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MORPHOMETRIC ANALYSIS OF THE HAND

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ABSTRACT

This study is an analysis of the patterns of variation of the human hand, particularly the metric characters of hand, palm, fingers, nails and dorsal distribution of hair over the digits. Anthropometric measurements were performed on 124 men and women, aged 21 to 41 years in and around medchal town. The data were analyzed by inferential statistics. Size variation in fingers is indicated in the present study. There is component of variability between all fingers as a whole and distal phalanges, the variation is much between the thumb and other fingers. Sexual dimorphism is proven fact as menhave greater dimensions than women in length of the thumb than other fingers.

Keywords: **anthropometric measurements, morphometry**

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INTRODUCTION

Tetrapod limbs are characterized by a maximum of five morphologically diversified digits. In the family Hominid, the hand evolved from an anatomical structure with a combination of human and pongid characteristics. Morphometric comparison with fossil hominids shows that the hand of Homo sapiens is characterized by a long thumb, broad ungual tufts and a general capacity for flexion and rotation of the digits, particularly the opposable thumb 1,2. These traits allow for the precise human grasp. The length of the human hand is about one-quarter the length of the upper limb and one-tenth the height. The area of the palm is about 1% of the total body surface. The embryological development of the hand begins at the 28th–30th day of gestation3,4. The digital rays are delineated at about the 46th day and the fingers are completely separate at the 52nd day.5

The number and shape of the digits are genetically determined. The homeotic genes, i.e. genes that determine the specialization of body segments, involved in the processes of embryological differentiation of the hand are highly conservative and belong to the HOXA and HOXD clusters6,. In each cluster, the arrangement of the genes on the chromosome corresponds to the topographical and temporal sequence of their expression during growth of the limb. The genes of the HOXA cluster control the proximo -distal differentiation of the limb, while those of the HOXD cluster control the antero-posterior (radio-ulnar) development7. The same homeotic clusters control the differentiation of the urogenital system8.The literature on the morphology and dimensions of the human hand involves different fields of bio-medical research. Various investigations deal with phyletic affinities during evolution, correlations with anthropometric or dermatoglyphic characters, embryology and development, anatomical malformations, asymmetry, kinematics, and comparison with non-human hominoids.9,10

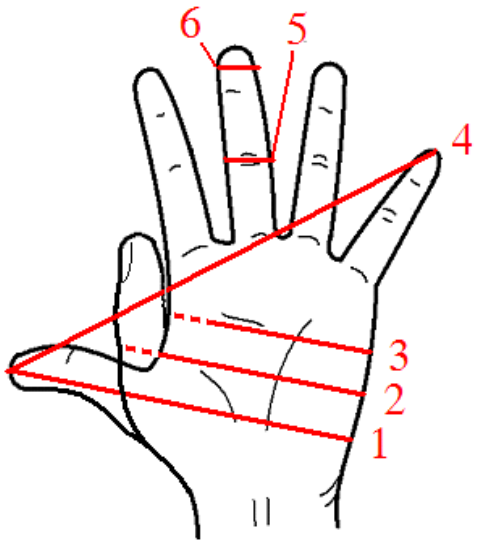
Most studies deal with the relative lengths of the digits, particularly fingers 2 and 4 (digit ratio). 10,11 Some studies associate the lengths of the fingers with various genetic, physiological and behavioral characteristics12. Others deal with sexual dimorphism and inter-population variability.13 The aim of the present paper is to increase the knowledge of the morphometry of the hand through the description of dimensional relationships between the palm, fingers, nails and dorsal distribution of hair over the digits in a sample from Medchal town.

MATERIALS AND METHODS

The sample consisted of 124 individuals (63 men and 61 women), residents of Medchal town, R.R, Dist, aged 21 to 41 years. The subjects were randomly selected among students and public of Medchal town. Personal, behavioral and medical history data were obtained in a structured interview. All participants were in good general health and presented homogeneous socio-economic characteristics.

Figure 1
The anthropometric variables

The following variables were considered



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1) Length of the hand
2)Breadth of the hand
3)Size of the palm
4)Span size
5) Length of the fingers
6)Length of the nails
7)Width of the digits
8)Dorsal distribution of hair over the digits.

The hand measurements were taken to the nearest millimeter with a sliding caliper according to methods reported by Hall. The length of the hand is the distance between the distal wrist creases to the tip of the 3rd digit. Breadth of the hand is measurement of the width of the palm along with the thumb. Span size is the distance from the tip of the thumb to the tip of the little or index finger. The length of the finger is the distance between the proximal metacarpo-phalangeal flexion crease and the fingertip. The »digital formula« was used to indicate the relative lengths of the fingers: the fingers are indicated by numbers 1 (thumb) to 5 (little finger) and listed in order of decreasing length. The »digit ratio« (2D:4D) between the length of the 2nd and 4th fingers was also calculated.

