

Estimation of the Height of an Individual to the Forearm Length

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Abstract: ***Aim:** Comparing the height of the individuals in correlation with the forearm length. **Objective:** To determine the height of the individuals from the forearm length. **Background:** The estimation of the height of individuals from the skeletal bears immense importance in the sciences in addition to the long bones, humerus, femur etc., the forearm length also been used for this purpose. This serves an important factor in forensic sciences. **Result:** In this study, the parameters were statistically analysed and tabulated. The study shows a positive correlation between the height of the individuals and forearm length. **Conclusion:** The regression equation derived in this study can be of great help to forensic sciences, anatomist and clinicians. The forearm being a parameter can be used for estimating the height of an individual.*

Keywords: forearm length, height, stature

1. Introduction

Anthropometry is a series of systemised measuring techniques that express quantitatively the dimensions of human body and skeleton. Anthropometry is often viewed as a traditional and perhaps the basic tool of biological anthropology, but it has a long tradition of use in forensic sciences and it is finding increased use in medical sciences especially in the discipline of forensic medicine¹. The height of an individual, when it cannot be estimated directly, as in bedridden, old or frail patients, or in patients who have limb and/ or vertebral column deformity; a indirect estimation can be achieved by correlating the height with other skeletal parameters².

Stature is one of the important criteria for establishing identification of unknown person/dead body. It is usually measured as standing height of the individual but evaluation of stature is difficult when dead bodies are mutilated, burnt or skeletonized³.

Sometimes, body fragments with soft tissue remain were found in the disasters and criminal cases. In this way, body fragments can be used for predicting the biological characteristics of individuals, especially height in forensic medicine. Mathematical methods and linear regression equations can predict the relation between height and body segments. In the previous studies, upper limb dimensions such as shoulder width, arm, forearm, hand, figures were considered for prediction of height⁴.

The aim of this study was to find the correlation between the forearm length and height of both males and females and to derive regression equations for estimation of the height. This enables helping hand to doctors, anthropologists, anatomist, and in forensic sciences to establish stature of an individual or in mutilated bodies especially when most of the body parts are damaged.

2. Materials and Methods

This research follows the methodology for estimating stature based on measurements of upper extremity as outlined by

Chikhalkar et al. This study was carried out in Saveethadental college and hospitals, TamilNadu, Chennai. 300 subjects wererandomly selected for this study , whose age was limited between 18-22. Prior to commencement of study, permission were taken from institution as well as from the subjects who were to participate. The data was collected and the measurements were repeated to avoid errors. The measurements were taken at a fixed time, between 3:00 PM to 5:00 PM, to eliminate diurnal variation.

The vertex to the heel height (in centimetre) was measured for each subject with them in the standing erect posture and also bare foot and they were asked to look forward straight to the horizon, so that the Frankfurt's plane remained horizontal. A ruler was placed on their heads tangentially, so that it could touch the highest point of his/her head. Then, with the help of a pencil, that level was marked on the wall. With the measuring tape, the height of that point was measured from the floor level².

Forearm length was measured in arm flex position by a standard measuring tape. Forearm length was measured from the tip of olecranon to the point between radius and ulnar tuberosity⁴.

3. Results

It is seen evident that as the height increases, the number of samples in case of females decreases. So the graph becomes like a negative slope with a linear line. Most of the samples is found at a height range of 150-154.5 cm. On the other hand, in case of males the graph shows a positive slope and a negative slope in which maximum number of samples lie in middle at a height range of 164.5-170.5.[Table:1/Fig:1]. As the height increases the length of the forearm also increases. This indicates that the height of the individual can be estimated from the length of forearm.[table:4]

Table1: The number of samples with their height range

Male	Female	Height Range
4	46	150-154.5
26	20	154.5-160.5
35	9	160.5-164.5
85	8	164.5-170.5
37	4	170.5-174.5
26	0	174.5-180.5

