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Original Research Article

# Anthropometric study of Femur in Krishna District of AP

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**Abstract:** Anthropometric studies have been taking place in various countries since last decade. Each worker has derived his own formula for calculating the stature from length of long bones. Since the relationship between stature and long bone depends on sex, age and side of the body, it requires such studies to be undertaken in different population groups. Fully ossified Femora belonging to 70 dissection hall cadavers. Cadaveric stature was measured in centimeters and living stature was obtained by deducting 1.5 cms for male and 2 cm for females. The data obtained was analyzed for average living stature of adult male and female. The linear relationship between the living stature and length of femur of each was worked out with regression equations. The average femur length ranged in males was from 42.8 to 50.10 cms and for females it was 37.1 to 46.0 cms. The regression equation for male right femur was S= 95.08 + 1.52 F and left femur was 94.96 + 1.52 F for female right femur S= 101.29 + 1.19 F and for left femur S = 102.33 + 1.17 F. Regression formulae and multiplication factor can be used to predict stature from the length of femur. The multiplication factor is a better guide for calculating the height, when it is not known as to which part of the country individuals belongs. The results can be utilized by Anatomists and Forensic experts where a bone or a piece of bone is subjected to medicolegal examination.
**Keywords:** Anthropometry, Femur, Length, Stature

## INTRODUCTION

Stature estimation from human skeletal remains is an essential step in assessing health, sexual dimorphism and general body size among the population [1]. Physical anthropology also makes an important medicolegal contribution through careful identification of skeletal remains and law enforcement agencies can appreciate this help. Anatomists and forensic experts have been consulted frequently regarding identification of skeletal remains found under suspicious circumstances and are asked to pronounce an opinion which may form an important evidence in the court of law [2]. There is limitation in the ability of the anthropologists for identification of human skeletal remains. The attitude is somewhat at variance with the implications of Dr Krogman's statement in the guide, which he prepared for FBI in 1939. There he says "The study of skeletons is an exact science, permitting of identification in terms of individual's age, sex and race". This outline will have served its purpose if it has indicated that physical anthropology, with its precise method, can bring its technique to bear upon problems of identification. Determination of sex of skeletal remains of an individual form an examination of single bone, except hip bone is considered to be difficult task and has been subject of investigations [3]. Even if the entire human body, pelvis and skull are available not more than 95% accuracy can be achieved [4]. Traditional methods for assignment of sex or stature estimation do not have an explicit basis. Visual impression of the bone can seldom be as accurate because of many pitfall associated with subjective assessment of observer. Stature is usually estimated by employing either anatomical or mathematical methods.

Anatomical method, more commonly referred to as the "Fully method", reconstructs stature by summing the measurements of the skeletal elements cranial height, vertebral height, femoral length, tibial length, and the articulated height of calcaneus and talus that contribute to height and adding a correction factor for soft tissue [5]. The other known method is mathematical method which makes use of one or more bone lengths to estimate the stature. It has been demonstrated that the weight-bearing bones of the lower limbs have the highest correlation with stature and the use of upper limb bones for estimation of stature is done only when lower limb bones are not available [6]. Intact femur has highest correlation with stature and is being widely used in derivation of

regression equations for stature estimation [7]. Examinations of skeletal samples of the burials are often fragmentary and found in mixed lots. For this reason there is a need for developing a technique for stature estimation and sex determination on skeletal parts which are durable. With this background we tried to evaluate the stature of individual from length of femur in Krishna District of AP.

## MATERIALS AND METHODS

The materials consisted of fully ossified femora belonging to 70 dissection hall cadavers out of which 48 were male and 22 were of female the study was done in Dr. Pinnamaneni Siddhartha Medical College, Gannavaram, and Andhra Pradesh. The bones of each side was identified for both sexes, numbered and kept separately. The bones showing pathological deformities were excluded from the present study. The bones along with their articular cartilages intact were measured on the ostemoetric board and recorded.

The study of stature estimation was done in centimeters [cms] and the living stature was obtained by deducting 1.5 cms for male and 2 cms for female from the length of cadaver [7]. Each bone was positioned in such a way that the highest point of the head was in contact with the fixed arm of the board. The moveable arm was then brought in firm contact with the distal point of the femur that is articular surface at the lower end of femur. In order to compare the measurements, the femur was divided into 5 segments Segment I was form most proximal point on the upper end of femur to the lower border of lesser trochanter. Segment II was from lower border of lesser trochanter up to the apex of popliteal surface of femur. Segment III was from apex of popliteal surface of femur to the adductor tubercle. Segment IV was from adductor tubercle to the most distal point on the lower end of femur. Segment V was from the apex of the popliteal surface to the most distal point on the lower end of femur. The observed values were recorded and analyzed for Range, Mean, Standard deviation, Regression coefficient and Regression equations were derived for each segment.

