Estimation of Stature from Foot Length and Hand Length Measurements In Gujarat Region

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Abstracts: Background & objectives: Stature is considered as the height of a person measured in erect position. It is one of the most important factors in establishing identity of a person. In certain medico-legal cases, where only parts or fragments of human body are found. Such a need arises when there is mass casualty. Aim of current study was to establish anthropometric correlation of stature with hand length and foot length in population of Gujarat and also to derive regression equations for correct estimation of stature of male and female in Gujarati population. **Material and Method:** 150 asymptomatic, apparently healthy, adolescent and adult medical students with age between 18 to 22 years belonging to various regions of Gujarat were selected. Left foot and left hand was selected for measurement. **Result:** Regression equation for estimation of height using both foot length and hand length were formulated. By using the derived regression equations, height of subjects was calculated and then compared with actual height of subjects. **Conclusion:** By the present study we conclude that both foot and hand length can be used in estimation of stature of both males and females with fairly accurate results in Gujarati population. [Shah RK NJIRM 2014; 5(6):16-19]

Key Words: Foot length, Hand length, Stature, Estimation

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Introduction: Stature or height is the combination of length of certain bones and appendages of body which is determined by racial differences[1]. Many factors such as genetics, environment and nutrition affect it. It is one of the most important factors in establishing identity of a person. In certain medico-legal cases, where only parts or fragments of human body are found as in incidents like bomb blast, aeroplane crash, earthquake, close compartment fire, accidents, body maimed by human or animals, establishing height is of paramount importance.

Many studies have been done in the past to estimate the stature from various body parameters such as length of long bones, hand length, hand breadth, foot length, arm span, cephalic index etc[1-13]. The aim of current study was to establish anthropometric correlation of stature with hand and foot lengths in population of Gujarat and also to derive regression equations for correct estimation of stature of male and female in Gujarati population.

Material and Methods: For current study, total 150 asymptomatic, apparently healthy, adolescent and adult medical students with age between 18 to 22 years belonging to various regions of Gujarat were selected. Left foot and left hand was selected for measurement as per recommendation of international agreement for paired measurement at Geneva.

- **Stature:** Stature was measured in standing erect anatomical position vertically in midline from heel to vertex.
- **Foot length:** Foot was placed on flat surface and foot length was measured as a direct distance from the most prominent point of the back of the heel to the tip of the hallux or to the tip of second toe, when the second toe was longer than hallux by spreading calliper.
- **Hand length:** Hand was placed on flat surface and hand length measured as a direct distance from tip of the styloid process of radius to the tip of the middle finger by using spreading.

All the measurements in limbs were taken from the left limb during fixed time of the day to avoid any diurnal variation and by the same person to avoid personal error in methodology. Obtained data was statistically analysed by linear regression analysis.

Results: The measurements were taken on 150 medical students, 72 males and 78 females. Regression equations for estimation of height using

both foot length and hand length were formulated (Table.1).

Table 1: Correlation Coefficient and Regression Equations for Estimation of Height from Foot Length and Hand Length

Subjects	Correlation coefficient (r)	R^2	Regression equation	P Value
Male	0.908	0.825	HT=57.725+(3.842)FT+(0.745)HL	<0.001
Female	0.875	0.765	HT=54.387+(3.513)FT+(1.276)HL	<0.001

HT= Height, FT= Foot Length, HL= Hand Length

By using derived regression equations; height of subjects was calculated and then compared with actual height of subjects (Table.2).

Table.2 Comparison of Measured Height with Estimated Height from Foot Length and Hand Length in Males and Females

Subjects	Estimated height (cm)		Measured height (cm)		P value
	Range (cm)	Mean±SD (cm)	Range (cm)	Mean±SD (cm)	
Male	159.65 – 186.164	175.955 ±5.374	158.80 – 191.0	175.95± 5.917	0.9803
Female	146.853 – 174.472	161.119 ±4.915	144.20 – 174.50	161.11± 5.620	0.988

From the analysis of the data, it can also be said that stature can be predicted using both hand and foot lengths with fairly good accuracy as they show significant correlation.

