Original Article

Indian Journal of Forensic Medicine and Pathology
Volume 10 Number 2, April - June 2017
DOI: http://dx.doi.org/10.21088/ijfmp.0974.3383.10217.6

Establishment of Sex in Adolescents from Inter Digit Ratios

Vrushali Sushil Raut*, Rajesh Bardale**

Abstract

Background: Establishment of sex is an important aspect of forensic medicine. Previously conducted studies have shown that differences exist between male and female index and ring finger ratios. *Aim:* The purpose of the present study is to evaluate sexual dimorphism of index and ring finger in adolescents in the western part of the Indian population. *Material and Method*: The study was carried out on a cross sectional sample of 103 adolescents; out of which 50 of the respondents were males and the remaining 53 were females. Data on age, sex, and handedness was collected through a structured paper questionnaire as primary data collection and the anthropometric measurements as secondary data collection. *Result:* The result of the present study shows that the mean age of male population is 13.74 years while the mean age of female population is 14.91 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 0.99 suggests male sex while a ratio of 0.99 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

Identification is a key aspect of medico legal studies and forensic medicine. While a number of factors play a role in the identification of an individual, the establishment of sex has great forensic implications. It assumes greater significance when only mutilated body parts or dismembered body parts are to be examined. In catastrophic events like earthquakes or bomb explosions, establishment of sex helps in assessing the magnitude of casualties.

Previous studies have indicated that sexual dimorphism exists as far as the hand is concerned. The differences in the lengths of the second digit (2D) and the fourth digit (4D) can be used as a useful indicator to ascertain the sex of an individual. The difference between the index finger and the ring finger has been studied previously in various communities and populations [1-6]. Ethnic differences have been observed, probably due to prenatal influences; however, the causes have not been demonstrated yet. A correlation has been established in the adult and neonatal populations and a hormonal basis has been suggested [7-9]. However, such studies are not available for the age group which boasts of hormonal instability, i.e. adolescence. This study aims at evaluating the relationship between the index and ring finger lengths in the adolescent population of western India.

Authors Affiliation: *Third MBBS Student **Professor and Head, Dept. of Forensic Medicine, Govt. Medical College and Hospital, Miraj, Dist. Sangli, Maharashtra, India.

Reprints Requests: Rajesh Bardale, Professor and Head, Dept. of Forensic Medicine, Govt. Medical College and Hospital Miraj, Dist. Sangli – 416410, Maharashtra, India.
E-mail: bardalerv@yahoo.co.in

Received on 09.02.2017, **Accepted on** 23.02.2017

Material and Method

Sample Size and Sampling Techniques

The present prospective study consists of adolescents aged 10 to 19 years (according to the WHO definition of an 'adolescent' individual [27]), from the visiting population of Government Medical College and Hospital, Miraj. The participants were

randomly selected from the population, the excluding criteria being the age limit of 10 – 19 years, any gross physical deformity or injury of the hands and any growth disorder. The study was carried out on a cross sectional sample of 103 individuals, of which 53 were females and the remaining 50 were males. Data on their age, sex, address was collected through a structured paper questionnaire as the primary data collection and the anthropometric measurements as the secondary data collection. The lengths of the second digit (2D) and the fourth digit (4D) were measured with a clear, transparent 12 inch plastic ruler, from the tip of the finger to the ventral proximal crease. Where the line was replaced by a band of crease, the most proximal crease was used. The subjects were asked to extend their digits fully when the readings were taken. All the measurements were made in centimetres to the nearest millimetre.

Instrumental Design

The instrument in the study was a structured questionnaire titled "Determination of sex on the basis of the measurement of the index finger and the ring finger". The questionnaire consisted of personal demographic data such as age, handedness of the volunteer, sex and the address as the primary information. The anthropometric values were included in the secondary questionnaire.

Method of Validation

Careful and appropriate steps were taken to protect the rights of the respondents. Potential participants were duly informed that the survey was completely voluntary and all the data taken was confidential.

