

SEXUAL DIMORPHISM IN HAND DIMENSIONS: AN ANTHRO-POMETRIC STUDY IN NORTH INDIAN HARYANVI ADOLESCENTS

Vikas Dhawan ¹, Manju Bala ^{*2}, Shaveta Galhotra ³.

¹ Medical Officer, Ayurved Medical Officer , Department Of Ayurveda, Sriganaganagar, Rajasthan, India.

^{*2} Associate Professor, Department Of Anatomy, Medical College, MMIMSR, Mullana, Ambala, Haryana, India.

³ Lecturer, Department Of Biochemistry, Guru Nanak Dev Dental College And Research Institute, Sunam, Sangrur, Punjab, India.

ABSTRACT

Introduction: The human hand which is the most used and versatile part of the body is of great scientific importance. Studies have established racial identification, sexual dimorphism and height and age estimation from hand dimensions for forensic applications.

Materials and Methods: The present in study was conducted to observe the sex differences in hand dimensions among North Indian Haryanvi adolescent population. The study was carried out in the Department of Anatomy at MM Institute of Medical Science & Research, Mullana , Ambala (Haryana), India. Data for the study were obtained from 400 Haryanvi Adults (200 males and 200 females) aged between 21-25 years randomly selected from population of Haryana. Diseased and/or disabled hands were excluded from the study. Hand length, Hand breadth, Palm Length were measured using sliding vernier's callipers, Hand index was calculated using formula following standard protocols. Statistical analysis of the obtained data was done in relation with gender and side. The dimensions of both hands showed significant relation with sexual dimorphism.

Results: Results of our study may be useful to identify sex in medico-legal investigations and to decide man - machine compatibility in designing hand tools.

KEY WORDS: Sexual Dimorphism, Hand Length (HL), Hand Breadth (HB), Palm Length (PL), Hand Index (HI), Hand Dimensions, Anthropometry.

Address for Correspondence: Dr. Manju Bala, Associate Professor, Department Of Anatomy, Medical College, MMIMSR, Mullana, Ambala, Haryana, India. **E-Mail:** drmanju14@yahoo.in

Access this Article online

Quick Response code



DOI: 10.16965/ijar.2016.155

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 18 Feb 2016 Accepted: 10 Mar 2016
Peer Review: 22 Feb 2016 Published (O): 31 Mar 2016
Revised: None Published (P): 31 Mar 2016

INTRODUCTION

Person identification, ascertaining sex and estimation of stature from incomplete skeletal and decomposing bodies is a recurring theme in physical anthropology and forensic science [1-5]. This has become useful in recent times due to mass disasters like terrorist attacks, plane crash, mass suicide, tsunamis, forest fires, earth

quakes [6]. Relationship between different body parts especially the limbs is being used to establish sex and stature [5-8], which is a prerequisite to identification in forensic investigation. Specifically hand and foot have been used by many investigators to determine sex and estimate stature [2,5,7,9,10].

Sex, age, stature and ethnicity are big fours of

anthropometry. Among these 'big fours' of anthropometry, determination of sex is one of the foremost criteria in establishing the identity of an individual to Anthropologist, Anatomist, Ergonomist, Obstetrician and in medico-legal practice. Accurate sexing of the remains primarily narrows down the pool of possible victim matches [10-17]. Many human features have been used to estimate sex from skeletal remains and body parts owing to the established relationship between sex and different parts of the body [18].

Sex difference in hand dimensions is a common phenomenon in human population. But the magnitude of sex difference is found to be varying from population to population. So, many authors have been working on body anthropometry to find out sex differences [19-21]. Dimensions are more in males compared to females [22,23]. Differences in the morphological characters among inter and intra population is quite interesting. India is known to be quite unique for human diversity in anthropometry. Variations in the hand dimensions are influenced by various factors like nutritional status [24], socio- economic status [25] and climate [26]. Hence the human population tends to have certain specific characters which stamp them as residents of a particular place in the world [27] the hand dimensions have been found to show high accuracy in sex determination when compared to indices. Of all hand dimensions, hand breadth has been reported to have the highest accuracy in sex determination [28]. When a dismembered upper limb is encountered, the dimensions of hand can help to determine the sex of the individual. The dimensions of hand may also provide guidance in planning for the selection of free skin graft in plastic surgeries [19].