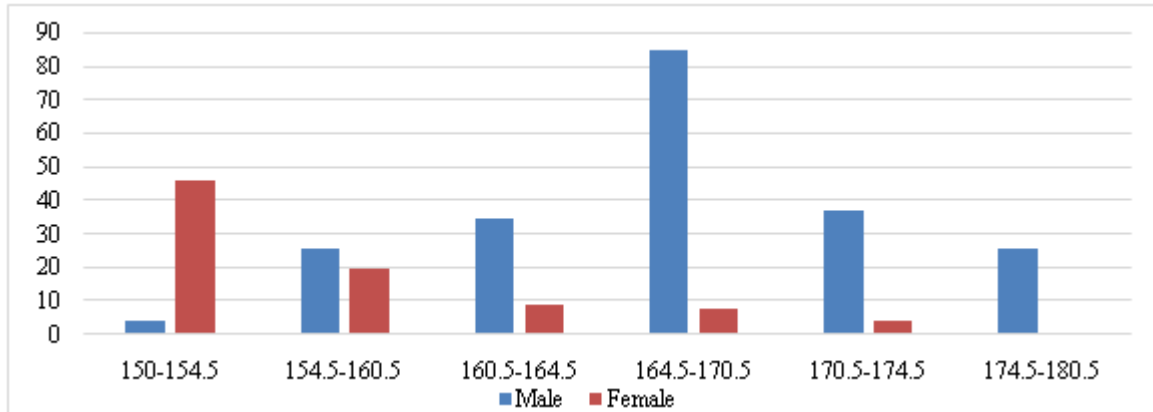


Figure 1: The number of samples with their height range.

Table 2: Height of the males in relation to their length of forearm. MAX-maximum, AVE-average, MIN-minimum

Height Range	Max	Ave	Min
150-154.5	23.3	23.3	23.3
154.5-160.5	24	22	23.2
160.5-164.5	26.2	23.71	21
164.5-170.5	26	24	22
170.5-174.5	26.45	24.5	22.1
174.5-180.5	27.7	25.15	24

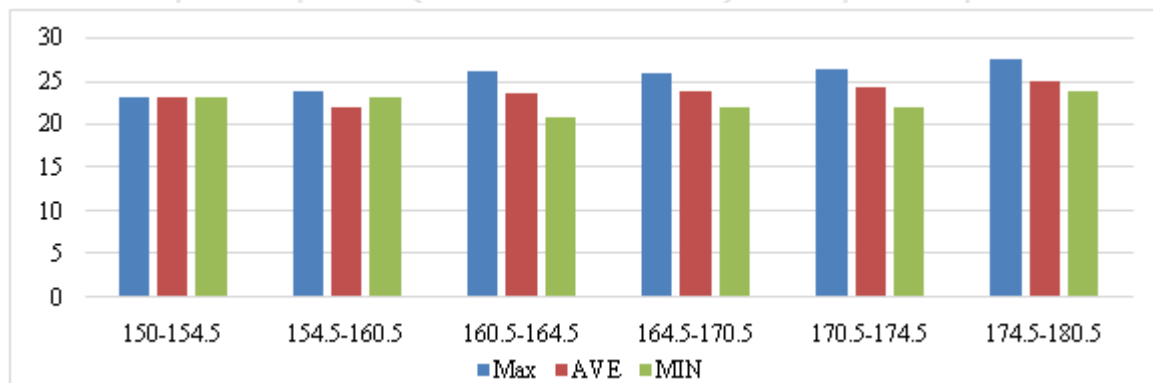


Figure 2: Height of the males in relation to their length of forearm.

Table 3: Height of the females in relation to their length of forearm. MAX-maximum, AVE-average, MIN-minimum

Height Range	Max	Ave	Min
150-154.5	23.9	21.5	18.75
154.5-160.5	22.5	21.79	19.9
160.5-164.5	26.5	23.77	20.6
164.5-170.5	24.9	24.01	22.4
170.5-174.5	24.1	24.1	24.1
174.5-180.5	X	X	X

