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Original Research Article

Estimation of sex from dimensions of hand prints in North Indian Haryanvi adolescent population

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ABSTRACT

Background: Studies have established racial identification, sexual dimorphism, height and age estimation from hand and hand print dimensions for forensic applications. The present investigation was conducted to study the sex differences in hand print dimensions among North Indian Haryanvi adolescent population.
Methods: The study was carried out in the department of anatomy at MM institute of medical science and 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 India. Diseased and/or disabled hands were excluded from the study. Hand print length (HPL), hand print breadth (HPB) and palm print length (PPL) were measured using sliding Vernier calipers.
Results: Hand print index (HPI) 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 print showed significant relation with sexual dimorphism.
Conclusions: The results of our study may be useful to identify sex in medico-legal investigations for the population of this specific area.

Keywords: Sexual dimorphism, Hand print length, Hand print breadth, Palm print length, Hand print index, Hand Print dimensions, Anthropometry

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, 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.[2,5,7-10]

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 sample primarily narrows down the pool of possible victim matches.[10-17] Many human features have been used to estimate sex from body, their prints and

skeletal remains parts owing to the established relationship between sex and different parts of the body.[18]

Identification of human remains an essential element of any medico-legal investigation. DNA technology has simplified the issue of sex/nation determination to a great extent, but technology has its limitations with regard to skilled man power, time and financial issues involved, especially in developing countries like India and in cases when DNA analysis cannot be performed. Various techniques in forensic anthropology are still most commonly employed for identification of human remains.[12,19]

The hand presents a palmar or grasping surface and a dorsal surface. On the palmer surface the skin is thick, devoid of hairs and sebaceous glands and having hand prints which is also a unique feature for identification of a person. So, identification of any person for sex, race, individual can be made by hand prints.[19,20]

Hand analysis and palmistry have intrigued humans throughout history. Perhaps earliest interest in hand reading occurred when cave dwellers left their hand prints on cave walls 12,000 years ago. Since writing was invented, thousands of documents have been created detailing hand analysis techniques and palmistry. In India "Samudrik Shastra" adorned supreme position as a form of science during ancient period. 'Samudrik Shastra' literally means 'ocean of knowledge', of which palmistry forms a subsection. Palmistry deals with morphological features of hand, for example size, shape, segmental lengths, birth marks and other fine lines forming symbols. As per palmistry every hand is a map of life and every part of hand from the finger tips to the wrist represents precisely constitutional nature and life history of person with events like major accidents, diseases or calamities.[21]

Sex difference in hand print 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.[22-24] Studies have reported that males are also usually taller than females, dimensions are more in males compared to females and dimensions of hand prints are less then hand dimensions.[25,26] Differences in morphological characters among inter and intra population is quite interesting. India is known to be quite unique for human diversity in anthropometry. Variations in hand and hand print dimensions are influenced by various factors like nutritional status, socio-economic status and climate.[27-29] Hence human population tends to have certain specific characters which stamp them as residents of a particular place in the world the hand and hand print dimensions have been found to show high accuracy in sex determination when compared to indices.[30] Of all hand and hand print dimensions, hand breadth and HPB has been reported to have the highest accuracy in sex determination.[31]

Aim

The aim of this study is to provide the authentic database for forensic investigators in the HPL, HPB, PPL and HPI, and to determine the relationship between sex and both hands print in sample of Haryanvi adolescent population.

METHODS

The study was conducted for period of one year from February 2013 to January 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 print dimensions were excluded.

Recording of hand-print dimensions

Precautions were taken by asking the subject to clean the hands by washing with soap and water. After cleaning and drying the hand the ink pad smeared with black ink was used for making hand print. The thumb was placed towards the body and other digits will be placed away from the body. Hand prints of both hands were taken separately on the A4 bond paper.

Palmer printing using the ink method

Ink pad was used to cover the entire palm, including the wrist creases, the hypothenar border and digits with ink.[32] Digits were inked by rolling across the ink pad one finger was inked one time by rolling across the inkpad. A sheet of paper was placed on a stable and flat surface. A foam pad was used under the sheet of paper to fill the concavity of the palm and pressure was applied to the back of the hand in order to prevent the appearance of blank spaces in the central region of the palm. Person's wrist was placed on the bottom of the paper and then rest of the palm was pressed down firmly making sure that the centre is printed without any white space. Digits were also pressed down firmly. Observer's hand was placed on the edge of the paper to assist the subject to remove the hand.

The HPL, HPB and PPL were measured by sliding Vernier's calipers in centimeters (Figure 1).[33]

HPB: Distance between the most lateral point of the handprint on the head of 2nd metacarpal to the most medial point of the handprint on head of 5th metacarpal.

HPL: Distance between mid-point of the handprint on distal transverse crease of the wrist to the most anterior projection of the print of the middle finger.

PPL: Distance from the mid- point of the handprint on distal transverse crease of the wrist to the proximal flexion crease of the middle finger.

