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Original Research Article

STATURE PREDICTION OF PUNJAB POPULATION (PAKISTAN) FROM HAND, FOREARM AND FOOT MEASUREMENTS

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Abstract: *Anthropometry is a systematic study of body measurements in man. Forensic anthropologist tries best to answer the questions relating to age, origin, height, gender, and race after examination of the body remains. The biological profile of a person such as age, sex, ethnicity, and stature can be determined with the help of anthropometry. Results of the study revealed the normal distribution of data and with tests, statistics are found to be significant at p≤0.05 level of significance for all parameters employed in this study. Males have consistently larger values as compared to the female's forearm length, hand length right/left, hand width right/left, foot length right/ left and foot width right/left. Therefore, it is concluded that there is a significant difference between males' and female's character measurements including hand, forearm, and foot.*

Keywords: Anthropometry, Stature, Forearm, Biological profile

Introduction

Forensic science has a keen interest in stature estimation due to its great importance in personal identification. Every part of human body has a close relationship with whole of the body. A person's identity may be represented by foot and hand dimensions. Stature of a man is an anatomical complex of linear dimensions (Moorthy *et al* 2014; Zaher *et al*., 2011). Researchers found a close relationship between different body parts and stature like face and head (Baume and Buschange 1983; Hautvast 1971; Sahni *et al*. 2010), feet and hands (Abdel-Malek *et al*. 1990), lower limbs and upper limbs bones (Ahmed 2013) and vertebral column (Jason and Taylor 1995). The previous reports stated that stature estimation can be done with the help of all types of body parts. Mathematical and anatomical methods are used for the estimation of stature standards.

For an individual biological profile establishment stature, age and sex are considered on priority in forensic sciences which can consequently move towards a constructive personal identification. Human stature is a structural complex of the linear dimensions that includes vertebral column, skull, pelvis and also lower extremities so; it can be assumed that there is a significant relation that exist between stature and all body parts (Ozaslan *et al*. 2003; Ahmad 2013). By using linear and multiple regression equations, reports are recorded to show the relation between foot length, stature and foot breadth (Rani *et al*. 2011; Jakhar 2010; Ilayperuma *et al*. 2008; Sen and Ghosh 2008; Kanchan *et al*. 2008).

Material and Methods

The study was conducted on 200 healthy male and female individuals. Healthy and without physical deformity individuals were taken for the study. Different areas of Punjab were selected for subject selection having different socio-economic background. The aim for understanding thee examinations was the paucity in literature data that allow for the reconstruction of stature from different dimensions of feet and hands in Punjab population by recording data of hand breadth, hand length, foot breadth and foot length and also forearm length. Anthropometry was used for stature measurement. For stature estimation (Fig.1), distance from vertex to floor having anatomical position with head (placed in Frankfort plane) was measured (Martin and Saller 1957).

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For the measurement of hand length Fig.2, the distance between the midpoint of distal transverse crease of wrist to most anterior skin projection of middle finger was recorded (Ishak *et al*. 2012). Hand breadth Fig.3 was reported by measuring the distance between the most metacarpal up to the most medial point on hand of fifth metacarpal (Oshak *et al*. 2012).

Fig. 1 Stature estimation byFrankfort plane

Fig. 2 Hand length estimation of healthy individual

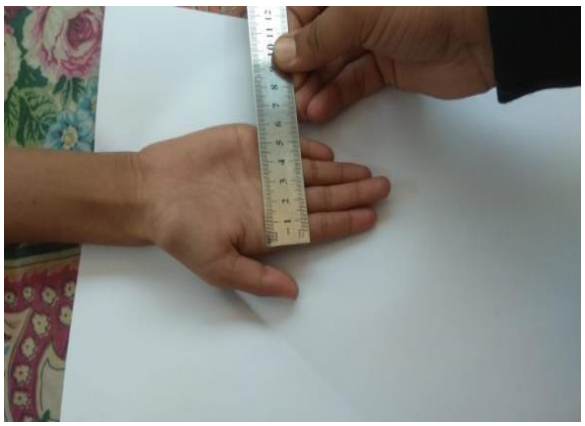

Fig. 3 Hand breadth estimation of healthy individual

Fig.4 Estimation of foot breadth

Fig.5 Estimation of foot length

Fig.6 Estimation of forearm length

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Foot length Fig.5 was reported by measuring distance between pternion (heel) and the akropodian (the longest toe) (Hemy *et al*. 2013). Foot breadth Fig.4 was reported by measuring the distance between most points on medial side of foot upto the lateral side (Hemy *et al*. 2013). For forearm length Fig.6 measurement the distance from the head of the radius (radiale) to the tip of the lateral styloid (stylion) was measured. Mean, standard deviation SD and paired t-test were used for data evaluation. Student t-test was used to compare stature with foot length, foot width, hand length, hand width and forearm length.

