



Short report

Sexual dimorphism in finger length ratios and sex determination – A study in Indo-Mauritian population

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ABSTRACT

Many studies have shown that the finger length ratios might be characteristic for sexual dimorphism. The aim of the study was to determine sexual dimorphism in finger length ratios among the representatives of the Indo-Mauritian population. The study group comprised of 200 healthy Indo-Mauritian people (100 male and 100 female) of the age ranged from 19 to 25 years. The lengths of second (2D), third (3D), fourth (4D) and fifth (5D) finger of both hands were measured by using a vernier caliper. Our results indicate that all finger length ratios have significant sex differences (p -value < 0.05) except 2D:5D and 3D:5D. To conclude, 2D:4D ratio is the most decisive ratio (predictive accuracy = 0.61) which can demarcate between male and female.

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1. Introduction

The relative lengths of fingers in human population attract a considerable research interest because male and female may have different finger length ratios as a result of different sex hormone exposure during early embryonic development. The finger length ratio particularly the second (index) and fourth (ring) finger ratio (2D:4D) is sexually dimorphic trait,^{1,2} and controlled by *HOX* genes^{3,4} and estrogen and testosterone concentrations in utero.⁵ Generally, the mean 2D:4D ratio has been found to be lower in male as compared to female.⁶ There are many evidences that suggest an association between gonad and digit differentiation. Sorenson et al.⁷ found a positive association between dermatoglyphic asymmetry determined in utero and testosterone in adult males. Garn⁸ observed a high sensitivity of dihydroxytestosterone in the 4th digit and low sensitivity in the 2nd digit.

Several studies have investigated sexual dimorphism in the 2D:4D ratio in many ethnic groups,^{8–16} but the studies on other finger ratios are very limited.^{14–16} According to Gillam et al.,⁹ sexual dimorphism in 2D:4D ratios becomes apparent by 4 years of age and age changes in ratios depended on sex, side and hand preference. Manning et al.,¹⁰ Kanchan et al.,¹¹ Mularczyk et al.¹² and Xi et al.¹³ found the significant sex differences that males had lower 2D:4D ratios than females. These differences were greatest for right hand 2D:4D.¹⁰ McFadden and Shubel¹⁴ demonstrated the largest sex difference in 2D:4D ratios for both hands, followed by 2D:5D and 3D:4D. Kyriakidis and Papaioannidou¹⁶ observed the sexual dimorphism of all the finger ratios in Greek population that were stronger in right than left. Voracek¹⁷ and Barrett and Case¹⁸ suggested that 2D:4D ratio may be population-specific, but is inappropriate for universal application of sex determination.

Mauritius is an island, geographically located in the Indian Ocean, approximately 2400 km of the south east coast of Africa. The majority of the population is Indo-Mauritians i.e. people of Indian descent, who makes about 68% of total population. Creoles, which are about a quarter of the population, are people of African descent. Agnihotri et al.^{19–22} and Jowaheer and Agnihotri²³ conducted the study in Indo-Mauritian population and found a significant gender

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difference in cephalofacial measurements, fingerprint ridge density and the dimensions hand and foot. Current status of the literature shows that there is no study of finger length ratios in the Indo-Mauritian people.

Sex determination by hand dimensions and finger length ratios by mathematical and anatomical methods is necessary when the human remains are recovered following mass fatality incidents such as an aircraft crash and armed violence, and from intentional dismemberment.

In view of forensic identification that all finger ratios may have sex variations and varied across ethnic groups, the present study has been conducted on the finger ratios in Indo-Mauritian population.

2. Methodology

2.1. Subject

A random sample of 100 male and 100 female medical students of age range between 19 and 25 years was selected. The study was conducted in the Department of Forensic Medicine at SSR Medical College in the year 2014. The students have given their verbal informed consent to participate in the study. The subjects with injuries and deformities of the digits are excluded from the study. Only Mauritians of Indian descent (Indo-Mauritians) were selected as participants of the study.

2.2. Measurement of fingers' length

The lengths of second (2D), third (3D), fourth (4D) and fifth (5D) finger of both hands were measured by using a vernier caliper with the accuracy of 0.01 mm. Finger length was measured from the basal crease of the finger proximal to the palm to the tip of the finger.⁵

2.3. Data analysis

Digit ratios were calculated. Exploratory analysis of the sample data is performed to compare the finger lengths and finger length ratios between the left and right hands of the participants as well as between males and females.

