IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 1 Ver. VII (January. 2017), PP 46-52
www.iosrjournals.org

Estimation of Stature from Percutaneous Length of Ulna and Tibia in Medical Students of Nagaland

Martula Lemtur[1],Chongtham Rajlakshmi[2],Ningthoujam Damayanti Devi[3]
[1] Post Graduate Trainee, [2] Associate Professor, [3] Professor & Hod
Department Of Anatomy, Regional Institute Of Medical Sciences, Imphal, Manipur, India.

Abstract:
Background and Objectives: *Stature estimation plays an important role in establishing individuality of an unidentified dead body or any mutilated part of the body by the medicolegal experts. A strong relationship exists between stature and dimensions of different body parts, particularly bone lengths. In this study, an attempt has been made to derive regression equation to estimate stature from percutaneous length of ulna and tibia among Naga population of Nagaland.*
Materials and Methods: *The study was conducted at Regional Institute of Medical Sciences, Manipur on 100 healthy Medical Students from Nagaland (50 males and 50 females; aged 19-35 years). Stature, length of ulna and tibia on both sides were measured in standard position. Statistical analysis done using SPSS 21.*
Results: *Mean ages of males and females were 23.22 ±3.93 years and 23.12 ±3.34 years, respectively which was not significant. Mean stature of males was 168.12±5.48 cms and females was 157±5.41 cms. Mean ulna and tibial length in males were significantly longer than that of females. A positive correlation between height and both the length of long bones was observed in both the sexes.*
Conclusion: *Distinct sexual dimorphism observed in stature and length of ulna and tibia and also positive linear correlations observed between height and length of ulna and tibia. Linear regression models for stature estimation derived. Stature estimation should be population based as it is racial and gender dependent.*
Key words: *Stature, ulna, tibia, correlation coefficient, regression equation*

I. Introduction

Stature is defined as height of body in upright position and is considered as one of the important parameters of personal identity.[1] Stature estimation, therefore, plays an important role in establishing individuality of an unidentified dead body or any mutilated part of the body by medicolegal experts.[2,3] Though, anatomical method is more accurate, but often complete skeletal remains are unavailable from a crime scene and therefore, the forensic anthropologists as well as medicolegal experts have to reconstruct stature from the relatively less precise mathematical method, which is workable even if only a single long bone is available.[4-6]

Professor Karl Pearson (1898-99) was the first to introduce correlation calculus for stature prediction from long bones.[6] Stature estimation from long bones length offers an important contribution to identification of unknown remains, as there exists an important relationship between different body parts dimensions and stature, particularly bone lengths.[3,7] However, Stature varies with race, age, sex, heredity, climate and nutritional status. Therefore, any study pertaining to stature estimation need to be a population and sex specific study.[2,3,5-9]

In this study, we have measured the percutaneous length of ulna and tibia as they are known to give strong correlation to body height.[10] Tibia is the medial bone of the leg and both its condyles and medial malleolus are visible and prominent and are easily accessible percutaneously. It provides one of the best estimates of stature and also resists erosion & retains anatomical shape for long even after burial. Ulna is the medial bone of the forearm in supination and its upper and lower ends are subcutaneous and thereby can be easily marked out percutaneously. Also, its length can be of advantageous when lower limb is deformed along with deformity of trunk or when the upper limb is the only body part available for stature estimation.[9,11,12]

The study was done on Nagas of Nagaland, a tiny State in the Northeastern part of India, inhabited by 16 tribes with many sub- tribes, belonging to Mongoloid race of different ethnic group to derive regression equations for stature estimation from the length of ulna and tibia among this ethnic population and to compare our study findings with other studies done on different populations.

