



AN ESTIMATION OF CORRELATION OF STATURE WITH FOOT LENGTH ALONG WITH ITS SIGNIFICANCE IN ADULT MALES & FEMALES POPULATION OF NORTH INDIA

Sumit Kumar	Tutor, S. N. Medical College, Agra.
Dr. Gupta Anshu	Associate Professor, S. N. Medical College, Agra.
Dr. Bhardwaj Kamal	Associate Professor, S. N. Medical College, Agra.
Dr. Agrawal Vasudha*	Assistant Professor, S. N. Medical College, Agra. *Corresponding Author

ABSTRACT **Background-** Stature is the quantitative and qualitative measurement of a personality. The purpose of this study is to estimate the correlation of stature with foot length and to estimate regression formulae for calculating the stature from foot length in Adult males and Females North Indian Population. **Methods:** This research was done on 400 Adult Human Subjects, (200 males and 200 females) of North Indian Population. The total number of subjects were categorised into four groups according to the age: Category 1 - 23 - 26 years of age, Category 2 - 27- 30 years of age, Category 3 - 31-34 years of age, Category 4 - 35-39 years of age. Stature and Foot length were measured and mean value, standard deviation and Pearson's correlation coefficient was calculated. Correlation between parameters with age group and gender has been estimated. **Results:** Correlation of Stature and foot length value is 0.404 in males, 0.422 in females and p value is <0.001. The results of the study found that stature and foot length shows statistically significant positive correlation. **Conclusion:** Stature shows a statistically significant positive correlation with Foot Length in adult males and females. Thus, for reconstruction surgeries of limb, it is a critical anthropologic tool. It can also be applicable in identifying an individual in mass disasters where the case is deteriorated, damaged and disfigured.

KEYWORDS : Foot length; Stature; Correlation

INTRODUCTION-

One of the classical and conventional tool of biological anthropology is Anthropometry which includes the scientific procedures and approach for different observations and measurement on the skeleton as well as on the living man (01). Anthropometry deals with the study of human body and skeleton that is helpful in forensic science for medicolegal cases. Anthropometry is also divided as social and cultural units as it deals with human and human behavior in societies. Each individual has its own identity. The primary characteristics for identity of an individual includes age, sex and stature (02). Stature of an individual is one of the important parameter which can lead to identification even after death (03). The height of an individual is influenced by many elements like age, gender, race, physique, hierarchy and temporal swings. For different types of demography, these variants are unique. So, for the various population sets various nomograms are required. By measuring standing height, longitudinal growth as well as body fitness and energy requirements to adjust drug dosage can also be estimated.

The measurement of height is difficult in some pathological and abnormal conditions such as in pain, vertebral abnormalities due to compression, scoliosis or palsy. In these conditions, anthropometric dimensions like arm-span, length of scapula, cranial sutures, height of the sternum, length of vertebrae, foot length is used. Identification of a person from foot and its parts become more salient in mass casualty, when there is probability of finding feet in shoes, isolated from the body. Determination of sex can be done by bone its shape and index of foot. Foot length is associated with weight and height of fetuses, this parameter can be used for assessing fetal age and bodily dimension even in deceased fetus. [04]. When body parts are injured or disfigured, it entitles an useful information in determining stature to doctors, anthropologists, anatomist, and in forensic sciences. This present study, is conducted to establish a relationship of stature with foot length in North Indian Population.

MATERIAL AND METHODS-

This study, was done on 400 Adult Human Subjects (200 males and 200 females) of North Indian Population. The work was conducted in Anatomy department, S. N. Medical College, Agra. A well described consent in writing was taken from the subjects prior to the study. Approval of Institutional Research committee and Ethical committee was taken before the beginning of the study. Subjects with history of trauma, Congenital anomalies affecting stature or limb are excluded from the study.

Measurements:

- Foot length was measured with the person in anatomical position. The foot was placed on the plywood square sheet (fig.1).