Statistical Analysis

Data was expressed as Mean ± Standard deviation (± SD). Descriptive statistics and Students'- t test were used to analyse and determine the parameters studied in both males and females. Statistical significance was accepted at P value less than or equal to 0.05 ($P<0.05$). 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. The sectioning point was calculated for sex differentiation from the index and ring finger ratios as the average of the mean male ratio and mean female ratio. (Mean male ratio + mean female ratio ÷ 2)

Results

The result of the present study shows that the mean age of the female population is 14.91 years while the mean age of the male population is 13.74 years. The mean lengths of the index and ring finger in females are 6.440 cm and 6.349 respectively in the right hand while and 6.457cm and 6.342cm respectively in the left hand (Table 1 and 2). The mean lengths of the index and ring finger in males are 6.316cm and 6.544 in the right hand while 6.320 cm and 6.572cm However, no significant differences exist between the lengths of index and ring finger in right and left hand in both sexes. In females, the mean difference between index and ring finger in right hand is 0.091 ± 0.185 cm and in left hand it is 0.115 ± 0.204 cm. In males, the mean difference between index and ring finger in right hand is 0.228 ± 0.197 cm respectively and in the left hand it is 0.252 ± 0.216 cm (Table 3 and fig 1). Statistically significant differences ($p < 0.05$) between 2D:4D ratios in male and female are observed (Table 2). In females, the mean 2D:4D ratio in right and left hand is 1.015 and 1.018 respectively while in female the mean 2D:4D ratio in right and left hand is 0.965 and 0.963 respectively.

A sectioning point was calculated for the index and ring finger ratios (2D:4D) by calculating the average of the mean 2D:4D ratios of males and females; which is 0.990. A ratio of 0.990 or more is suggestive of female sex while ratios less than 0.990 suggest male sex. With this sectioning point, we could predict 92.45% females from right hand and 88.67% females from left hand. Similarly, with a value of 0.99 or less we could predict 84% males from right hand and 88% males from left hand.

Table 1: Showing age related descriptive data

Parameter	Females				Males			
	Min	Max	Mean	SD	Min	Max	Mean	SD
AGE	10	19	14.91	2.691	10	19	13.74	2.791

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

Sex	Parameters	Min	Max	Mean	SD	Significance
Male	R2D	4.3	7.5	6.316	0.72	p<0.05
	R4D	5.1	8	6.544	0.732	
	L2D	5	7.6	6.32	0.698	p<0.05
	L4D	5.2	8	6.572	0.754	
Female	R2D	5.4	7.8	6.44	0.514	p<0.05
	R4D	5.2	7.5	6.349	0.511	
	L2D	5.3	7.8	6.457	0.54	p<0.05
	L4D	5.1	7.5	6.342	0.508	

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

Parameters	Male Mean±SD	Female Mean±SD
R2D-R4D	0.228 ± 0.197	0.091 ± 0.185
L2D-L4D	0.252 ± 0.216	0.115 ± 0.204

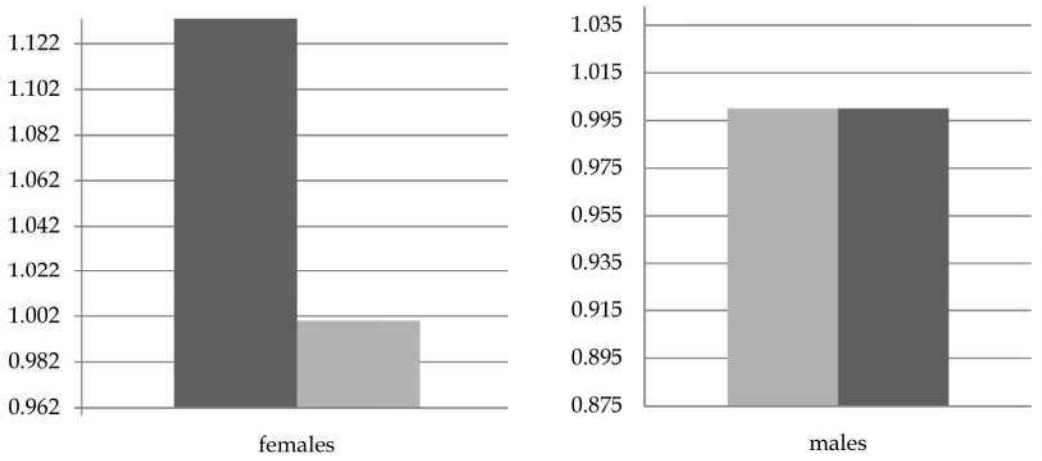

Chart 1: Showing differences in the male and female ratios.

