

ORIGINAL COMMUNICATION**SEXUAL DIMORPHISM OF HAND DIGIT RATIO (2D:4D) IN INDIAN POPULATION****Asha.K.R¹, Srinivasa Reddy.P², Lakshmiprabha Subhash³, Vinay Kumar. K⁴**^{1,3,4} Department of Anatomy, Sri Siddhartha Medical College, Tumkur² Department of Forensic Medicine & Toxicology, Sri Siddhartha Medical College, Tumkur

Date of Acceptance of Manuscript: 11 Nov 2014

Abstract:

Determination of sex from extremities plays an important role in identifying the deceased in forensic examinations. The purpose of present study was to investigate sexual dimorphism by hand digit ratio 2D:4D among 200 South Indian and North Indian subjects. 2D (index finger length) and 4D (ring finger length) were measured using sliding calipers. 2D:4D was computed by dividing index finger length by ring finger length. The data obtained was analyzed statistically using SPSS 15. Mean 4D was greater than mean 2D in both males and females. Statistically significant sex differences were observed from the derived 2D:4D ratio. The mean 2D:4D ratio was found to be higher in females than males. This once again highlights the fact that digit ratio is a lifelong signature of prenatal hormonal exposure. Further study with large population is required to provide more concrete base for this analysis.

Key words: Finger length, Sexual dimorphism, 2D:4D ratio and Indian population.**Introduction:**

Identification of an individual is main objective of forensic investigations. Identification of an individual from dismembered, mutilated and fragmentary remains is a challenge event to forensic experts; in such cases, complete identification becomes unlikely and partial identification assumes importance to proceed into further investigations.¹The primary factors that are helpful in the identification include age, sex and stature.² Many factors like racial, ethnic and nutritional factors play an important role in human development and growth; therefore different nomograms become necessary for different population.³ Sexual dimorphism in digit ratio was first reported by Ecker in 1875.⁴ The index and ring finger ratio is a sexually

dimorphic biometric marker, related to prenatal estrogen and testosterone levels in utero and determined genetically by the HOX genes.⁵ This observation was reestablished by a number of researchers later on. In present study, an attempt has been made to find out the gender difference in 2D:4D ratio in representative sample of South Indian and North Indian population using statistical considerations.

Material and Methods:

The present study was undertaken in the Departments of Anatomy and Forensic Medicine, Sri Siddhartha Medical College, Tumkur, amongst 200 right handed medical students, aged between 20-30 years after taking informed consent to participate in the study. The student population of Tumkur comes from all over India. The division of subjects into South and North Indians was based on their region of origin and taking into

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account other zonal divisions of India³. The total sample consisted of 50 South Indian females, 50 South Indian males, 50 North Indian females and 50 North Indian males.

In the present study, index and ring finger lengths of both hands of each individual were measured using sliding calipers in centimeters to the nearest millimeter. All the measurements were taken by single observer in order to avoid inter-observer bias. Exclusion criteria for the study were those who had deformed digits and history of injury to digits.

To measure the Finger Length, subjects were asked to place the hands on a flat table, and the distance between the phalanges (point on proximal end of basal phalange of the finger which lies on the dorsal margin of the articular surface) and dactylions (lowest point on the anterior margin of the finger) of the 2D and 4D was taken using a sliding caliper.⁶

Measurements were taken to accuracy of 0.1 cm.⁶ Index and ring finger ratio was calculated by dividing the index finger length by ring finger length.

Statistical Analysis:

Analysis was done using Statistical software namely SPSS 15, Stata 8.0, MedCalc 9.0 and Systat 11.0. The data were statistically analyzed by bilateral measurements of index and ring finger lengths.

Results:

Descriptive statistics for bilateral measurements of index and ring finger lengths among South Indian and North Indian males and females are shown in tables 1 and 2.

Abbreviations used in tables: South Indian males (SIM), North Indian males

(NIM), South Indian females (SIF) and North Indian females (NIF).

Statistical analysis indicated that bilateral variation was insignificant for index and ring finger lengths in both sexes. Finger lengths on both sides were significantly greater ($p < 0.001$) in males when compared with females. No statistically significant differences were found in the mean lengths of 2D and 4D of South and North Indian population when compared for the same sex.

Table 3: depicts the mean values and standard deviations of bilateral 2D:4D ratios. It is observed that bilateral 2D:4D ratios were increased in females.