The aim of this study is to provide the authentic database for forensic investigators in the hand length, hand breadth, palm length and hand index, and to determine the relationship between sex and both hands in a sample of Haryanvi adolescent population.

MATERIALS AND METHODS

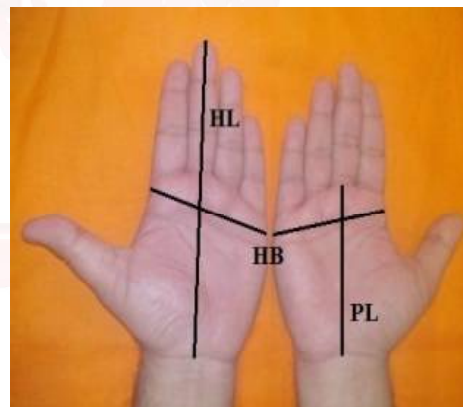
The study was conducted for period of one year from Feb 2013 to Jan 2014. This study was

carried out on a cross sectional sample of adolescent population (200 males and 200 females) aged between 21-25 years of the Haryana state, India. Samples were drawn randomly across the permanent resident of Haryana state of India, after giving informed consent both in English and Vernacular to participate in the study. Those with genetic, psychological, neurological or any chronic diseases affecting hand dimensions were excluded.

Recording of Hand Dimensions: Precautions were taken by asking the subject to clean the hands by washing with soap and water. After cleaning and drying following hand dimensions were measured. The subject was asked to place their hands in supine position on a table with fingers extended.

The hand dimensions in the categories given below were taken by sliding vernier's callipers in centimetres [29].

Fig. 1: Hand dimensions: (HB) Hand Breadth; (HL) Hand Length; (PL) Palm Length.



All the measurements were taken from the palmer aspect of hand with fingers fully extended, adducted on the flat surface and thumb extended. The hand length, hand breadth and palm length were measured [29] (Figure 1) and hand index was calculated using formula following standard protocols.

Hand Breadth (HB): Distance between the most lateral point on the head of 2nd metacarpal to the most medial point on the head of 5th metacarpal.

Hand Length (HL): Distance between mid-point of the distal transverse crease of the wrist to the most anterior projection of the skin of the middle finger.

Palm Length (PL): Distance from the mid- point

of the distal transverse crease of the wrist to the midpoint of proximal flexion crease of the middle finger.

Hand Index (HI): Hand breadth / Hand length x 100

Statistical Analysis: During data collection completed questionnaires were checked regularly to rectify any discrepancy, logical errors or missing information. The data entry was carried using Microsoft Office Excel Worksheet and then exported to statistical software and analyzed using statistical tests by using Statistical Package for Social Services (SPSS vs. 21 Mac.IBM Inc. Chicago).

Data was analyzed statistically by Minimum, maximum, mean, standard deviation, independent t-test was used to calculate significant level, pearson correlation were used to evolve regression analysis and other appropriate statistical tests which were applied depending upon the data collected.

RESULTS

The study was conducted with 400 adolescent population of Haryana state of India (males- 200; females- 200) aged between 21 – 25 years. Of 800 hands studied, the values of HL, HB, PL and hand index shown in Tables: 1 and 2 and were found to be significantly greater in males than females. The dimensions of hand were more on the left side than right side in both sexes except HL of females where $RHL_F > LHL_F$. Out of the parameters studied, the measurements of HL, HB, and PL were significant as compared with the indices ($p < 0.05$).

Hand Length (HL): The hand length in males on right side varied from 16.90 cm to 21.70cm (Mean $19.36 \pm SD 0.826$) but the left side varied from 16.60 cm to 21.40 cm (mean $19.42 \pm SD 0.787$). In females, the right hand length measured from 15.50 cm to 19.30 cm (mean 17.73 ± 0.686) and the left hand length varied from 15.60 cm to 19.40 cm (mean $17.72 \pm SD 0.727$).