Fig.1: Positioning of foot for foot length measurement

- Two points has been marked on the sheet, one point at the level of front of tip of great toe and other point at the level of back of heel (fig.2).



Fig.2: Positioning of foot for foot length measurement

- Height was precise in anatomical position and subject standing on their heels together, buttocks, shoulder and head touched the walls. The head lie in the Frankfurt horizontal plane. The subjects have been taken a deep breath and hold it. A non-elastic tape was placed against the head and wall to decide maximum height then told to extent out and to step away from the wall (fig.3).



Fig.3: Positioning of the subject for stature measurement

Measurement was taken from vertex to the heel (fig.4). All measurements were done with measuring tape.



Fig-4: Stature measurement

For the purpose of study, the total number of subjects has been divided into four groups according to the age: Category 1 - 23 to 26 years, Category 2 - 27 to 30 years, Category 3- 31 to 34 years, Category 4 - 35 to 39 years. Stature and Foot length of each subject was measured thrice and average was taken. Then, the mean of stature and mean of Foot length was calculated. The standard deviation and p value were calculated, and the regression equation was calculated using SPSS software, version 22. Correlation between parameters with age group and gender has been estimated.

Results- Anthropometric measurements are of significant importance for prediction of stature in humans. This study, relates the estimation of Stature with Foot length in North Indian Adult Human Population. Using the anthropometric measurements, a regression equation for the calculation of stature was estimated.

In this study, it was calculated that the mean and standard deviation of Stature in males is 167.24±6.37 cm and 154.17±8.35 cm in females and it was observed that the mean value and standard deviation of stature in males is higher than in females (Table 1).

Table-1: Measurement of Stature (in Cms)

Group	N (%)	Min-Max(cm)	Mean+SD	Mean diff	P value
I	Total -199 (50%)	131-180	161.70+8.61	11.04	<.0001
	Male -89 (23%)	153-180	167.87+5.71		
	Female -110 (27%)	131-170	156.83+7.30		
II	Total -76 (19%)	136-180	160.89+10.44	0.81	<.0001
	Male-40 (10%)	145-180	167.57+6.87	14.10	
	Female-36(9%)	136-170	153.47+8.56		
III	Total-54 (13%)	129-182.5	159.09+12.46	1.80	<.0001
	Male-29(7%)	152-182.5	167.82+7.73	18.86	
	Female-25(6%)	129-162	148.96+8.63		
IV	Total-71(18%)	124-177	158.74+10.22	0.35	<.0001
	Male-42(10%)	148-177	164.90+6.01	15.08	
	Female-29(8%)	124-162	149.82+8.31		

Table 1: shows the mean and standard deviation of stature in different groups and also shows the comparison between the heights in males and females

In the present study, it was calculated that the mean and standard deviation of foot length in males 24.53±1.36 cm and 21.64±1.79 cm in females and it was observed that the mean and standard deviation of

foot length in males is higher than in females (Table 2)

Table-2: Measurement of foot length

Group	N (%)	Min-max	Mean + SD	Mean diff.	P value
I	Total-110 (50%)	18-27	23.03+2.05	3.05	<.001
	Male -89(23%)	22-27	24.74+1.14		
	Female-110 (27%)	18-26	21.69+1.54		
II	Total -76(19%)	18-27.5	23.32+2.22	0.282	<.001
	Male-40(10%)	18-27.5	24.61+1.69	2.71	
	Female-36(9%)	18-26	21.90+1.84		
III	Total-54 (13%)	17-27	22.91+2.59	0.41	<.001
	Male-29(7%)	22-27	24.60+1.33	3.64	
	Female-25(6%)	17-24	20.96+2.32		
IV	Total-71 (18%)	16-27	23.09+1.98	0.180	<.001
	Male-42(10%)	20-27	24.01+1.35	2.26	
	Female-29(8%)	16-24.5	21.75+2.01		

Table 2: shows the mean and standard deviation of foot length in different groups and also shows the comparison between the foot length in males and females

In Table 3, the correlation coefficients between body height and foot length are displayed. Correlation of body height and foot value 0.404 in males, 0.422 in females and p value was <0.001. The Associations between standing height and foot length were significant (p<0.001) and high in this sample in both the gender.