Discussion:

Sometimes, fragments of soft tissues are found disposed off in the open, in ditches or rubbish dumps etc and are brought to forensic pathologist for examination.⁷ One of the important objectives of examination is identification. The present study was aimed to establish the co-relation between 2D:4D ratio and sex.

Androgen and estrogen differentially regulate the network of genes that controls chondrocyte proliferation, leading to differential growth of digit 4 in males and females.⁸ There has been increasing use of the 2D:4D ratio as an index of prenatal hormone exposure, and extensive studies in humans have found correlations between digit ratios and a variety of physiological and psychological conditions, including fertility⁹, athletic ability¹⁰, sex-biased diseases¹¹ and social behaviors.¹² Evolutionarily, hormonal regulation of sexually dimorphic brain development, a likely target of selection, may have had secondary effects on structures such as the digits. Digit ratios,

therefore, may be simply readouts of androgen to estrogen activity during this developmental period.⁸

In present study, statistically insignificant differences in 2D:4D ratios of South and North Indian population when compared for the same sex were observed. This suggests that in persons of different population groups (belonging to the same race) geographical variations do not have much influence on body proportions.¹³

The present study strongly confirms sexual dimorphism in 2D:4D ratio. Sex differences observed for bilateral index and ring finger length were not significant in both South and North Indian population. Statistically significant sex differences were observed from the derived 2D:4D ratio. The mean index and ring finger ratio was found to be higher in females than males. These observations are compatible to those arrived by Tanuj Kanchan.¹

Insignificant bilateral variation for the measurements of 2D and 4D lengths in both the sexes as observed in the present study differed from that of Geetha.N⁴ in which it is concluded that sexual dimorphism in 2D:4D ratio is more pronounced in right hand ratio than left hand ratio.

In our study, borderline of 2D:4D ratio between males and females was 0.94. Thus 2D:4D ratio in both sexes was below 1.00. These findings were concurrent with that of study by Geetha⁴ and Tanuj⁵ which showed arbitrary value of 2D:4D ratio to distinguish males and females were 0.98 and 0.97 respectively. But the present study differed from other studies which suggested that males generally have 2D:4D ratios below 1.00 and females generally have 2D:4D ratio about 1.00 or high digit ratio.^{14, 15, 16}

Thus the present study confirms that sex can be determined by 2D:4D ratio with fair accuracy. The results of this study are however applicable only when an intact hand examined.

Conclusion:

In present study showing that 2D:4D ratio is a reliable indicator for the determination of sex in forensic examination and anthropological studies. This once again highlights the fact that 2D:4D ratio is an index of prenatal hormone exposure. The study thus has medico legal implications when a dismembered hand is brought for examination. Further study with large population is required to provide more concrete base for this analysis.

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Table 1: Measurements (cm) of 2D length in Males and Females (n=200)

Group	2D length	Minimum	Maximum	Mean	SD
SIM	Right	7.6	10.2	8.98	0.59
	Left	7.8	10.3	9.01	0.55
NIM	Right	8.2	10.5	8.98	0.47
	Left	7.8	10.2	8.96	0.50
SIF	Right	7.2	9.4	8.28	0.46
	Left	7	9.3	8.23	0.45
NIF	Right	7.4	9.3	8.38	0.47
	Left	7.4	9.7	8.4	0.50

Table 2: Measurements (cm) of 4D length in Males and Females (n=200)

Group	4D length	Minimum	Maximum	Mean	SD
SIM	Right	8.6	10.8	9.64	0.56
	Left	8.6	10.7	9.63	0.53
NIM	Right	8.5	11.5	9.56	0.56
	Left	8.7	11.5	9.6	0.52
SIF	Right	7.4	9.8	8.73	0.47
	Left	7.3	9.9	8.68	0.49
NIF	Right	7.4	10.1	8.83	0.52
	Left	7.5	10.2	8.81	0.52

Table 3: Bilateral 2D:4D ratios in SIM, NIM, SIF and NIF (n=200)

Study group	Rt 2D:4D(mean)	S D	Lt 2D:4D(mean)	S D
SIM	0.930563	0.037641	0.940893	0.030122
NIM	0.940098	0.03661	0.933321	0.030399
SIF	0.939251	0.02972	0.949419	0.02972
NIF	0.950112	0.041747	0.954365	0.043318