Hand Breadth (HB): In males, the right hand breadth varied from 7.40 cm to 10.00 cm (mean $8.77 \pm SD 0.486$), and the left hand breadth varied from 7.80 cm to 10.70 cm (mean $8.81 \pm SD 0.470$). In females, the HB on right side varied

from 6.90 cm to 9.00 cm (mean $7.80 \pm SD 0.408$), and that on left side hand breadth varied from 6.80 cm to 8.80 cm (mean $7.92 \pm SD 0.802$).

Palm Length (PL): In males, the right palm length varied from 9.30 cm to 11.80 cm (mean $10.54 \pm SD 0.553$), and the left palm length varied from 8.90 cm to 11.70 cm (mean $10.61 \pm SD 0.488$). In females, the right palm length varied from 8.30 cm to 10.80 cm (mean $9.72 \pm SD 0.461$), and that on left side left palm length varied from 8.40 cm to 11.10 cm (mean $9.79 \pm SD 0.462$).

Table 1: Hand dimensions of Haryanvi males versus Haryanvi females on right side (cm).

	Right hand length		Right hand breadth		Right palm length		Right hand index	
	Male	Female	Male	Female	Male	Female	Male	Female
Min	16.9	15.5	7.4	6.9	9.3	8.3	37.19	38.5
Max	21.7	19.3	10	9	11.8	10.8	52.91	49.03
Mean	19.36	17.73	8.77	7.8	10.54	9.72	45.34	43.99
SD	0.82	0.68	0.48	0.4	0.55	0.46	2.63	2.12
t value	21.39		21.62		16.13		5.62	
p value	0.000*		0.000*		0.000*		0.000*	

Independent t test used to calculate significant level, *p value ≤ 0.05 has been considered to be statistically significant

Table 2: Hand dimensions of Haryanvi males versus Haryanvi females on Left side (cm).

	Left hand length		Left hand breadth		Left palm length		Left hand index	
	Male	Female	Male	Female	Male	Female	Male	Female
Min	16.6	15.6	7.8	6.8	8.9	8.4	39.5	36.08
Max	21.4	19.4	10.7	8.8	11.7	11.1	52.2	50
Mean	19.42	17.72	8.81	7.92	10.61	9.79	45.41	44.72
SD	0.78	0.72	0.47	0.8	0.48	0.46	2.31	4.29
t value	22.41		21.57		17.11		4.32	
p value	0.000*		0.000*		0.000*		0.000*	

Independent t test used to calculate significant level, *p value ≤ 0.05 has been considered to be statistically significant

Hand Index (HI): In males, right hand index varied from 37.19 cm to 52.91 cm (mean 45.34 and SD 2.633), and the left hand index varied from 39.50 cm to 52.20 cm (mean 45.41 and SD 2.312). In females, the right hand index varied from 38.50 cm to 49.03 cm (mean 43.99 and SD 2.126), and left hand index varied from 36.08 cm to 50.00 cm (mean 44.72 and SD 4.299).

There was a statistically highly significant

difference in these two groups of males and females for right hand length (RHL), right hand breadth (RHB), right palm length (RPL), right hand index (RHI), left hand length (LHL), left hand breadth (LHB), left palm length (LPL), left hand index (LHI) (p=0.000).

DISCUSSION

Our present study strongly denotes sexual dimorphism in the hand dimensions as stated earlier (Table 3). Regarding sexual differences, men presented greater dimensions than women similar to other studies. Hand length can be a good predictor of body surface area independent of the sex of an individual [30].

The hand dimensions were significantly greater in males than females and the left hand showed higher dimensions than left side. The findings regarding the hand dimensions were very near with that of Khaled et al [12].

Kanchan et al [28] noted that in all hand dimensions, the hand breadth had highest accuracy for sex differences but our study found all dimensions were significant.