Results

Table 1 shows the scores of t scores regarding differences of male and female forearm length (Right), HLR, HWR, FLR, and FWR. Results of the study revealed normal distribution of data and with test statistics are found to be significant at $p \leq 0.05$ level of significant for all parameters used in present study. Table 2 shows the scores of t scores regarding differences of male and female forearm Length (Left), HLL, HWL, FLL and FWL of present study. Results of the study showed normal distribution of data and by statistics it is found to be significant at $p \leq 0.05$ level of significant for all parameters employed. Table 3 shows the correlation between height and forearm length (R), HLR, HWR, FLR and FWR in the present study. There was significant positive high correlation between height and forearm length (R), HLR, HWR, FLR and FWR at $p \leq 0.05$ level of significance. Along with the increase of height the length of arms, HLR, HWR, FLR and FWR also increases. Table 4 shows the correlation between height and Forearm Length (L), HLL, HWL, FLL and FWL of the study. It was concluded that there was significant positive high correlation between height and Forearm Length (L), HLL, HWL, FLL and FWL at $p \leq 0.05$ level of significant. It is seen that along with the increase of height the length of arms also increases. Table 5 shows linear regression in height and forearm length (L), HLL, HWL, FLL and FWL in present study. The value of R-Square change shows the increase in variation explained by the addition of the interaction term. The change in R^2 is reported in this table range from 0.301-0.325, which is a proportion. This increase is statistically significant. The results from tables 6 and 7 showed the descriptive statistics for both male and female age wise left and right forearm lengths.

Table 1 shows difference in male and female forearm length right (FLR), hand length right (HLR), hand width right (HWR), foot length right (FLR), and foot width right (FWR) of the study

Measurement	T Stat	P value	Mean Difference	Standard Error of Difference
FLR	11.02	0.001	-0.5981	0.5923
HLR	35.11	0.0	-0.3361	0.3297
HWR	18.55	0.00	0.3489	0.2172
FLR	14.89	0.00	0.1844	0.4615
FWR	25.51	0.00	-0.0252	0.1851

Table 2 Show Difference in Male and Female Forearm Length (L), HLL, HWL, FLL and FWL of the Study

Measurement	T Stat	P value	Mean Difference	Standard Error of Difference
FLL	10.955	.001	-.59404	.58919
HLL	35.145	.000	-.33617	.32432
HWL	18.497	.000	.34662	.21725
FLL	15.203	.000	.17882	.46148
FWL	25.680	.000	-.02957	.18518

Table 3 Show Correlation Co-efficient in Height and Forearm Length (R), HLR, HWR, FLR and FWR of the Study

	Parameters	Correlation	Co-	P value

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		efficient (r)	
Height	**FLR**	.867**	.000
	HLR	.919**	.000
	HWR	.667**	.000
	FLR	.825**	.000
	FWR	.766**	.000

Table 4 Show Correlation Co-efficient in Height and Forearm Length (L), HLL, HWL, FLL and FWL of the Study

	rameters	**rrelation icient (r)**	**Co-**	**P value**
Height	**FLL**	.867**		0.000
	HLL	0.919**		0.000
	HWL	0.666**		0.000
	FLL	0.825**		0.000
	FWL	0.752**		0.000

Table 5 Show Linear Regression in Height and Forearm Length (L), HLL, HWL, FLL and FWL of the Study

	Parameters	**Linear Regression Equation**	***SEE***	***R^2***
Height	**FLL**	0.301+2.18	0.113	0.867**
	HLL	0.541+0.145	0.230	0.919**
	HWL	0.255+.576	0.094	0.667**
	FLL	-0.015+.202	-0.005	0.825**
	FWL	0.072+.325	0.026	0.766**

Table 6 Age wise Summary of Descriptive Statistics of Male and Female Forearm Length (R)

Age		**FLR**	**HLR**	**HWR**	**FLRR**	**FWR**
5 to 15	Mean	20.5093	14.6536	6.6804	19.3258	7.3784
	N	97	97	97	97	97
	Std. Deviation	3.50316	1.77835	1.24463	2.66049	1.05220
16-35	Mean	26.2692	17.8912	8.2549	23.6626	8.9813
	N	91	91	91	91	91
	Std. Deviation	1.85638	1.18553	1.30139	1.81846	0.89479
Total	Mean	23.2973	16.2207	7.4426	21.4250	8.1543
	N	188	188	188	188	188
	Std. Deviation	4.03594	2.22077	1.49427	3.15399	1.26446