## RESULTS

In males the length of the living stature varied from 155.4 cm to 171.2 cms the average length being 164.5 cms. The standard deviation is 3.83 in females the maximum length of living stature was 154.4 cms and minimum length 144.2 cms the average length being 150.1 cm with Standard deviation 2.91 cms given in table 1.

**Table 1: showing the average living stature in males and females.**

| Sex | Number (n) | Range in cms | Mean | SD | SEM |
|---|---|---|---|---|---|
| Male | 48 | Min 155.2<br>Max 171.2 | 164.5 | 3.83 | 0.552 |
| Female | 22 | Min 144.2<br>Max 154.2 | 150.1 | 2.91 | 0.620 |

The length of femur ranged from 42.8 to 50.1 cms the average length being 45.71. The length of left femur varied from 42.9 to 50.0 with average 45.71. The length of left femur varied from 42.9 cm to 50.0 cm average being 45.7. In females the length of femur varied from 38.3 to 43.4 cms with average of 40.9 cms. From the table 2 it can be concluded that the average length of male femur was larger than the female femur, although no significant difference was seen in the length of right and left femur between both sexes.

**Table 2: Showing the statistical values of length of femur**

| Sex | Femur | No. of bones | Range in cms | Mean | SD | SEM |
|---|---|---|---|---|---|---|
| Male (n = 48) | **Right** | 48 | 42.8 – 50.1 | 45.71 | 1.77 | 0.255 |
| | **Left** | 48 | 42.9 – 50.0 | 45.70 | 1.77 | 0.255 |
| Female (n=22) | **Right** | 22 | 38.3 – 43.4 | 40.90 | 1.66 | 0.360 |
| | **Left** | 22 | 38.2 – 43.3 | 40.83 | 1.7 | 0.360 |

The table 3 shows the regression equations calculated for male and female for calculating the living stature from the length of femur. The equations differ for male and females, though no significant difference was observed between the right and left sides of the same sex. Form these regression equations the length of stature can be calculated. In such calculation the probability of error was approximately 2 cms in male and less than 1 cm in female.

**Table 3: Showing the regression equation and the significance**

| Sex/bone | Regression Formulae | Chi-square DF | Significance |
|---|---|---|---|
| Male Right Femur | S = 95.08 + 1.52 F | $X^2$ = 5.08 df = 50 | P > 0.05 |
| Male Left Femur | S = 94.96 + 1.52 F | $X^2$ = 6.03 df = 50 | P > 0.05 |
| Female Right Femur | S = 101.29 + 1.19 F | $X^2$ = 4.5 df = 50 | P > 0.05 |
| Female Left Femur | S= 102.33 + 1.17 F | $X^2$ = 4.5 df = 50 | P > 0.05 |

## DISCUSSION

The measurement of length of long bones from the available fragments plays an important role in estimation of stature of individual. Height of the individual is an important medicolegal investigation. Pearson pioneered stature estimation in early 19th century with similar studies now being done on large populations [7]. In the present study the average length of stature in male was 164.5 cms and in females it was 150.1 cms. The present finding in male was similar with the finding of study in western Maharastra by Athwale *et al.;* [8] they found the average stature of male to be 163.11 cms and another study in Marathawa region by Kotle and Bansal *et al.;* [9] found the average height to be 165.78 cms in male. Other similar studies have found the height to range from 162.3 to 166.6 cms. [10, 11]. The average living stature in female was 150.1 cm in the present study which was in agreement with finding of Patil *et al.;* have found average height to be 149 cms in Vidharba region of Maharastra [12]. Kotle and Bansal found average height to be 149.72 cm in females in Marathwada region [9]. The regression formulae derived in this study to estimate stature from the length of femur. Similar studies done by the other authors are shown in the table 4 below.

| Authors | Sex | Regression Formulae | Race |
|---|---|---|---|
| Pearson [13] | M<br>F | S = 81.306 + 1.880 F<br>S = 72.844 + 1.94 F | British |
| Stevenson [14] | M | S = 61.721 + 2.44 F | Chinese |
| Dupertuis [15] | M<br>F | S = 69.089 +2.236 F<br>S = 61.412 + 2.317 | American Whites and Blacks |
| Kate and Muzumdar [16] | M<br>F<br>M<br>F | S = 51.68 + 2.60 F<br>S = 51.54 + 2.59 F<br>S = 52.02 + 2.58 F<br>S = 50.34 + 2.60 F | Indian (Nagpur)<br>Indian (Nagpur)<br>Indian (Amritsar)<br>Indian (Amritsar) |
| Patil and Gawhale [12] | M | | |
| Present Study | M<br><br><br>F | Right S= 95.08 + 1.52 F<br>Left S = 94.96 + 1.52 F<br>Right S = 101.29 + 1.19 F<br>Left S = 102.23 + 1.17 F | Indian [Krishna Andhra Pradesh] |