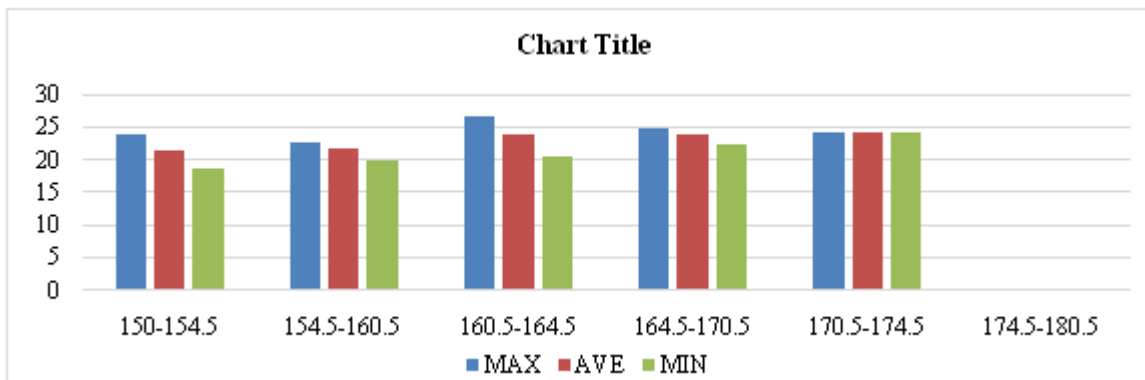


Figure 3: Height of the females in relation to their length of forearm. MAX-maximum, AVE-average, MIN-minimum.

Table 4: Variation of length of forearm between males and females

Height Range	Male	Female
150-154.5	23.4	21.45
154.5-160.5	23.8	21.92
160.5-164.5	23.97	23.88
164.5-170.5	24.2	24.11
170.5-174.5	24.66	24.44
174.5-180.5	25.14	0

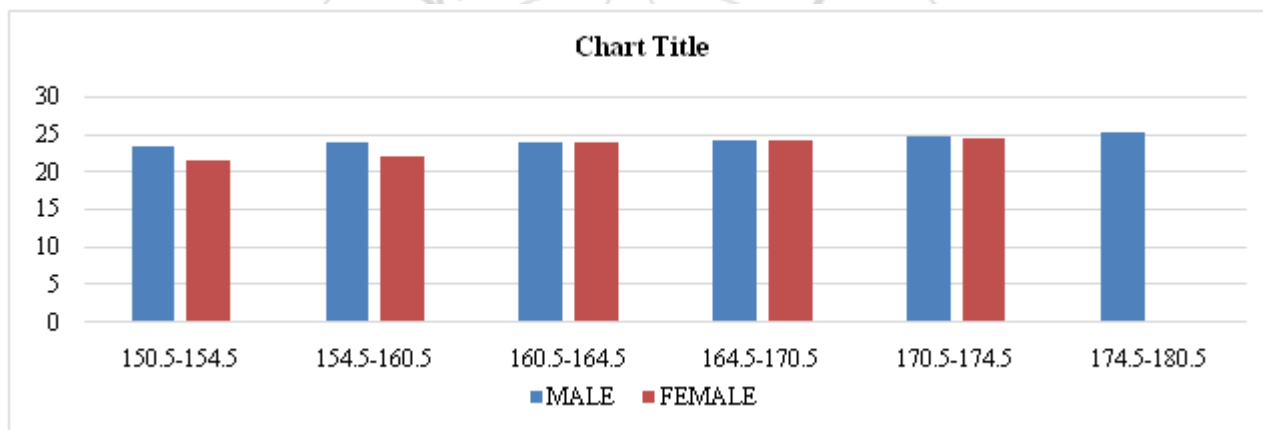


Figure 4: Variation of length of forearm between males and females.

The Regression equation is,
 Height of individual = intercept + slope(X),
 Where,
 X = forearm length of individual.
 Therefore, the regression equation of males was found to be [table:2],
 Height of individual = -253.02 + 17.5(x).
 And the regression equation of the females was found to be [table:3],
 Height of individual = 32.11 + 5.74(x).

4. Discussion

Estimation of stature is an important parameter in medico-legal examinations and anthropological studies. Morphology of forearm can be used to estimate the stature. Therefore the study was carried out to investigate the relationship between the stature and length of ulna¹.

The average height of adult males within a population is significantly higher than that of adult females⁵⁻⁷. The results obtained in this study correlate with the same result. Furthermore, racial variation in the relationship between

ulna length and height has been clearly demonstrated by comparative studies between Black, White and Asian subjects⁸. The results of the present study further highlight the racial diversity in mean forearm length. The ulna length was proven to be superior to arm span measurement and hand length in predicting height.

In other study, Akhlaghi et al. (2012) used 105 cadavers from Iranian population to determine the relation between radius bone length and height. They could find the formulae for each age and sex groups separately. Their results were more reliable for height prediction compared with the results of present study. In addition, their results showed that isolated bones were more valuable predictors for height estimation. Singh et al. (2013) formulate the relation between height and Forearm length and height in north Indian population. In other study, Ilayperuma et al. (2010) could find a relation between height and Forearm length in Sri Lankan population. Their model was Height = 97.252 + 2.645 (ulna length) for all cases⁴. The present study could highlight such a relationship between height and forearm length in both male and female.

