2D:4D) is sexually dimorphic with males having on an average longer fourth finger (ring finger) relative to their second finger (index finger) showing a low 2D:4D ratio than females, who had on an average have a higher 2D:4D ratio.[4,7] This sexual dimorphism in 2D: 4D ratio is apparent by 2 years of age and appear to be established early in life, by the 14th week of gestation [5,6,9]. The differences may be linked to the prenatal production of testosterone and oestradiol and, in the case of testosterone, to interactions with the homeobox genes *Hoxa* and *Hoxd,* which control differentiation of the urogenital system and development of the digits [10].

**Table 4: Showing the ratios of index and ring fingers in male and female subjects**

| Sex | Parameters | Min | Max | Mean | Median | SD | CV*% | CD** | Correlation |
|---|---|---|---|---|---|---|---|---|---|
| Male (n = 100) | D2:D4 ratio right | 0.899 | 1.044 | 0.960 | 0.960 | 0.027 | 2.8% | 0.021 | 0.892 |
| | D2:D4 ratio left | 0.894 | 1.038 | 0.957 | 0.957 | 0.025 | 2.6% | 0.020 | 0.903 |
| Female (n = 95) | D2:D4 ratio right | 0.935 | 1.031 | 0.981 | 0.982 | 0.022 | 2.2% | 0.018 | 0.909 |
| | D2:D4 ratio left | 0.889 | 1.050 | 0.978 | 0.980 | 0.027 | 2.7% | 0.021 | 0.860 |

*CV% = coefficient of variation, **CD = coefficient of dispersion

**Fig 1: Showing index to ring finger ratio in both hands in male population**

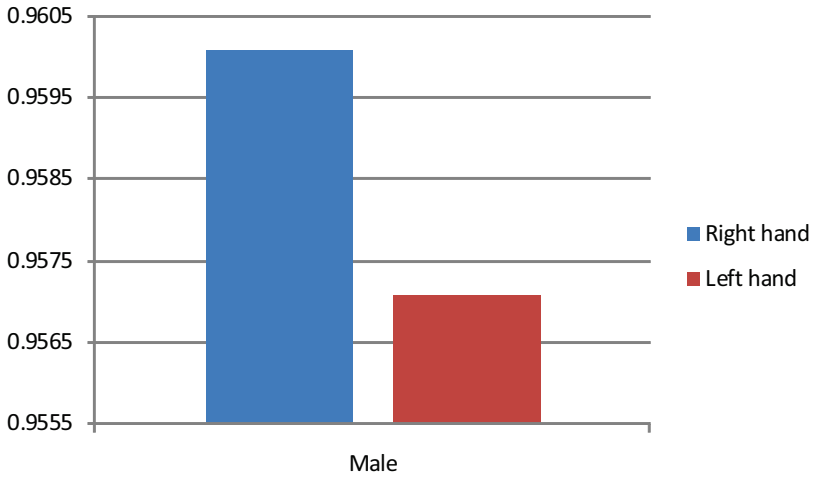
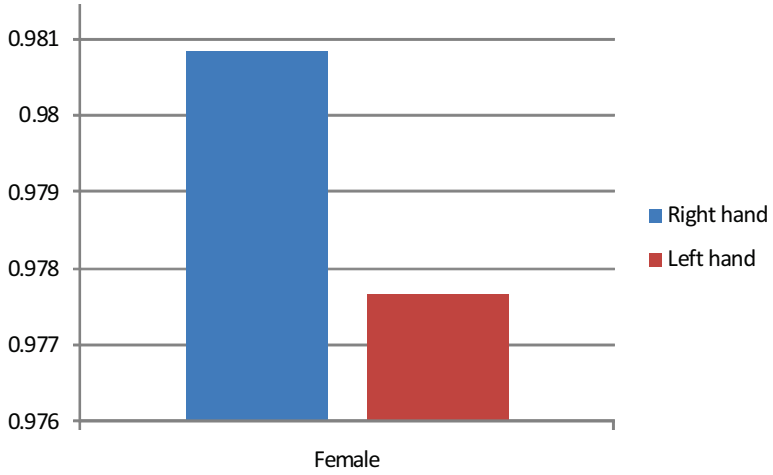



**Fig 2: Showing index to ring finger ratio in both hands in female population**




The sex difference in 2D:4D ratio is present before birth in human and therefore it rules out any social influences that might affect digit growth. However, ethnicity differences in 2D:4D are apparent in first 2 years of life.[7,9,12] A low 2D:4D ratio has been shown to correlate with high testosterone levels which are characteristic of males, while a high 2D:4D ratio is correlated with low testosterone level, a characteristic of females.[4]

Manning *et al* (2000) had noted that females had longer second digits than fourth digits while males have longer fourth digits than second digits. This difference was accounted for higher digit ratios in females than in males. It was observed in present study that second finger length of Indian males was shorter than fourth finger and statistically significant difference was noted ($P < 0.05$). The findings are in accordance with other studies. [4,6,7,13,14,15] Similarly in females we observed that the lengths of second and fourth digits were approximately same or was like that of males. We had also noted that males have longer digits compared to females. The 2D:4D ratio has been found to be sexually dimorphic with females having higher digit ratios ($\geq 0.97$) compared to males. The findings are in accordance with earlier published literature.[13-15]

In conclusion we have noted that males have longer digits than females. It was observed that lengths of second and fourth digits in females were approximately same or was like that of males. The 2D:4D ratios were found higher in females than males and appear sexually dimorphic. The present study suggests that 2D:4D ratio of less than 0.97 suggests male

sex while a ratio of 0.97 or more suggests female sex. The findings of present study can be utilized to establish sex especially in circumstances where body was mutilated or only remains were brought or in cases of mass disaster.

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