II. Methods and materials

The study was conducted on 100 healthy Naga medical students from Nagaland, all studying at Regional Institute of Medical Sciences, Imphal, Manipur, comprising of 50 males and 50 females with the age ranging from 19 to 35 years, after taking informed written consent and permission from Institutional Ethical

Clearance Committee. The study timing was between 4 to 6 PM to eliminate discrepancies due to diurinal variation.[13] Subjects with any deformity or history of fracture of any long bones were excluded from the study. Stature was measured with stadiometer with the subject standing in anatomical position and head adjusted in Frankfurt's plane as shown in [Figure 1]. Percutaneous ulna length (PCUL) was measured with the elbow flexed and palm placed over the opposite shoulder and marking the tip of olecranon process and tip of styloid process of ulna with a skin marker and measuring the distance between these two points.[14] [Figure 2]. Percutaneous tibial length (PCTL) was measured with the subject sitting with knee flexed at 90°. The most prominent, palpable upper margin of the medial condyle and the tip of medial malleolus of tibia were marked with the skin marker and the distances between these two bony points were measured.[15] [Figure 3]. Both PCUL and PCTL were measured on both sides using a non- stretchable measuring tape calibrated to 0.1cm. All measurements were done in cms and by the same observer. Statistical analysis was done using SPSS version 21 and P- value of <0.05 was taken as significant.

Fig 1: Measurement of Stature by Stadiometer

Fig 2: Measurement of Percutaneous Ulna length
(1= tip of olecranon process; 2= tip of styloid process of ulna)

Fig 3: Measurement of Percutaneous Tibial Length
(1= most prominent upper border of medial condyle; 2= tip of medial malleolus)

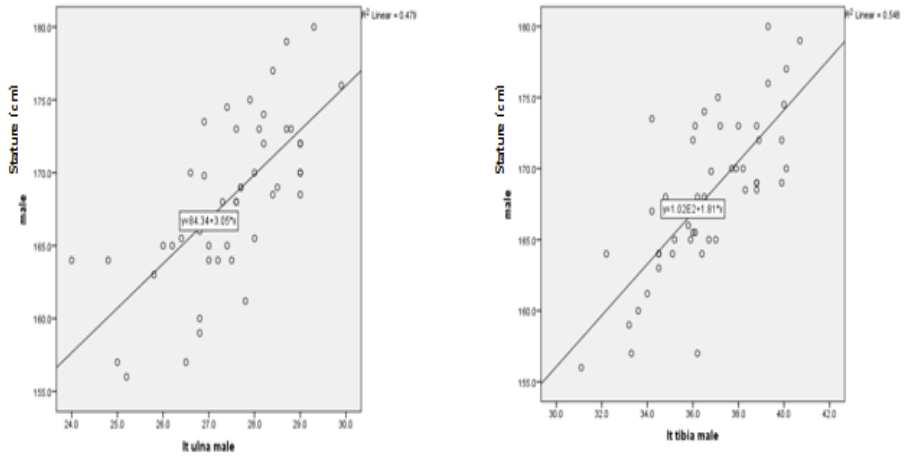

Fig 4: Scatterplot showing positive linear correlation between stature and length of ulna & tibia in males

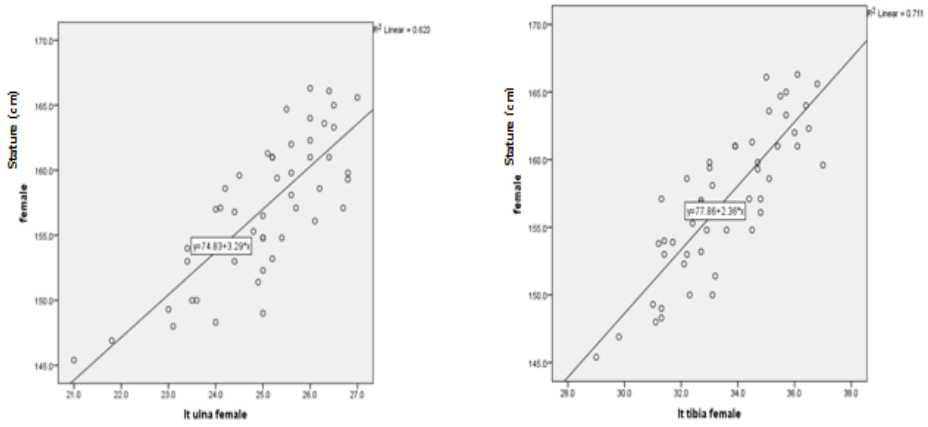

Fig 5: Scatterplot showing positive linear correlation between stature and length of ulna and tibia in females