Gleser *et al.;* has shown that the weight bearing bone of lower limbs have the highest correlation with the stature and they must be preferred to the upper limbs whenever stature determination is required form bones [17]. The regression analysis is a more appropriate method to define relationship between length of long bones and living height of individuals and between length of measurements of long bone fragments and their maximum length. Studies by Mukhopadhyay P on 65 dry adult male femurs and Chandan M in 60 south Indian female femurs that the osteometric data obtained by measurements of long bone and their regression equations can be fairly accurately used to estimate stature in specific group of population [18, 19]. The multiplication factor in the present study was compared to different authors and found to be similar to findings of Siddiqui and Shah, Singh and Shoal [10, 20]. Pan *et al.;* noted that multiplication factor was same in both sexes. With the help of the multiplication factor in the present study the stature was calculated which showed the average error less than 3cms in both sexes [21]. Multiplication factor can also be used if the sample of the skeleton source remains unknown. In this study as well as other similar studies sex variations was considered but the age factor was not taken in consideration including the nutritional status of the person these could act as short comings especially when accuracy of data is considered, however the data obtained is fairly accurate with very negligible variations.

## CONCLUSION

Regression formulae and multiplication factor can be used to predict stature from the length of femur. The multiplication factor is a better guide for calculating the height when it is not known as to which part of the country individuals belongs. The results can be utilized by Anatomists and Forensic experts where a bone or a piece of bone is subjected to medicolegal examination.

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**REFERENCES**

1. Raxter MH, Ruff CB. The effect of vertebral numerical variation on anatomical stature estimates. Journal of forensic sciences. 2010 Mar 1; 55(2):464-6.
2. Crist TA. Bad to the bone? Historical archaeologists in the practice of forensic science. Historical Archaeology. 2001 Jan 1:39-56.
3. Krogman WM. Sexing skeletal remains. In The human skeleton in forensic medicine. 1st edition. Charles C Thomas Publisher Springfield. Illinois. U.S.A., 1962; 114-122.
4. Stewart TD. Medico-legal aspects of the skeleton. I. Age, sex, race and stature. American Journal of Physical Anthropology. 1948 Sep 1; 6(3):315-22.
5. Trotter M, Gleser GC. A re-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. American Journal of Physical Anthropology. 1958 Mar 1; 16(1):79-123.
6. Sandeep Singh, Shema K Nair, Vaibhav Anjankar, Vishal Bankwar, D.K. Satpathy, Yogender Malik. J Indian Acad Forensic Med 2013; 35(3):223-26.
7. Pearson K. Mathematical contributions to the theory of evolution. V. On the reconstruction of the stature of prehistoric races. Philosophical Transactions of the Royal Society of London. Series A, Containing Papers of a Mathematical or Physical Character. 1899 Jan 1; 192:169-244.
8. Athwale MC. Estimation of height from length of forearm bones-A study on 100 Maharashtrian male adults of age 25-30. American journal of physical anthropology. 1963; 21:105-12.
9. Kolte PM, Bansal PC. Determination of regression formulae for reconstruction of stature from the long bones of Upper limb in Maharashtrian of Marathwada region. J of Anatomical Soc. of India. 1974; 23:6-11.
10. Singh B, Sohal HS. Estimation of stature from clavicle in Punjabis; a preliminary report. The Indian journal of medical research. 1952 Jan; 40(1):67-71.
11. Bose A. Anthropometry of the Kayasthas of Bengal with special reference to Vangaj Kayastha. Journal of Anatomical society of India. 1963; 12:20-5.
12. Patil TL, Gawhale RS, Muzumdar RD. Reconstruction of stature from long bones of both upper limbs. J Anat Soc India 1983; 32:111-118.
13. Pearson FG. The characters of the English Thigh bone. Part I. J Anat and Physiol 1914; 48(3): 238-67.
14. Stevenson PH. On racial differences in stature long bone regression formulae, with special reference to stature reconstruction formulae for the Chinese. Biometrika. 1929 Dec 1:303-21.
15. Dupertuis C, Hadden JA. On the reconstruction of stature from long bones. American Journal of Physical Anthropology. 1951 Mar 1; 9(1):15-54.
16. Kate BR, Mujumdar RD. Stature estimation from femur and humerus by regression and autometry. Cells Tissues Organs. 1976 Jul 1; 94(2):311-20.
17. Trotter M, Gleser GC. A re-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. American Journal of Physical Anthropology. 1958 Mar 1; 16(1):79-123.
18. Mukhopadhyay PP, Ghosh TK, Dan U, Biswas S. Correlation between maximum femoral length and epicondylar breadth and its application in stature estimation: A population specific study in Indian Bengali Males.
19. Chandran M, Kumar V. Reconstruction of femur length from its fragments in South Indian males. Journal of forensic and legal medicine. 2012 Apr 30; 19(3):132-6.
20. Siddiqui MA, Shah MA. Estimation of stature from long bones of Punjabis. Indian J Med Res. 1944; 31:105-8.
21. Pan N. Length of lone bones and their proportions by body height in Hindus. J Anat Lond 1924; 58:374-78.