Discussion

Inter digit ratios have been increasingly considered as a fairly reliable indicator for the establishment of sex [1-8]. In humans, the index finger and the ring finger are considered to be symmetrical about the axis of the middle finger. However, there is considerable difference between the lengths of the index finger and the ring finger.

In the present study, a statistically significant difference has been observed between the two fingers. In males, this difference is due to greater ring finger length as compared to the index finger. Hence, in males, the 2D:4D ratio is usually lower as compared to females. In females, it has been observed that the index finger is longer than the ring finger, which accounts for the higher 2D:4D ratios.

This morphological difference is considered to be established prenatally, as early as the 14th week of gestation [7]. The 2D:4D ratio is said to be predefined intranatally due to exposure to prenatal hormones likes testosterone and oestrogen. Subsequently, a greater exposure to testosterone has been linked to a lower 2D:4D ratio, corresponding to the inter digit ratios observed in males [6]. Adolescence is a period during which there is considerable exposure to the hormones in greater amounts, and this study aimed to highlight any alterations in the observed phenomenon brought about by this sensitive period of hormonal instability. However, it has been demonstrated in the study that a greater inter digit ratio is suggestive of the female sex, while a lower inter digit ratio is suggestive of the male sex; the sectioning point being 0.99 cm.

As indicated in other studies conducted on the same subject, the 2D:4D ratio can be used as the basis for identification of sex, across various age groups. This study provides substantial basis for its usage in the establishment of sex in adolescents as well [3]. It can have great implications in medico legal cases in which mutilated bodies or parts of bodies are

involved. With further exploration, it can also be used as a diagnostic aid for certain diseases in which a hormonal imbalance is a manifest feature. An unusually high or low inter digit ratio as per the sex of the individual, could be one of the first indicators of the possibility of certain corresponding diseases. For example, a high 2D:4D ratio may indicate high oestrogen levels and thus, the possibility of breast cancer, while a low 2D:4D ratio may suggest high testosterone levels, and thus a greater possibility of prostatic cancer.

References

1. Dahodwala T M, Bardale R. Determination of sex from index and ring finger ratio. Indian J Forensic Med Pathol 2013; 6:51-55.
2. Shelake M, Ninal N, Bardale R, Sonar V. Determination of sex from index and ring finger ratios in neonates. J Indian Acad Forensic Med 2015; 37:378-80.
3. Kanchan T, Kumar GP, Menezes RG, Rastogi P, Rao PP, Menon A, et al.Sexual dimorphism of the index to ring finger ratio in South Indian adolescents. J Forensic Leg Med. 2010; 17:243-6.
4. Kanchan T, Kumar GP. Index and ring finger ratio—a morphologic sex determinant in South-Indian children. Forensic Sci Med Pathol 2010; 6:255-60.
5. Krishan K, Kanchan T, Asha N, Kaur S, Chatterjee PM, Singh B. Estimation of sex from index and ring finger in a North Indian population. J Forensic Leg Med 2013; 20:471-9.
6. Sen J, Kanchan T, Ghosh A, Mondal N, Krishan K. Estimation of Sex From Index and Ring Finger Lengths in An Indigenous Population of Eastern India. J Clin Diagn Res 2015; 9(11):HC01-5. doi: 10.7860/JCDR/2015/14940.6846. Epub 2015 Nov 1.
7. Galis F, Ten Broek CM, Van Dongen S, Wijnaendts LC. Sexual dimorphism in the prenatal digit ratio (2D:4D). Arch Sex Behav. 2010; 39:57-62.
8. Mularczyk M, Ziêtek-Czeszak A, Ziêtek Z. Assessment of sexual dimorphism of finger length ratio (2D:4D) Ann Acad Med Stetin. 2014; 60(1):47-51.
9. Zheng Z, Cohn MJ. Developmental basis of sexually dimorphic digit ratios.Proc Natl Acad Sci U S A. 2011 Sep 27; 108(39):16289-94.