HPI=HPB/HPL×100

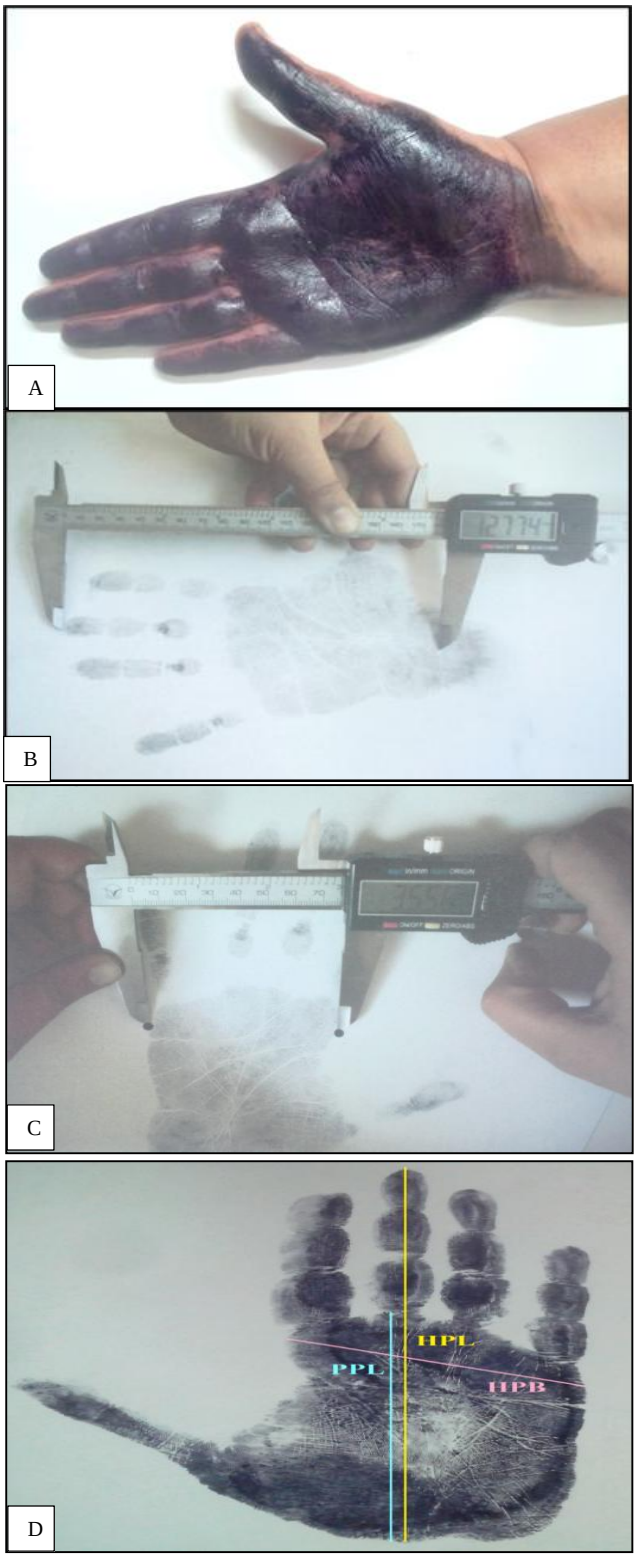

Figure 1 (A-D): Palmer printing using the ink method and measurements of hand print dimensions: HPL, HPB and PPL.

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 hand prints studied, the values of HPL, HPB, PPL and HPI on right and left side shown in Tables 1 and 2 and were found to be significantly greater in males than females.

In Haryanvi females we can conclude that the dimensions of hand prints were more on the left side than right side in both sexes except HPB and HPI of males where RHPB_M> LHPB_M, RHPI_M> LHPI_M. All studied parameters of current study were significant for estimation of sex in current study group ($p<0.05$).

HPL

The HPL in males on right side varied from 15.80 cm to 19.90 cm (Mean 18.26±SD=0.78) but the left side varied from15.60 cm to 20.00 cm (mean 18.32±SD=0.76). In females, the right HPL (RHPL) measured from 14.60 cm to 18.20 cm (mean 16.73±0.67) and the left HPL (LHPL) varied from 14.70 cm to 18.40 cm (mean 16.78±SD=0.70).

HPB

In males, the right HPB (RHPB) varied from 7.00 cm to 9.60 cm (mean 8.25±SD=0.45), and the left HPB (LHPB) varied from 7.20 cm to 9.30 cm (mean 8.24±SD=0.43). In females, the HPB on right side varied from 6.40 cm to 8.40 cm (mean 7.35±SD=0.39), and that on left side HPB varied from 6.40 cm to 8.30 cm (mean 7.39±SD=0.39).

PPL

In males, the right PPL (RPPL) varied from 8.70 cm to 11.30 cm (mean 10.03±SD=0.53), and the left PPL (LPPL) varied from 8.70 cm to 11.20 cm (mean 10.10±SD 0.46). In females, the RPPL varied from 7.90 cm to 10.10 cm (mean 9.24±SD 0.44), and that on LPPL varied from 7.90 cm to 10.60 cm (mean 9.32±SD=0.45).