3. Results

Table 1 displays the mean \pm SD of all the variables. No significant difference is remarked between the left and right hands in males as well as in females. In this sample, lengths of all the fingers in males on average are bigger than in females. However, the ratios 2D:4D,

Table 2
Normality test for finger lengths and length ratios.

ID	Shapiro–Wilk	Statistic		
		Statistic	df	p-Value
2D	Male	0.985	100	0.310
	Female	0.994	100	0.925
3D	Male	0.990	100	0.661
	Female	0.970	100	0.023
4D	Male	0.989	100	0.573
	Female	0.981	100	0.162
5D	Male	0.992	100	0.795
	Female	0.916	100	0.000
2D:3D	Male	0.992	100	0.848
	Female	0.989	100	0.594
2D:4D	Male	0.995	100	0.985
	Female	0.966	100	0.011
2D:5D	Male	0.982	100	0.180
	Female	0.598	100	0.000
3D:4D	Male	0.988	100	0.515
	Female	0.920	100	0.000
3D:5D	Male	0.984	100	0.287
	Female	0.595	100	0.000
4D:5D	Male	0.984	100	0.251
	Female	0.580	100	0.000

3D:4D are higher in females whereas 4D:5D is lower in females. 2D:3D, 2D:5D are same in males and females.

Normality test is done on each variable and the results are shown in Table 2. The shaded p-values under the Shapiro–Wilk's test indicate that the corresponding variables are not normal. As some of the variables are not normal, comparisons are done using box-plots as well (Figs. 1 and 2). Box plots confirm the finding made on the basis of Table 1.

Correlation analysis is conducted to determine any relation between the finger lengths and finger length ratios. The correlograms are provided in Fig. 3a for males and Fig. 3b for females. From Fig. 3, it is clear that the pairs marked are significantly correlated.

Independent Sample Mann–Whitney *U*-test is performed to compare the finger lengths and length ratios of the males and females at the population level. The results of this test are shown in Table 3. Male finger lengths are significantly higher than female finger lengths. Except 2D:5D and 3D:5D, all the male ratios are significantly different from female ratios.

Table 1
Descriptive comparison of average finger lengths and length ratios in the hands of males and females.

	RM	LM	M	RF	LF	F
2D	7.24 \pm 0.441	7.25 \pm 0.431	7.25 \pm 0.434	6.75 \pm 0.398	6.74 \pm 0.367	6.75 \pm 0.384
3D	7.98 \pm 0.460	8.03 \pm 0.485	8.01 \pm 0.473	7.37 \pm 0.414	7.39 \pm 0.421	7.39 \pm 0.416
4D	7.46 \pm 0.452	7.46 \pm 0.458	7.47 \pm 0.451	6.81 \pm 0.397	6.82 \pm 0.395	6.82 \pm 0.396
5D	6.06 \pm 0.441	6.08 \pm 0.443	6.07 \pm 0.441	5.63 \pm 0.428	5.62 \pm 0.588	5.64 \pm 0.511
2D:3D	0.91 \pm 0.028	0.90 \pm 0.027	0.91 \pm 0.028	0.92 \pm 0.029	0.91 \pm 0.028	0.91 \pm 0.028
2D:4D	0.97 \pm 0.048	0.97 \pm 0.046	0.97 \pm 0.047	1.00 \pm 0.048	0.99 \pm 0.046	0.99 \pm 0.047
2D:5D	1.20 \pm 0.059	1.20 \pm 0.060	1.20 \pm 0.059	1.20 \pm 0.066	1.21 \pm 0.188	1.20 \pm 0.140
3D:4D	1.07 \pm 0.030	1.08 \pm 0.032	1.07 \pm 0.031	1.08 \pm 0.032	1.08 \pm 0.033	1.08 \pm 0.032
3D:5D	1.32 \pm 0.067	1.32 \pm 0.063	1.32 \pm 0.065	1.31 \pm 0.070	1.33 \pm 0.202	1.32 \pm 0.151
4D:5D	1.23 \pm 0.055	1.23 \pm 0.051	1.23 \pm 0.053	1.21 \pm 0.062	1.23 \pm 0.180	1.22 \pm 0.135

RM: Right-Male hand, LM: Left-Male hand, RF: Right-Female hand, LF: Left-Female hand, M: Mean-Male hand, F: Mean-Female hand.

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