III. Results

The age of the participants ranges from 19 to 35 years with 73% between 21 to 30 years of age. The mean ages of males and females were 23.22 ±3.93 years and 23.12 ±3.34 years, respectively, which was comparable. [Table 1]

The total stature of subjects ranges from 145.4 to 180 cms with the mean stature of males, 168.12 ±5.48 cms and females, 157.0 ±5.4 cms. Maximum number of males (60%) had their stature between 161-170 cms and 54% of females had their stature between 151-160 cms. [Table 2 & 3]

Mean length of right and left ulna in males were 27.45± 1.21cms and 27.42 ± 1.24 cms, respectively and that of females were 25.15± 1.29 cms and 25±1.29 cms, respectively. Mean length of right and left tibia in males were 36.70± 2.26 cms and 36.67± 2.24 cms, respectively and that of females were 33.57± 1.92 cms and 33.54± 1.93 cms, respectively. [Table 4]

Comparisons of these dimensions between the right and left side were insignificant in both the sexes (P >0.05). Therefore, for further statistical analysis, lengths of left ulna and tibia were used for both sexes. There was a strong significant difference (P< 0.001) in all the three parameters between the two sexes.

The correlation coefficient (r) between stature and ulna in males and females were 0.629 and 0.787, respectively, whereas, the r values between stature and tibia in males and females were 0.740 and 0.843, respectively. This showed strong positive correlations between stature and ulna and tibial lengths [Fig 4 & 5], that were statistically significant, with tibial length showing better correlation than ulna length in both the sexes. Also, the r values were higher in females, implying that females have better correlation between stature, and ulna and tibial lengths than males. [Table 5]

Regression equation for estimation of stature was derived using the formula y= a + bx ± S.E.E., where y= estimated stature, a= intercept, b= regression coefficient, x= length of the variable and S.E.E. = Standard Error of Estimate. [Table 6]

Table 1: Range and Mean age of participants

Age (years)	Male	Female
Range	19-35	19-31
Mean±SD	23.22±3.93	23.12±3.34

Table 2: Distribution of participants by Stature

	Frequency (%)	
Height (cm)	**Male**	**Female**
141 – 150	0 (0)	8 (16)
151- 160	5 (10)	27 (54)
161 – 170	30 (60)	15 (30)
171 – 180	15 (30)	0 (0)

Table 3: Mean Stature of participants

Mean Height (cm)		SD	Min	Max
Total	162.56	7.78	145.4	180
Male	168.12	5.48	156	180
Female	157	5.4	145.4	166.3

Table 4: Mean and range of ulna and tibial lengths in males and females

		Ulna length (cm)			Tibial length (cm)		
		Right	**Left**	**P- value**	**Right**	**Left**	**P- value**
Male	**Mean length± SD (cm)**	27.45±1.21	27.42±1.24	0.922	36.70±2.26	36.67±2.24	0.961
	Range	24.3- 29.8	24- 29.9		32- 40.8	31.1- 40.7	
Female	**Mean length± SD (cm)**	25.15±1.29	25±1.29	0.558	33.57±1.92	33.54±1.93	0.942
	Range	21.1- 27.1	21- 27		29- 37	29- 37	

Table 5: Correlation coefficient and regression coefficient between stature and ulna and tibia in males and females

	Male		Female	
	Ulna	**Tibia**	**Ulna**	**Tibia**
Pearson's Correlation Coefficient (r)	0.692	0.740	0.787	0.843
P- value	<0.001	<0.001	<0.001	<0.001
Regression coefficient	3.055	1.807	3.287	2.359