5. Conclusion

From this study the regression equation and the slope obtained correlate with the previous studies. But there exists a difference between the slope and the intercept of the equation which may occur due to racial variation of the subjects. Hence, the study states that from the length of forearm the height of an individual can be estimated. Future studies can focus on estimating the height using other different body parameters.

References

- [1] BiswaBhusanMohanty, Divya Agrawal, Kunal Mishra, PusparajSamantsinghar, Prafulla Kumar Chinara. Estimation of height of an individual from forearm length on the population of eastern india. *Journal of Medical&Allied Sciences*. 2013; 3 (2): 72-75.
- [2] Malay Kumar Mondal, Tapan Kumar Jana, SusmitaGiri (Jana), and Hironmoy Roy. Height Prediction from Ulnar Length in Females: A Study in Burdwan District of West Bengal (Regression Analysis). 2012 Oct; 6(8): 1401-1404.
- [3] Kumar Amit, Srivastava A. K., Verma A.K. Estimation of Stature by Percutaneous Measurements of Distal Half of Upper Limb (Forearm & Hand). *J Indian Acad Forensic Med*, 32(4). ISSN 0971-0973.
- [4] Seyed Hassan Eftekhari Vaghefi, Fatemeh Sheikhbahaei, Tahmineh Mokhtari, Frouzan Khademi, Hassan Bahari, Rostam Ghorbani. A Model for Individual Height Estimation from Forearm Length in Natives of Kerman, Iran. *Anatomy journal*. August 2014, Volume 11, Number 3.
- [5] Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE. In: *Gray's Anatomy: The anatomical basis of medicine and surgery*, 38th ed., Churchill Livingstone, New York, 2000.
- [6] Ebite LE, Ozoko TC, Eweka AO, Otuaga PO, Oni AO, Om'Iniabohs FAE. 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).
- [7] Ilayperuma I, Nanayakkara BG, Palahepitiya KN. A model for reconstruction of personal stature based on the measurements of foot length. *Galle Med. J.* 2008; 13:6-9.
- [8] Madden AMT, Tsikoura T, Stott DJ. The estimation of body height from ulnar length in adults from different ethnic groups. *J. Hum. Nutr. Diet.* 2008; 21(4):394.
- [9] Lundy JK. The mathematical versus anatomical methods of stature estimation from the long bones. *Am J Forensic Med Pathol* 1985 ;(6) No.1: 73-76.
- [10] Lal CS, Lala JK. Estimation of height from the tibial and the ulnar lengths in north Bihar. *J Indian Med Assoc* 1972 Feb 16; 58 (4) :120-21.
- [11] Nath S, Krishan G. Determination of stature by using the percutaneous measurement of the upper and the lower limb bone among the Hindu females of Delhi. *J Anthropol Survey Ind* 1990;(39): 151-66.
- [12] Devi S, Das H, Purnabati BK, Singh SD, Devi J. Estimation of stature from the upper arm length among the Marings of Manipur. *Ind Med J Aug* 2006;100: (8): 271-73.
- [13] Mondal M, Jana TK, Das J, Biswas S. Use of the length of the ulna in the estimation of stature in living adult males in the Burdwan district and in the adjacent areas of West Bengal. *J Anat Soc Ind* 2009; 58(1): 16-19.
- [14] Agnihotri AK, Kachhwaha S, Jowaheer V, Singh AP. Estimating stature from the percutaneous length of the tibia and the ulna in an Indo- Mauritian population. *Forensic Sci Int.* 2009 May 30; 187(1-3):109. e1-3. Epub 2009 Mar 14. (available in <http://www.pubmed.gov>. accessed on 23 June 2012).
- [15] Singh B, Kaur M, Kaur J, Singh M, Batra A. Estimation of stature from forearm length in north Indians an anthropometric study. *International Journal of Basic and Applied Medical Sciences.* 2013; 3(1):201-4.
- [16] Jee SC, Yun MH. Estimation of stature from diversified hand anthropometric dimensions from Korean population. *Journal of Forensic and Legal Medicine.* 2015; 35(1):9-14.
- [17] Trotter M, Gleser GC. Estimation of stature from long bones of American Whites and Negroes. *American Journal of Physical Anthropology.* 1952; 10(4):463-514.