Table-3: Correlation of stature with foot length

Body height		Foot length			0.593
Group	N (%)	Mean+SD (cm)	Mean + SD (cm)	Ratio B.H F. length	
I	Total -199 (50%)	161.70+8.61	23.03+2.05	7.02	0.656
	Male -89 (23%)	167.87+5.71	24.74+1.14	6.78	
	Female -110 (27%)	156.83+7.30	21.69+1.54	7.23	
II	Total -76 (19%)	160.89+10.44	23.32+2.22	6.89	0.775
	Male-40 (10%)	167.57+6.87	24.61+1.69	6.80	
	Female-36(9%)	153.47+8.56	21.90+1.84	7.00	
III	Total-54 (13%)	159.09+12.46	22.91+2.59	6.94	0.693
	Male-29(7%)	167.82+7.71	24.60+1.33	6.82	
	Female-25(6%)	148.96+8.63	20.96+2.32	7.10	
IV	Total -71(18%)	158.74+10.22	23.09+1.98	6.87	0.693
	Male-42(10%)	164.90+6.01	24.01+1.35	6.86	
	Female-29(8%)	149.82+8.31	21.75+2.01	6.88	

Table 3: shows the correlation of stature with foot length in different groups in adult males and females of North India Population

The associations between foot length measurements and body height among the above models is sketched as a scatter diagram in fig.5 and fig. 6 in males and females respectively.

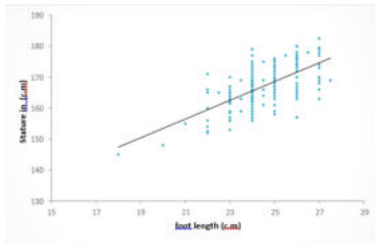


Fig:5: Scatter diagram representing correlation stature of stature with foot length in males

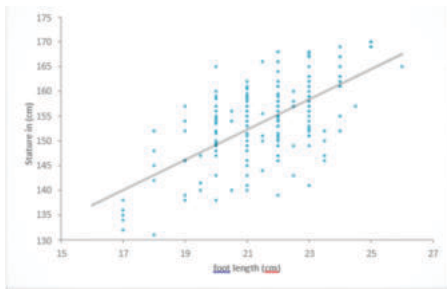


Fig:6: Scatter diagram representing correlation of stature with foot length in females

Regression formula is calculated on SPSS Version 22.

The Linear Regression Equation

Male $Y = 94.647 + 2.958x$
 Female $Y' = 87.633 + 3.076x'$

Where-x and x' is the foot length of male and female, Y and Y' is the Height of the male and female. So, Positive correlation exists between Body height and Foot length.

DISCUSSION-

The stature of an individual is an important parameter in the identification of unknown and discrete human remain which is mainly pre-determined genetically but also affected by different environmental factors. Table 1 shows the mean and standard deviation of stature in different groups and also shows the comparison of stature in males and females. A relationship exists between the stature of an individual with various parts of the body like head, trunk and lengths of the upper and lower limbs. Many workers did their work to estimate stature from pelvic, skull, clavicle, bones of upper limb and lower limb etc. In this study, approximate stature was estimated from foot length and a linear regression equation formulae is derived for estimation of stature from foot length dimensions in North Indian Adult Human Population. Table 2 shows the mean and standard deviation of Foot length in different groups and also shows the comparison between the foot lengths in males and females. Foot length of both males and females (Mean 23.03) of group I increase with increase in stature (mean 161.70) which shows a positive correlation of stature with foot length. Foot length of both males and females (mean 23.32) of group II increases with increase in stature (mean 160.89) that indicates foot length has a positive correlation with stature. Foot length of both males and females (mean 22.91) of group III increases with increase in stature (mean 159.09) that signifies foot length has a positive correlation with stature. Foot length of both males and females (mean 23.09) of group IV increases with increase in stature (mean 158.74) that means foot length has a positive correlation with stature. The association Ratio between Body height and foot length ratio was 7.02 in group I, 6.87 in group II, 6.94 in group III and 6.87 in group IV. Table 3 shows the correlation of stature with foot length in different groups in males and females. This study is compared with different preceding studies (Table 4).