Table 6: Linear Regression Equations derived for estimation of stature from lengths of ulna and tibia in males and females

		Linear regression equation, y= a+bx (cms)	±S.E.E.
Male	**Using ulna length (x_{u1})**	y_{u1}= 84.34 + 3.05x_{u1}	± 4
	Using tibial length (x_{t1})	y_{t1}= 101.85+1.81x_{t1}	±3.73
Female	**Using ulna length (x_{u2})**	y_{u2}= 74.83 + 3.29x_{u2}	±3.37
	Using tibial length (x_{t2})	y_{t2}= 77.86 +2.36x_{t2}	±2.94

Table 7: Comparison of the present study findings with studies done on different populations

Author(s)	Age group (yrs)	Stature (cm)		ulna length (cm)		Tibial length (cm)		Study Population
		Male	Female	Male	Female	Male	Female	
Bhavna, Nath S[5]	20-40	167.66±5.69				36.48±1.91		Shia Muslims, Delhi
Mohanty NK[15]	20-80	161.92±9.21	152±9.87			37.08±2.34	35.03±2.06	Oriya population
Gaur R et al[3]	18-21	167.21± 5.01	154.92± 5.41			38.29± 1.76	35.43± 1.71	SC Haryana
Meitei NJ, Devi HS[2]	18-44	159.54±4.71				33.26± 1.68		Maring tribe Manipur
Prasad A et al[14]	25-30	171.93±5.99	165.43±3.07	26.86±1.34	21.68±0.87			Marathwada Maharashtra
Ghanbari K et al[19]	19-23		162.01±0.87		25.36±0.16			Kurdish
Mondal MK et al[16]	20-50	164.31±6.34		27.01± 1.17				Burdwan, West Bengal
Ebite L et al[17]	20-45	169.44±6.82	162.2±5.57	30.33± 1.53	28.5± 1.8			Edo, Nigeria
Ilayperuma I et al[8]	20-23	170.14± 5.22	157.55±5.75	27.56± 1.3	25.11± 1.24			Sri Lankans
Yadav SK et al[18]	25-40	169.59± 4.56	157.45± 3.79	27.2± 1.18	23.67±1.17			Nepalese
Duyar I et al[10]	18-44	174.39± 8.82		27.36± 1.68		38.91± 2.74		Turkish
Present Study	19-35	168.12± 5.48	157± 5.4	27.42± 1.24	25± 1.29	36.67± 2.24	33.54±1.93	Nagas, Nagaland

Table 8: Comparison of correlation coefficient between stature and length of ulna and tibia, in different studies

Author(s)	Correlation coefficient Ulna & Stature		Correlation coefficient Tibia & Stature	
	Male	Female	Male	Female
Meitei NJ & Devi HS[2]			0.863	
Bhavna & Nath S[5]			0.765	
Mohanty NK[15]			0.951	0.939
Trivedi A et al[21]			0.434	0.601
Ilayperuma I et al[8]	0.66	0.76		
Prasad A et al[14]	0.65	0.6		
Duyar I et al[10]	0.601		0.802	
Present study	0.692	0.787	0.740	0.843

IV. Discussion

Estimation of stature from different body parts is one of the important parameters for personal identity in medicolegal cases. With the increase in catastrophic events causing mass deaths from natural and manmade

errors, often forensic experts have to deal with dismembered, mutilated and comingled parts of body or some skeletal remains. In such situations, stature estimation from the parts of the body available can prove to be vital in narrowing down the investigation to a limited number of individuals [3].

Many studies[2,3,5-8] have shown correlation of stature and different body parts dimension particularly long limb bones which has been found to be true in the present study with strong positive correlation between stature, and ulna and tibial lengths in both the sexes. Our male study subjects had a mean stature of 168.12± 5.48 cms, which was comparable to that of Bhavna and Nath S [5] who found that the male Shia Muslims of Delhi had a mean stature of 167.66±5.69 cms. Also Gaur R et al [3] found the mean stature of Scheduled castes male population of Haryana as 167.21±5.01 cms which was close to the present findings. Mean stature of females was 157±5.4 which was similar with those of Sri Lankans [8] and Nepalese women [18].

