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Stature estimation from foot length among Naga population

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Abstract
Establishing personal Identity is a very important concern in Forensic investigations. Estimation of stature gives a basic domain of the investigation process in unknown and co-mingled human remains in forensic anthropology case work. The objective of the present study was to set up standards for estimation of stature from width and foot length in a sub-adult Male and female Naga population. The stature Estimation was done with linear regression equation of 200 students (100 males and 100 females) with no disabilities. The regression factors were computed and checked for their accuracy and reliability. High significant positive correlation ($r=0.67$) for males and ($r=0.81$) for females was observed. Our study provides equation that can help in estimation of stature.

Keywords: Forensic anthropology, stature estimation, foot measurements, right foot length, right foot breadth

Introduction
A person's stature is an identifying characteristic that is often used in forensic investigation. Footprint is the one of the valuable physical evidence encountered in the crime scenes. The foot length reflects a biological correlation with height suggesting that height may be estimated from shoe print length also. Foot print are still found at crime scenes, the foot length reflects a biological correlation with height suggesting that height may be estimated from shoe print length also. Foot prints are commonly found at crime scenes, while entering and exiting.
Most of the foot print studies were conducted on mixed population and a single formula cannot represent all parts of the country or world, Hence the present study entitled "Estimation of stature from foot length among Naga population" has been carried out to contribute to the field of forensic anthropology collected from 100 Naga females and 100 Naga males with the following objectives:

Objectives
- To estimate stature using linear regression equation.
- To study the correlation between foot measurement and stature among Naga population.
- To compare the regression formula for its reliability and accuracy.

Materials and Methods
The present field work was conducted in the month from January to May 2017 at Sam Higginbottom University of Agricultural, Technology and Sciences, Allahabad.
Measurements of stature and right foot length and right foot breadth were obtained from 100 females and 100 males aged between 18 – 26 years among Naga student population were collected.
The right foot length was selected for measurement. The height was measured using stadiometer using method. The subject was instructed to stand barefooted on a wooden board in straight position with the trunk in braced along the vertical board and head oriented in Frankfort horizontal plane of a standard height measuring instrument. The measurements were taken in centimetres. Foot length was measured from the longest toe to the heel and the foot breadth from metatarsal tibiale and metatarsal fibulare.

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Observation and Results

Table 1: (Males)

Variables	Stature	Right foot length	Right foot breadth
Mean	168.57	24.48	9.62
Standard deviation	5.31	1.006	.55
Coeffecient correlation (r)		.670**	.38**
S.e.e		3.968	4.927
Regression equation		Y = 81.305 +3.54 (x)	Y = 133.128 + 3.74 (x)

Table 2: (Females)

Varaibles	Stature	Right Foot Length	Right Foot Breadth
Mean	157.278	22.4	8.45
Standard Deviation	6.98	1.25	.66
Coeffecient Correlation (R)		.81**	.54**
S.E.E		4.055	5.874
Regression Equation		Y = 54.61 + 4.56 (X)	Y = 108.27 + 5.77(X)

Formula validation

For the validation of the formula, 10 more unknown male and female samples were taken, their right foot length, right foot breadth were measured and these values were put in the formulated regression formula obtained.

Table 3: Height comparison for males using foot length

Sl. No.	RFL	Calculated height	Actual height	Error	% accuracy
1	24.5	168.035	166	±2.035	98%
2	24.3	167.327	168	±0.673	99%
3	24.5	168.035	168	±0.035	99%
4	24.5	168.035	170	±1.965	98%
5	23.8	165.557	173	±7.443	95%
6	25.6	171.929	169	±2.929	98%
7	27	176.885	172	±4.885	97%
8	24	166.265	171	±4.735	97%
9	24.5	168.035	167	±.035	99%
10	23.5	164.495	165	±0.505	99%
	25.5	171.575	169	±2.575	98%

Table 3 shows the actual and calculated height of the unknown samples of males from their respective foot length and it was observed that the regression equations formulated in this study for calculations of stature from foot length is satisfactory with more than 95% accuracy.

Table 4: Height comparison for males using foot breadth

S No	RFB	Calculated height	Actual height	Error	% accuracy
1	9.5	168.677	166	±2.677	98%
2	10	170.548	168	±2.548	98%
3	9	166.806	168	±1.194	99%
4	9.1	167.1802	170	±2.8198	98%
5	9.3	167.9286	173	±5.0714	97%
6	9.2	167.5544	169	±1.4456	99%
7	10.6	172.7932	172	±0.7932	99%
8	9.3	167.9286	171	±3.0714	98%
9	9	166.806	167	±0.194	99%
10	9	166.806	165	±1.806	98%

Table 4 shows the actual and calculated height of the unknown samples of males from their respective foot breadth and it was observed that the regression equations formulated in this study for calculations of stature from foot length is satisfactory with more than 90% accuracy.

Table 5: Height comparison for females using foot length

S. No	RFL	Calculated height	Actual height	Error	% accuracy
1	23.5	161.77	159.5	±2.27	98%
2	21	150.37	149	±1.37	99%
3	22	154.93	153	±1.93	98%
4	23.5	161.77	157.5	±4.27	97%
5	24.8	167.698	162	±5.698	96%
6	21.5	152.65	150	±2.65	98%
7	23.8	163.138	160.5	±2.638	98%
8	24.9	168.154	162	±6.154	96%
9	22.8	158.578	158.5	±0.078	99%
10	21.5	152.65	152	±0.65	99%

Table 5 shows the actual and calculated height of the unknown samples of females from their respective foot breadth and it was observed that the regression equations formulated in this study for calculations of stature from foot length is satisfactory with more than 90% accuracy.

Table 6: Height comparison for females using foot breadth

S. No	RFB	Calculated height	Actual height	Error	% accuracy
1	9.5	163.085	159.5	±3.585	97%
2	9	160.2	149	±11.2	93%
3	8.8	159.046	153	±6.046	96%
4	8.8	159.046	157.5	±1.546	99%
5	9.3	161.931	162	±0.069	99%
6	8.2	155.584	150	±5.584	96%
7	9.4	162.508	160.5	±2.008	98%
8	9	160.2	162	±1.8	98%
9	9.1	160.777	158.5	±2.277	98%
10	8.8	159.046	152	±7.046	95%

Table 6 shows the actual and calculated height of the unknown samples of females from their respective foot breadth and it was observed that the regression equations formulated in this study for calculations of stature from foot length is satisfactory with more than 90% accuracy.

Summary and conclusion
In the present study, measurements of stature and right foot measurements (RFL and RFB) were taken from 100 males and 100 females among Naga population. The percentage of accuracy obtained from both the male and female samples were satisfactory. From this study we can say that the regression equations derived from foot length and foot breadth measurements are reliable.
The results also showed high correlation between stature and foot length (r=.67) in males and (r=.81) in females.
Thus, it is concluded that the estimation of stature among the Naga population can be carried out using foot length and regression equation analysis shows satisfactory positive correlation between stature and foot length in a studied population.

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