In present study, the hand length of north Indians was found to be more than that of south Indians [9,19], Mauritius [32] and Port Harcourt, Nigeria [33] but less than with that of Jat sikh, Punjab [16], Delhi [31] and Nigerian [1]

population. The hand length of women of Delhi [31], Nigeria [1], Upper Egypt [12] and Istanbul [15] were found to be more than Haryanvi Indian females (our study).

The hand breadth in Haryanvi Indian males in our study was found to be more compared to all studies shown in table 3 except RHB of Nigerians [1]. But the female HB in the present study was found to be more compared to all studies shown in Table 3.

The palm length in our study showed a statistically significant higher value in males as compared to females but this was lesser in values as compared to south Indians [19].

The Hand Index in our study showed a statistically significant higher value in males as compared to females and this was also greater in values as compared to all tabulated studies.

The key features found in present study were:

1. All hand measurements are sexually dimorphic.
2. The length, breadth and index of the hand contribute most significantly to sex discrimination.
3. All dimensions of right hand of males were greater than right hand dimensions of females, difference were statistically highly significant (p=0.000).

Table 3: Comparison of mean hand dimensions of males and females of present study group with some accessible previous studies.

Sr. No.	Authors	Population and Country	Age Group	Sex and No. of subjects	Mean Hand Length		Mean Hand Breadth		Mean Palm Length		Mean Hand Index	
					RHL	LHL	RHB	LHB	RPL	LPL	RHI	LHI
1	Jasuja OP et al. (2004) [16]	Jat sikh, Punjab, India	18-60	M (30)	19.8	19.79	--	--	--	--	--	--
				F (30)	17.51	17.47	--	--	--	--	--	--
2	Oommen A et al. (2005) [9]	Manglore, Karnataka, India	19-25	M (50)	19.06	19.06	--	--	--	--	--	--
				F (50)	17.32	17.24	--	--	--	--	--	--
3	Sunil et al. (2005) [31]	Delhi, India	18-22	M (75)	19.6	19.5	--	--	--	--	--	--
				F (75)	18.2	18.1	--	--	--	--	--	--
4	Agnihotri A et al. (2006) [32]	Mauritius	18-30	M (125)	18.89	18.9	8.45	8.42	--	--	> 44	
				F (125)	17.22	17.22	7.48	7.42	--	--	< 44	
5	Danborn B et al. (2008) [1]	Nigeria	18+	M (250)	19.85	19.93	8.9	8.68	--	--	44.92	43.65
				F (250)	18.51	18.52	7.72	7.67	--	--	42.27	41.74
6	Devi KVS et al. (2011) [19]	South Indian	17-20	M (99)	19.01	19.07	8.46	8.28	10.93	11	44.59	43.52
				F (151)	17.72	17.59	7.65	7.39	10.08	10.6	43.34	42.1
7	Ibeachu PC et al. (2011)[33]	Port Harcourt, Nigeria	18-30	M (150)	19.02	19.09	8.58	8.43	--	--	44.64	
				F (150)	17.62	17.69	7.69	7.58	--	--	43.29	
8	Khaled EAH et al. (2011) [12]	Upper Egypt	18+	M (250)	19.47	19.49	8.13	8.14	--	--	41.78	41.79
				F (250)	18.13	18.16	7.16	7.17	--	--	39.53	39.5
9	Ozaslan A et al. (2012) [15]	Istanbul, Turkey	20-51	M (224)	19.23	--	8.29	--	--	--	--	--
				F (132)	17.96	--	7.57	--	--	--	--	--
10	Present study	Haryana, India	21-25	M (200)	19.36	19.42	8.77	8.81	10.54	10.61	45.34	45.41
				F (200)	17.73	17.72	7.8	7.92	9.72	9.79	43.99	44.72

4. All dimensions of left hand of males were greater than left hand dimensions of females, difference were statistically highly significant ($p=0.000$).

The present study revealed that in males, the hand length was more than 16.60 cm, the hand breadth was more than 7.40 cm and the palm length was more than 8.90 cm but in the females, these values were found to be lower than males. Hence 16.60 cm for hand length, 7.40 cm for hand breadth and 8.90 cm for palm length can be considered as a deviation point for determination of sex.