Maring tribe of Manipur [2], Scheduled caste female population of Haryana [3], Oriya population [15] and Burdwan population of West Bengal [16] were shorter than the present study population whereas Sri Lankan males [8], Turkish [10], Maharashtran population [14], Nigerian [17] and Kurdish females [19] were taller than the present group. Oriya population [15] shorter stature may be due to the inclusion of elderly age groups upto 80 years as study has shown reduction of stature after the age of 50 years [20] due to the degeneration of spine, loss of intervertebral tissue and loss of BMD.

The average height of adult males within a given population is significantly higher than that of adult females [8,9,13,17] which was observed in the present study.

Distinct sexual dimorphism was observed with the males having significantly longer ulna and tibial lengths than females, in agreement with the observations of many researchers [3,7,8,13,14,17,18].

Though, the mean stature of 171.93±5.99 cms and 165.43±3.07 cms in males and females, respectively, of the Maharashtan population [13] were taller than the study population with mean stature of 168.12± 5.48 cms and 157± 5.4 cms, respectively, their mean ulna length of 26.86±1.34 cms in males and 21.68±0.87 cms in females, was comparatively shorter than the present findings of 27.42 ±1.24 cms and 25 ±1.29 cms, respectively. Also the scheduled castes population of Haryana [3] as well as Oriya population [15] though comparatively shorter in stature, their mean tibial lengths were longer than the present findings. In general, when we compared the findings of our study with the study done in India and abroad, it was deduced that Nagas of Nagaland have proportionately longer ulna length but shorter tibial length. [Table 7]

Studies [3-9] have shown that race, age, sex, environment and nutrition affect not only the stature but also different body proportions and the differences found in the present study may be due to these factors.

Bhavna and Nath S [5] found the r value between stature and tibia in males as 0.765 which was comparable with the present finding of 0.740. Ilayperuma et al [8] found the r value between stature and ulna in males and females to be 0.66 and 0.76, respectively, which was close to the present findings of 0.692 and 0.787, respectively, with the r values more in females than that of males in both the studies. [Table.8] Trotter and Gleser [7], Duyar et al [10], Jantz and Jantz [22] observed that upper limb was less correlated with stature than lower limbs which was found to be true in present study.

As the proportional relationship of long bone length with the stature varies not only from one racial group to another but also from individual to individual within the same racial group, so by taking only the mean lengths of the bone would miss the individuality of each body. Therefore, to overcome this problem, the standard error of estimate (S.E.E.) was taken into account. Thus, the regression equation was derived by the formula $Y= a + bx \pm S.E.E$,[14] where S.E.E. in the present study for stature estimation from ulna and tibia lengths were found to be 4 and 3.73, respectively in males and 3.37 and 2.94, respectively in females.

V. Conclusion

- In accordance with studies of many researchers, Nagas of Nagaland shows distinct sexual dimorphism in stature and ulna and tibial length, with positive linear correlations between these dimensions.
- The study group is found to have proportionately longer PCUL but shorter PCTL, supporting the view that body dimensions proportion depend on heredity, ethnicity, environmental and nutritional factors.
- As no known previous study has been done on this ethnic group, the linear regression equations derived may be of value in estimating the stature on this population, and this may be particularly important to the medicolegal experts and the anthropologists.
- The linear regression equations derived for the study population are:

* Male : Stature(S)= 84.34 + 3.05 x PCUL ± 4
=101.85+1.81 x PCTL± 3.73
* Female : S= 74.83 + 3.29 x PCUL ± 3.37
= 77.86 +2.36 x PCTL± 2.94