RESULTS

Tables below reports the descriptive statistics for all the variables (left and right hand) in the groups subdivided by sex. The table also gives the results of the statistical comparison between sides. An evident direction of lateral divergence does not exist because differences are rather equally distributed between right and left sides in both sexes. All differences between the sexes are significant, with men presenting larger dimensions.

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Tables 1
frequencies of the digital formulas recorded in both hands of the male groups

Men	Right hand (mean length)	Standard deviation	Left hand (mean length)	Standard deviation
Hand length	18.4	2.15	18.51	1.66
Width of the hand	9.4	0.396	9.4	0.46
Palm size	7.6	0.569	7.61	0.554
Span size	19.98	2.49	20.3	2.5
Length of thumb	6.38	0.319	6.4	0.4
Length of 2nd digit	7.6	0.302	7.6	0.346
Length of 3rd digit	8.13	0.682	8.2	0.242
Length of 4th digit	7.55	0.596	7.6	0.2
Length of 5th digit	6.13	1.025	6.2	0.295
width of thumb	2.16	0.219	2.2	0.2
width of2nd digit	1.88	0.111	1.9	0.137
Width of 3rddigit	1.96	0.09	2.0	0.1
Width of 4th digit	1.76	0.138	1.9	0.109
Width of 5th digit	1.54	0.064	1.6	0.1
Nail Lngth thumb	1.29	0.056	1.3	0.056
Nail Lngth2nddigit	1.12	0.032	1.1	0.1
Length 3rd digit	1.15	0.037	1.2	0.05
Length 4th digit	1.12	0.034	1.1	0.1
Length 5th digit	0.99	0.085	1.0	0.07

Tables 2
frequencies of the digital formulas recorded in both hands of the female groups

Women	Right hand (mean length)	Standard deviation	Left hand (mean length)	Standard deviation
Hand length	15.972	0.505	15.89	1.092
Width of the hand	8.505	0.33	8.3	0.482
Palm size	6.819	0.293	6.68	0.351
Span size	17.554	1.383	17.59	1.435
Length of thumb	5.501	0.168	5.41	1.38
Length of 2nd digit	6.581	0.302	6.64	0.318
Length of 3rd digit	7.216	0.32	7.25	0.378
Length of 4th digit	6.708	0.333	6.64	0.438
Length of 5th digit	5.242	0.761	5.12	0.782
width of thumb	1.712	0.135	1.68	0.231
width of2nd digit	1.5	0.2	1.53	0.16
Width of 3rddigit	1.564	0.147	1.57	0.136
Width of 4th digit	1.472	0.108	1.43	0.131
Width of 5th digit	1.254	0.139	1.25	0.019
Nail Lngth thumb	1.34	0.26	1.17	0.1
Nail Lngth2nddigit	1.045	0.101	1.07	0.073
Length 3rd digit	1.057	0.089	1.08	0.065
Length 4th digit	1.007	0.079	1.03	0.068
Length 5th digit	0.795	0.056	0.81	0.064

The most common digital formula in both sexes is 3>4> 2>1>5. The 2D:4D finger length ratio (averaged ratio for right and left hands) is 0.98 in males and females.

Table 3
DIGITAL FORMULA

Digital formula	Men		Women	
	Right % (No)	Left % (No)	Right % (No)	Left % (No)
3>4>2>1>5	55% (35)	49% (31)	62.06% (38)	59.54% (36)
3>2>4>1>5	24.4 % (15)	30.61% (19)	24.32% (15)	29.7% (18)
3>2=4>1>5	20.4 % (13)	22.4% (13)	13.51% (8)	10.81%(7)

Figure 2
Measuring 2D:4D digit ratio

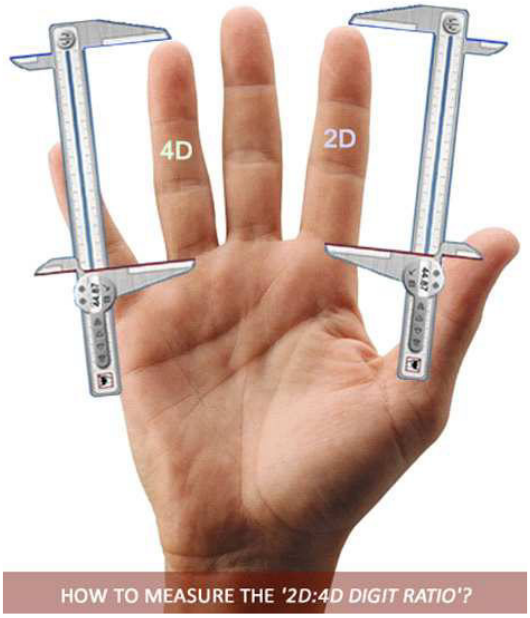

Table 4
2D/4D RATIO

2D/4D	Male(NO)		Female(NO)	
RATIO	Right	Left	Right	Left
0.93 – 0.97	9	9	12	11
0.98 – 0.99	26	22	26	22
1.0	13	14	8	7
1.0 – 1.05	15	18	15	21