The present study has taken into consideration only the age group between 21 and 25 years in north Indian Haryanvi adolescent population. In future, the authors recommend a study including different age groups and in different populations for better interpretation of results.

CONCLUSION

The measurements of hands in our study demonstrated a significant impact in deciding the sex with a high degree of expected accuracy in Haryanvi adolescent population; they can be utilized in identification of sex in forensic science, in planning plastic surgeries, in designing hand tools and appliances, products, machines and devices for this specific population.

ACKNOWLEDGEMENTS

We greatly acknowledge the willingness of the subjects who volunteered to participate in this study despite their busy daily schedule.

Conflicts of Interests: None

REFERENCES

- [1]. Danborn B, Elukpo A. Sexual dimorphism in hand and foot length, indices, stature-ratio and relationship to height in Nigerians. *Internet J Foren Sci* 2008;3(1): DOI: 10.5580/379
- [2]. Agnihotri AK, Shukla S, Purwar B. Determination of sex from the foot measurements. *The Internet J Forensic Sci* 2007;2:1.
- [3]. El-Meligy MMS, Abdel-Hady RH, Abdel-Maaboud RM, Mohamed ZT. Estimation of human body built in Egyptians. *Forensic Sci Int* 2006;159:27-31.
- [4]. Ozaslan A, Iscan MY, Ozaslan I, Tugcu H, Koc S. Estimation of stature from body parts. *Forensic Sci Int* 2003;132:40-5.
- [5]. Ozden H, Balci Y, Demirustu C, Turgut A, Ertugrul M. Stature and sex estimate using foot and shoe dimensions. *Forensic Sci Int* 2005;147:181-4.
- [6]. Ozaslan A, Iscan MY, Ozaslan I, Tugcu H, Koc S. Estimation of stature from body parts. *Forensic Sci Int* 2003;132:40-5.
- [7]. Sanli SG, Kizilkanat ED, Boyan Ozsahin NE, M. Bozkir MG, Soames R, Erol H, and Oguz O. Stature Estimation Based on Hand Length and Foot Length. *Clin Anat* 2005;18:589-96.
- [8]. Case DT, and Ross AH. Sex Determination from Hand and Foot Bone Lengths. *J Forensic Sci*, 2007;52:264-70.
- [9]. Oommen A, Mainker A, Oommen T. A Study of the Correlation Between Hand Length And Foot Length In Humans. *J Anat Soc. India* 2005;54:1-9.
- [10]. Krishan K, Sharma A. Estimation of stature from dimensions of hands and feet in a North Indian population. *J Forensic Legal Med* 2007;14:327-32.
- [11]. Habib SR, Kamal NN. Stature estimation from hand and phalanges length of Egyptians. *J Foren Leg Med* 2010;17(3):156-60.
- [12]. Khaled EAH, Soheir AM, Maha AH, Eman AM. Determination of sex from hand dimensions and index/ring finger length ratio in Upper Egyptians. *Egypt J Foren Sci* 2011;1:80-6.
- [13]. Kanchan T, Kumar GP, Menezes RG. Index and ring finger ratio: A new sex determinant in the South-Indian population. *Foren Sci Int* 2008;181(1):53.e1-4.
- [14]. Kanchan T, Krishan K, Sharma A, Menezes R. A study of correlation of hand and foot dimensions for personal identification in mass disasters. *Foren Sci Int* 2010;199(1):112.e1-6.
- [15]. Ozaslan A, Karadayi B, Kulusayin MO, Kaya A, Afsin H. A Predictive role of hand and foot dimensions in stature estimation. *Rom J Leg Med* 2012;20(1):41-6.
- [16]. Jasuja OP, Singh G. Estimation of Stature from Hand and Phalange Length. *JIAFM* 2004;26(3):100-6.
- [17]. Ozaslan A, Karadayi B, Kulusayin MO, Kaya A. Stature estimation from bi-acromial and bi-iliocrystal measurements. *Rom J Leg Med* 2011;19(3):171-6.
- [18]. Ilayperuma I, Nanayakkara G, Palahepitiya N. Prediction of personal stature based on the hand length. *Galle Med J* 2009;14(1):15-18.
- [19]. Devi KVS, Udhaya K, Prabakaran J, Shastri D. Sexual dimorphism in hand dimensions-An anthropometric study in South Indian adolescents. *Nat J Basic Med Sci* 2011;2(1):14-7.
- [20]. Sidhu LS, Singal P, Bhatnagar DP and Jain S: Sexual Dimorphism, physique and body composition of adult Bhotia-A high altitude population. *Indian Anthropologist*. 1985;15(2):115-26.
- [21]. Bhatnagar D P, Singal P, Kaur G and Khendelwal N. Age changes in growth and body composition of Rajput of Kulu valley. *Ind.J.Sports Sc.P.Ed.* 1990;2(1):56-61.
- [22]. Verma SS, Sharma YK and Anand S. A multivariate study of three body measurements of different states of India. *Anthropol. Anz.* 2005;63(2):199-204.