Discussion: Many authors previously tried to establish correlation between height and length of various long bones[2-7]. Most of these studies were done on Caucasians and the regression equations derived by them cannot be applied to Indian population due to racial differences. In the present study we have tried to estimate stature from foot length and hand length of male and female as well as to derive regression equations using both the parameters in Gujarati population.

A study by Abdi Ozaslan *et al*[8]on 224 males and 132 women of 20-51 years shows high amount of correlation between stature and all variables used such as hand breadth, hand length, wrist breath, foot breadth, foot length and ankle breath. A study by Jitendarkumar *et al*[9]on 52 males and 51 females in age group of 21-32 years in Haryana state showed significant correlation between height and left foot length (r=0.969). A study by S. M.Patel *et al*[10]on 502 students in age group of17-22 years also showed significant correlation between foot length and stature (r=0.6102) in population of Gujarat. Similarly, a study by Agnihotri *et al*[11]on 250 students showed positive correlation between height and foot length (r=0.769). In all the above mentioned studies a single parameter was compared and used to derive the stature.

In our study we have tried to use foot length and hand length simultaneously to correctly estimate the stature. In present study, the correlation coefficient was found to be statistically significant suggesting a strong relationship between foot length and hand length with stature for both males and females. Regression equations for estimation of stature from foot length & hand length were derived for both males and females. Stature were calculated by using regression equation and compared with measured stature which also showed high amount of accuracy in predicting the stature (Table 2).

Previous studies have positively found that the regression equations using various anatomical parameters of one race or population do not apply to another[17,18]. We also found that to be correct as our data differs from data of previous studies of other ethnic groups[19,20].Thesame is reflected when we compared the correlation coefficient and regression equations of different studies (Table 3).

Table 3: Comparison between Correlation Coefficient and Regression Equations of Different Studies

Studies done indifferent ethnic groups	Correlation coefficient Male	Correlation coefficient Female	Regression equation to measure stature in males	Regression equation to measure stature in females
Abdi Ozaslan et al.[8]	HL: 0.578 FL: 0.696	HL: 0.309 FL: 0.496	ST=668.04+(2.01)HL+(2.67)FL	
Abdi Ozaslan et al. [8]	0.578	0.309	ST=922.01+(4.15)HL	ST=1116.56+(2.80)HL
Abdi Ozaslan et al. [8]	0.696	0.496	ST=840.88+(3.52)FL	ST=941.95+(2.96)FL
Khanpurkar& Radke[12]	0.616	0.647	ST = 92.1 + (4.2) HL	ST = 84.9 + (4.3) HL
Ilayperuma et al.[13]	0.580	0.590	ST = 103.37 + (3.49) HL	ST = 93.70 + (3.63) HL
Sunil et al.[14]	0.7 (R) 0.6 (L)	0.7 (R) 0.7 (L)	ST= 86.93+(4.25) HLRT ST= 85.44+(4.32)HLLT	ST= 77.42+ (4.56) HLRT ST= 80.94+ (4.4) HLLT
Jasuja OP [15]	0.502 (R) 0.0452 (L)	0.529 (R) 0.557 (L)	ST= 69.51+(5.22) HLRT ST= 84.74+ (4.5) HLLT	ST= 130.95+(1.61) HLRT ST= 130.04+(1.66) HLLT
Krishan K et al. [16]	NA	NA	ST= 87.33+(4.45) HLLT	ST= 84.539+(4.238) HLLT
Present Study	0.908	0.875	ST=57.725+(3.842)FT+(0.745)HL	ST=54.387+(3.513)FT+(1.276)HL

ST=Stature, HL=Hand Length, FT=Foot Length, HB=Hand breadth, WB=Wrist breadth, FB=Foot breath, AB=Ankle Breath, RT=Right, LT=Left

Conclusion: By the present study we conclude that both foot and hand length can simultaneously be used to correctly estimate the stature of both males and females in Gujarati population. The regression equations we derived can be used in cadavers or in cases where only body parts are available. Estimation of individual's stature is of paramount importance for forensic expert and anthropologist. By estimation of stature one can come to know individual's physical description which is very useful in forensic and archaeological studies as well.

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