HPI

In males, right HPI (RHPI) varied from 37.23 cm to 54.24 cm (mean 45.24±SD=2.64), and the left HPI (LHPI) varied from 38.42 cm to 52.38 cm (mean 45.04±SD=2.39). In females, the RHPI varied from 38.46 cm to 49.38 cm (mean 43.99±SD=2.19), and LHPI varied from 35.87 cm to 50.34 cm (mean 44.08±SD=2.17).

There was a statistically highly significant difference in these two groups of males and females for RHPL, RHPB, RPPL, RHPI, LHPL, LHPB, LPPL, LHPI (p=0.000).

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

Variables	RHPL		RHPB		RPPL		RHPI	
	Male	Female	Male	Female	Male	Female	Male	Female
Min	15.80	14.60	7.00	6.40	8.70	7.90	37.23	38.46
Max	19.90	18.20	9.60	8.40	11.30	10.10	54.24	49.38
Mean	18.26	16.73	8.25	7.35	10.03	9.24	45.24	43.99
SD	0.78	0.67	0.45	0.39	0.53	0.44	2.64	2.19
T value	20.84		20.80		16.09		5.14	
P value*	0.000		0.000		0.000		0.000	

*p<0.05 has been considered to be statistically significant, independent t test used to calculate significant level.

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

Variables	LHPL		LHPB		LPPL		LHPI	
	Male	Female	Male	Female	Male	Female	Male	Female
Min	15.60	14.70	7.20	6.40	8.70	7.90	38.42	35.87
Max	20.00	18.40	9.30	8.30	11.20	10.60	52.38	50.34
Mean	18.32	16.78	8.24	7.39	10.10	9.32	45.04	44.08
SD	0.76	0.70	0.43	0.39	0.46	0.45	2.39	2.17
T value	20.84		20.49		17.00		4.17	
P value*	0.000		0.000		0.000		0.000	

*P value <0.05 has been considered to be statistically significant, independent t test used to calculate significant level.

DISCUSSION

Our present study strongly denotes sexual dimorphism in the hand print dimensions as stated earlier (Table 3). Regarding sexual differences, men presented greater dimensions than women similar to other studies in other human populations. Although our findings are similar to those reported earlier, the mean value of hand print measurements differs from that reported in earlier studies conducted on different population; we found that very less work is done and accessible on hand print dimensions; comparison between two studies is shown in Table 3. The average HPL was highest obtained by Jasuja et al compared to our studies.[16]

The average PPL was highest in our study. Above mentioned studies did not report the other dimensions of hand print (HPB and HPI) so could not be compared.

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

Authors	Population and country	age group (in years)	Sex and no. of subjects	Mean HPL		Mean HPB		Mean PPL		Mean HPI	
				RHPL	LHPL	RHPB	LHPB	RPPL	LPPL	RHPI	LHPI
Henneberg et al[34]	South Africa	5-20	M (71)	17.51		--	--	9.73		--	--
			F (125)	16.66		--	--	9.10		--	--
Jasuja et al[16]	Jat Sikh, Punjab, India	18-60	M (30)	20.23	20.30	--	--	--	--	--	--
			F (30)	17.86	17.83	--	--	--	--	--	--
Present study	Haryana, India	21-25	M (200)	18.26	18.32	8.25	8.24	10.03	10.10	45.24	45.04
			F (200)	16.73	16.78	7.35	7.39	9.24	9.32	43.99	44.08

The key features found in present study were: All hand print measurements are sexually dimorphic. The length, breadth, index of the print hand and palm print contribute most significantly to sex discrimination There was a statistically highly significant difference in these two groups for all hand print dimensions. Almost all the

studies examining the gender differences in body and their print size show that males are significantly heavier and taller than the females. They possess broader shoulders and have bigger bone widths and circumferences than the females.[35] Age of epiphyseal fusion varies in both sexes. Thus, sex determination from hand and hand print dimensions can immensely help the forensic scientists in identification of human remains.[36] Studying intra and inter population variations in different morphological characters have long been an interest of anthropologists.

Human diversity in body size and shape is a hallmark of Indian population. Intra- and inter-populational morphological variations are influenced by micro and macro environmental factors like socioeconomic condition, nutritional status, climatic condition, physical setting of the habitat and level of physical work.

As a consequence, human populations possess characteristics that stamp them as residents of particular areas of the world.[35] All dimensions of right hand print of males were greater than right hand print dimensions of females, difference were statistically highly significant (p=0.000).

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

The present study revealed that in Haryanvi adult males, the HPL was more than 15.60 cm, the HPB was more than 7.00 cm and the PPL was more than 8.70 cm but, in the females, these values were found to be lower than males. Hence 14.60 cm for HPL, 6.40 cm for HPB and 7.90 cm for PPL can be considered as a deviation point for determination of sex.

Limitations

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 print 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 for the population of this specific area.

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