Table 5
LENGTH OF THE HAND

LENGTH OF THE HAND	MALE		FEMALE	
Length (cms)	Right (no's)	Left (no's)	Right (no's)	Left (no's)
15.1 – 15.9	0	0	12	15
16.1 – 16.9	1	1	28	25
17.1 – 17.9	8	9	15	18
18.1 – 18.9	16	17	4	2
19.1 – 19.9	20	20	2	1
20.1 – 20.9	12	10	0	0
21>	6	6	0	0

Table 6
WIDTH OF THE HAND

WIDTH OF THE HAND	Male		Female	
Length (cms)	Right	Left	Right	Left
7.1 – 8.9	7	7	38	36
9.1 – 9.9	29	31	22	23
10.1 – 10.9	23	22	1	2
11.1 – 11.9	4	3	0	0

Table 7
SPAN SIZE

SPAN	MALE		FEMALE	
Length(cms)	Right	Left	Right	Left
18.1 – 18.9	5	4	20	16
19.1 – 19.9	9	8	11	12
20.1 – 20.9	15	13	8	11
21.1 – 21.9	18	19	0	0
22.1 – 22.9	13	16	0	0
23.1 – 23.9	3	3	0	0
17.1 – 17.9	0	0	12	10
16.1 – 16.9	0	0	5	7
15.1 – 15.9	0	0	5	4
14.1 – 14.9	0	0	0	1

DISCUSSION

The Homeobox genes Hox a and d control (a) the differentiation of the urinogenitalsystem, and may therefore indirectly influence the prenatal production of testicular androgen and (b) the development of the digits. This observation has led to the suggestion that patterns of digit formation may relate to gonad function . One likely candidate for such a link is the ratio between the length of the 2nd (the ‘‘index’finger) and 4th (the ‘‘ring’’ finger) digit (2D:4D). The 2D:4D ratio is a sexually dimorphic trait which is lower in men than women, relative digit length is established as early as the 14th week , and the sex difference appears by two years and perhaps before birth. 2D:4D is associated with measures of size at birth in males, sperm counts, family size, age at breast cancer presentation and age at myocardial infarction. It is therefore important to understand the factors which lead to 2D:4D formation. There is indirect evidence that the sex difference in 2D:4D is causally related to relative concentrations of testosterone and oestrogen14. Thus, (a) the waist/hip ratio of mothers, a positive correlate of testosterone and a negative correlate of estradiol, is negatively related to the 2D:4D ratio of their male and female children. (b) some behavioural traits with an excess of males have been shown to be associated with low values of 2D:4D, e.g. left hand preference, good visual spatial ability, autism and Asperger’s syndrome; (c) males and females with congenital adrenal hyperplasia, a trait associated with high prenatal testosterone, have low values of 2D:4D compared to controls; and (c) traits which show an excess of females, e.g. high verbal fluency and high levels of emotional behaviour, are associated with high 2D:4D. However, these and similar observations may result from interactions between 2D:4D and sex-related factors other than prenatal androgen and estradiol14. The purpose of this work was to examine the association between 2D:4D and relative concentrations of fetal testosterone (FT) and estradiol (FE) .Similar study was done by Shaima etal which on index finger coincide with our findings11. Also such studies were done by many authors like Pratibha ramani etal15.These data show that in about 75% of the studied females the little finger is shorter than 3/4 of the length of the middle finger. In the hands of the studied males this condition is observed in about 35%. The studied females show relatively frequently a short little finger! The hands of apes are known to have a long ring finger ... and a long little finger 16. In other words the research data related to the little finger indicate that the body constitution of males resembles more to the body constitution of apes - regarding the length of the little finger the female body constitution appears to be positioned at a further distance from the body constitution of apes7 .The information is useful anthropologically in Ranga Reddy Dist, Medchal as it is an industrial area where hand injuries are common and correction would need Indian parameters. The information is likely to be useful in sports medicine glove manufacturing, artificial aids, size of the industrial hand tools. Orthopedic splinting

is a common procedure in hand injuries and current information may provide useful parameters.

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