Table 7 Age wise Summary of Descriptive Statistics of Male and Female Forearm Length (L)

Age		**FLL**	**HLL**	**HWL**	**FLRL**	**FWL**
5 to 15	Mean	20.5052	14.6526	6.6794	19.3216	7.3773
	N	97	97	97	97	97
	Std. Deviation	3.49953	1.78022	1.24649	2.65680	1.05480
16-35	Mean	26.2692	17.8901	8.2516	23.6615	8.9802
	N	91	91	91	91	91
	Std. Deviation	1.85638	1.18688	1.30071	1.81945	0.89346
	Mean	23.2952	16.2197	7.4404	21.4223	8.1532

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Total	N	188	188	188	188	188
	Std. Deviation	4.03581	2.22186	1.49418	3.15371	1.26510

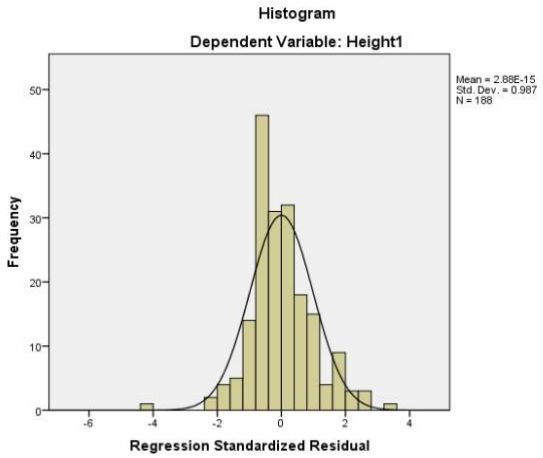

Fig. 7

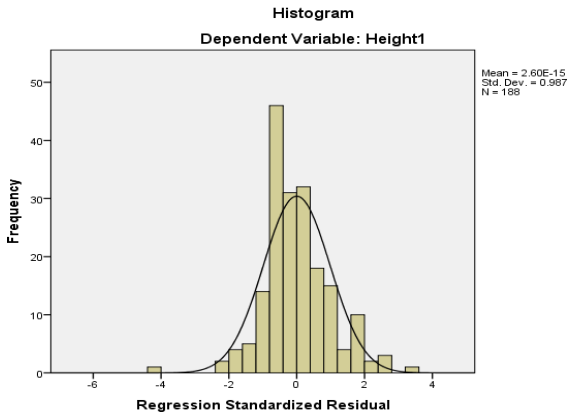

Fig. 8

Above figure 7 and 8 show the normal distribution of data in this study. In figure 7 the curve is normally distributed which means that data is normally distributed, there is significance relationship found between the height and forearm length (L), HLL, HWL, FLL, and FWL of the study. Meanwhile, there is significance relationship found between the height and forearm length (R), HLR, HWR, FLR, and FWR of the study.

Discussion

For any kind of investigation in forensic sciences, identification of an individual is of extreme importance. Body parts are recovered from crime scenes, from natural disasters e.g. earthquakes etc. also from man-made disasters like road accidents, plane crash or bomb blasts. In all these cases identification of an individual is a difficult task. When victims' bodies are recovered, they are found at different states of decomposition and dismemberment. Forensic scientists face problems in determining the exact identity of an individual. If surviving foot is available, it can help in partial identity to estimate stature by taking different dimensions of foot (Kanchan *et al*. 2008).

New methods are developed to eliminate this difficulty. When any part of body is recovered from the crime scene, the dimensions taken can be very helpful in finding height and sex of the body. Significant correlation is found between body segments and body length that can be calculated using different statistical equations for the estimation of sex and height. The result may vary due to different genetics and environmental conditions.

Conclusion

Males have consistently larger values as compared to the females forearm length, hand length right/left, hand width right/left, foot length right/ left, and foot width right/left. Therefore it is concluded that there is significance difference between males and females statistical values. With the increase of height the length of arms, hand length right/left, hand width right/left, foot length right/ left and foot width right/left also increases. It was concluded that there was significant positive high correlation between forearm length, hand length right/left, hand width right/left, foot length right/ left and foot width right/left height and at $p \leq 0.05$ level of significant. It is reported by the statistical data analysis that hand length is preferred for stature estimation as compared to other parts of the body in the region of Punjab.

Abbreviations

FLR: Forearm length right; HLR: hand length right; HWR: hand width right; FLR: foot length right; FWR: Foot width right; FLL: Forearm length left; HLL: hand length left; HWL: hand width left; FLL: foot length left; FWL: Foot width left

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Authors' contributions

All authors read and approved the final manuscript.

Conflict of interest

The authors of manuscript showed absence of conflict of interest.

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