- [23]. Reddy PY and Rao AP. Growth pattern of Sugaliss- A tribal population of Andhra Pradesh, India. *Ann.Hum.Biol.* 2000;27(1):67-81.
- [24]. Stini WA. Nutritional stress and growth: Sex differences in adaptive response. *Am.J. Phys.Anthropol.* 1969;31(3):417-26.
- [25]. Tanner JM, Hiernaux J and Jarnan S. Growth and physic studies. In: *Human biology-A guide to field methods.* IBP Handbook No.9. J.S.Weiner and J.A.Lourie (Eds). Blackwell scientific publication. Oxford.1969;315-40.
- [26]. Khongsdier R and Mukherjee N. Growth and nutritional status of Khasi boys in North east India relatind to exogamous marriages and socioeconomic classes. *Am.J.Phys. Anthropol.* 2003;122:162-70.
- [27]. Stini WA. Adaptive strategies of Human populations under nutritional stress. In: *Physiological and morphological adaption and evaluation.* M o u t o n Publishers 1979;387-403.
- [28]. Kanchan T, Kumar GP, Menezes RG, Rastogi P, Rao PP, Menon A, Shelty BS, Babu YP, Monteiro FN, Bhagavath P, Nayak VC. Sexual Dimorphism of the index to ring finger ratio in South Indian Adolescents. *J Forensic Leg ed.* 2010;17(5):243-6.
- [29]. Krishan K, Kanchan T, Sharma A. Multiplication factor versus regression analysis in stature estimation from hand and foot dimensions. *J Foren Leg Med* 2012;19:211-14.
- [30]. Amirshaybani HR, Crecelius GM, Timothy NH, Pfeiffer M, Sagggers GC, Manders EK. The natural history of growth of hand. Part II: Hand length as a therapeutic guide in paediatric trauma patients. *J. Trauma* 2000;49(3):457-60.
- [31]. Sunil, Dikshit PC, Aggrawal A, Rani M. Estimation of stature from hand length. *JIAFM* 2005;27(4):219-21.
- [32]. Agnihotri A, Purwar B, Jeebun N, Agnihotri S. Determination of sex by hand dimensions. *Internet J Forensic Sci* 2006;1(2). ISSN: 1540-2622 DOI: 10.5580/1785.
- [33]. Ibeachu PC, Abu EC, Didia BC. Anthropometric Sexual Dimorphism of Hand Length, Breadth and Hand Indices of University of Port-Harcourt Students. *As J Med Sci* 2011;3(8):146-50.

How to cite this article:

Vikas Dhawan, Manju Bala, Shaveta Galhotra. SEXUAL DIMORPHISM IN HAND DIMENSIONS: AN ANTHROPOMETRIC STUDY IN NORTH INDIAN HARYANVI ADOLESCENTS. *Int J Anat Res* 2016;4(1):2102-2107. DOI: 10.16965/ijar.2016.155