Table-04: Correlation Of Stature With Foot Length In Different Populations

S. No.	Authors	Populations	Male		Female		p-value
			Sample size	r-value	Sample size	r-value	
1	Malik et al (2015)	Lahore	145	0.807	146	0.807	<0.001
2	Moitra et al (2017)	AIIMS, new Delhi	200	0.522	200	0.283	-

3	Singh et al (2012)	Chandigarh	272	0.497	128	0.213	<0.001
4	In the present study	North Indian population	200	0.404	200	0.422	<0.001

Table-04: Shows Correlation of Stature with Foot length in different populations

Malik et al, 2015[05] found that the correlation coefficient (r) value was 0.807(both male and female) and p value was <0.001. So there was statistically significant positive correlation between stature and foot length of all subjects. Moitra et al, 2017[06] estimated that the correlation coefficient (r) value between stature and foot length was 0.522 in males and 0.283 in females. So there was positive correlation between height and foot length. Malik et al, 2015[05] also found that the correlation coefficient (r) value was 0.807(both male and female) and p value was <0.001. So there was statistically significant positive correlation between stature and foot length of all subject. Singh et al, 2012[07] concluded that the correlation coefficient (r) value was 0.875 in males and 0.856 in females (correlation of height using arm- span). Correlation coefficient value was 0.497 in males and 0.213 in females (correlation of height using foot length). They found that there was a positive correlation of stature with arm span, foot length. Shah et al, 2013[08] estimated that the correlation coefficient (r) value was 0.806 in males, 0.866 in females and p value was <0.001. Correlation of stature with and foot value was 0.404 in males, 0.422 in females and p value was <0.001. The results of the study shows that there is statistically significant positive correlation of stature with foot span.

CONCLUSION-

This study was done on 400 Adult Human Subjects (200 males and 200 females) of North Indian Population. From the study, a regression equation was derived which shows a positive correlation of stature with foot length. This fact can be used by Anthropologists for estimation of stature with foot length when the identity of a person is unknown.

Conflicts of interest-Nil
 Source of Funding- Nil.

REFERENCES-

- Choudhary A, Chowdhary DS. Comparative anthropometric study of nasal parameters between two ethnic groups of Rajasthan state. International Journal of Medicine and Public health. 2012; 2(2).
- Vij K. Textbook of Forensic Medicine and Toxicology.5th edition NewDelhi: Elsevier;2011.P.37
- Singh B, Kaur M, Kaur J, Singh M and Batra APS. Estimation of stature from forearm length in north indians – an anthropometric study.International Journal of Basic and Applied Medical Sciences.2013;3 (1):201-204
- G.,S.,Shankar,V.,V.,Shetty,s.,Radhika,K. Correlation of human height with foot length in Indian Individual. Int.J.Anat.Res.2018; 6(1.2):4943-46.
- Malik A.,R.,Akhtar,N.,Ali,R.,Farrukh,R.,Aziz,K. A study on estimation of stature from foot length. Professional MedJ.2015;22(5):632-639.
- Moitra,s.,Majumdar,S.,Nidhi,L.,Arijit,D. Estimation of height from foot length in Bengal population. Indian j.medical Research.2017;4(6):23-49.
- Singh, A., Kumar,A., Chavali, K.H., Harish D. Use of arm span and foot length for estimation of height of the person. J Panjab Acad Forensic Med Toxicol.2012; 12[2]:87-91.