References

[1]. Krogman WM, Iscan MY. The human skeleton in forensic medicine. Thomas CC. 2nd Ed. Springfield, 1986:58
[2]. Meitei NJ, Devi HS. Estimation of Stature Using Lower Limb Dimensions among Maring Males of Manipur. Anthropologist 2014; 17(2):681-3.
[3]. Gaur R, Kaur k, Airi R, Jarodia K. Estimation of Stature from Percutaneous Lengths of Tibia and Fibula of Scheduled Castes of Haryana State, India.Ann Forensic Res Anal 2016;3(1):1025-30.
[4]. Raxter MH, Auerbach BM, Ruff CB. Revision of the Fully Technique for Estimating Statures. Am J Phys Anthropol 2006;130:374–84
[5]. Bhavna, Nath S. Estimation of Stature on the Basis of Measurements of the Lower Limb. Anthropologist 2007;3:219-22.
[6]. Pearson K. Mathematical contribution to the theory of evolution and on the reconstruction of the stature of prehistoric races. Philos Trans R Soc series 1899;192:169-241.
[7]. Trotter M, Gleser GC. Estimation of stature from long bones of American whites and negroes. Am J Phys Anthropol 1952;10:463-514.
[8]. Ilayperuma I, Nanayakkara G, Palahepitiya N. A model for the estimation of personal stature from the length of forearm. Int J Morphol 2010;28:1081-6.
[9]. Williams PL, Bannister LH, Berry MM, Collins P, Dyson M. Dussek JE. Gray's Anatomy: The Anatomical basis of medicine and surgery. 38th Ed. New York: Churchchill Livingstone. 2000
[10]. Duyar I, Pelin C, Zagyapan R. A new method of stature estimation for forensic anthropological application. Anthropological Science 2006;114:23–7.
[11]. Krici Y, Ozan H. Determination of gender from the tibia of adult Turkish cadavers. Kaibogaku Zasshi 1999; 45:537-43.
[12]. Joshi NB, Patel MP, Dongre AV. Regression equation of height from ulna length. Indian J Med Res 1964;52:1088-91.
[13]. Krishan K, Vij K. Diurinal variation of stature in three adults and one child. Anthropologist 2007;9(2):113-7
[14]. Prasad A, Bhagwat VB, Porwal S, Joshi DS. Estimation of Human Stature from length of ulna in Marathwada Region of Maharashtra. Int J Biol Med Res 2012;3(4):2337-41.
[15]. Mohanty NK. Prediction of height from percutaneous tibial length amongst Oriya population. Forensic Science International 1998;98:137–41.
[16]. Mondal MK, Jana TK, Das J, Biswas S. Use of length of ulna for estimation of stature in living adult male in Burdwan District and adjacent areas of West Bengal. J Anat Soc India 2009;58(1):16-8.
[17]. Ebite L, Ozoko T, Eweka A,Otuaga P, Oni A, Om'Iniabohs F. Height: Ulna Ratio: A Method of Stature Estimation in a Rural Community in Edo State, Nigeria. The Internet Journal of Forensic Science 2008;3(1):6-9.
[18]. Yadav SK, Mandal BK, Karn A. Determination of stature from ulnar length in Nepalese population. Eur J Forensic Sci 2015;2(1):5-8
[19]. Ghanbari K, Nazari AR, Ghanbari A, Chehrei S. Stature estimation and formulation of based on ulna length in Kurdish racial subgroup. Italian Journal of Anatomy And Embryology 2016;121(1):43-50.
[20]. Giles E. Corrections for age in estimating older adults' stature from long bones. J Forensic Sci 1991;36:898-901.
[21]. Trivedi A, Saxena S, Morya R, Jehan M, Bhadkaria V. Stature Estimation Using Per-Cutaneous Tibial Length in People of Gwalior Region. IOSR- Journal of Dental and Medical Sciences JDMS 2014;13(5):65-70.
[22]. Jantz LM, Jantz RL. Secular change in long bone length and proportion in the United States, 1800- 1970. Am J Phys Anthropol 1999;110(1):57-67