Research Paper

Estimation of Height Using Length of Humerus in Adult North Indian Population-An Anthropometric Study

Medical Science

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ABSTRACT

Estimation of stature from bone has always played an important role in identifying unknown bodies, part of bodies or skeletal remains. Height of individual is also vital to medico legal investigations. Thus in forensic anthropology, projection of the stature from bones play an important role in the identification of missing persons. Estimation of living stature can be done from the humeral length in the absence of more appropriate long bones as femur or tibia. The assessment of height is obtained from Regression formula derived from femoral and tibial length but sometime humerus may be the only bone found in burial. After studying literature it was found that though lot of work has been done on humerus, but very scanty work was been reported on anthropometric measurement of humerus, hence the aim was to focus on measurement of humerus in living subject and estimation of individual's height by correlating length of humerus with the height of individual, in living subjects using "REGRESSION FORMULA FOR HUMERUS". The present study could be a boon when instead of dry skeletal remain an entire soft tissue fragment with the muscles intact on the bone is found. It would be a great time saving method for anthropologist, forensic etc to determine the height of the individual from the existing specimen without processing it further in order to extract the dry bone from it.

INTRODUCTION

Estimation of stature from bones plays an important role in identifying unknown bodies. Reconstruction of life from human skeletal remains has been a challenge among anthropologist, anatomist and forensic scientist. Living stature prediction from length of the limb bone is one of the oldest problem in the history of anthropology (HOPPA & GRUSPIER, 1996)[1].

Height of individual is also vital to medico legal investigations. Thus in forensic anthropology, projection of the stature from bones plays an important role in the identification of missing persons. (ROSS & KONIGSBERG, 2002)[2].

Estimation of height from the length of humerus is possible; if any part of body is found from shoulder to forearm-a guide line for forensic scientist and anthropologist. (STEELE & MCKERN, 1969).[3]

The Humerus being the longest and largest bone in the upper limb is a vertically located bone in the arm. The rounded head occupies the proximal and medial part of the upper end of the bone and forms an enarthrodial articulation with the glenoid cavity of scapula. Proximal end of humerus consist of Head, Anatomical neck, Greater tubercle, lesser tubercle. Head of humerus forms less than half of spheroid its smooth articular surface is covered by hyaline cartilage which is thicker centrally. Anatomical neck of humerus immediately adjoins the margins of the head and forms a slight constriction. Lesser tubercle is anterior to and just beyond the anatomical neck. The shaft of humerus is almost cylindrical in proximal half but is triangular in cross section in distal half. The distal end of humerus is a modified condyle. It is wider transversally and has articular and non articular part. The articular part is curve forward, articulates with radius and ulna at elbow joint and is divided by a faint groove into a lateral capitulum, and trochlea.

Capitulum is a rounded convex projection which covers the anterior and inferior surface of lateral part of condyle of the humerus but does not extend on posterior surface. Trochlea is a pulley shape surface that covers anterior, inferior, and posterior surface of condyle of humerus, it articulates with the trochlear notch of ulna. Medial border of humerus ends by turning slightly backward as medial epicondyle which forms a conspicuous blunt projection on the medial side of condyle, it is subcutaneous and usually visible. Lateral border of humerus terminate at the lateral epicondyle .The olecranon fossa is a deep hollow on the posterior surface of condyle which lodges the tip of olecranon of ulna in extended elbow. A similar but smaller hollow lie immediately above the trochlea on the anterior surface of condyle and is called coronoid fossa. A very slight depression lies above the capitulum on the lateral side of coronoid fossa called as radial fossa.

Humerus has always been quite a studied bone as far as anthropometric studies are concern. It has played an important role in sex determination, reconstruction, of individuals stature, forensic studies etc.

While some attention has been given to the estimation of living stature from long bone length in ancient population, few studies have been accomplished with modern human groups. For this reason there are few available data regarding estimating of living height in actual human group. (MALL, HUBIG, BUTTNER et al, 2001)[4]

After studying literature it was found that though lot of work has been done on humerus but very scanty work was been reported on anthropometric measurement of humerus ,hence the aim of this project was to focus on measurement of humerus in living subject and estimation of individual's height by just determining the length of humerus.

Material and Methods

The entire study was carried out on 100 living subjects using REGRESSION FORMULA of both the sexes aged between 17-22 years in the Department of anatomy of Saraswati medical college Hapur & Mayo Medical College, Gadia, Barabanki. It was been kept in mind that the subjects had no visible upper limb deformity & bone metabolic disorder (by history).Subjects were divided into male (52) & female category (48).

Instruments used-
1. Anthropometric rod.
2. Measuring tape.
3. Skin marker.

Surface marking of elbow joint line
Medial and lateral epicondyle were felt by palpation .Two points were marked; first point was marked 2 cm vertically below medial epicondyle and another point was marked 1 cm vertically

below to lateral epicondyle. Than both the points were joint using a horizontal line; midpoint of this line was taken as reference point.

The length of humerus was measured in living subject in between two points:-

Proximal Point- Acromian landmarks.

- **Distal Point-** Midpoint of elbow joint line was measured and recorded.
- Height of each individual was measured using anthropometric rod.
- Length of the Humerus obtained was put in regression equation for Humerus.
- **MALES** (height in cm) Height = (length of humerus x 2.9) + 70.6
- **FEMALES** (height in cm) Height = (length of humerus x 2.8) + 71.4

To ensure reliability of measurement each measure was taken 3 times and then the average was calculated. Data assessment was carried out by statistical package for social sciences (SPSS 15.0).

Fig1-Showing measurement of height using Anthropometric rod.
Fig 2-Showing measurement of Humeral length in living subjects.

RESULTS
- According to the method mentioned above and taking those reference points, the height of humerus and individual's height were recorded and tabulated separately for males and females.
- The total of 100 living individual was included in this study 58 Males and 42 Females. All the readings were recorded in centimeter(cm)and were analyzed statistically using SPSS v15.0 and following results were obtained:-

Table1:-Table Showing Data of Males

N	Mean height in cm	Mean humeral length in cm	Co-efficient of significance	P value
52	167.73±6.72	34.78±1.93	0.8451	<0.0001

- Mean height of the males was found 167.73±6.72 cm and the Mean humeral length was found 34.78±1.93 cm.
- Co-relation between these two values were 0.8451 (p=<0.0001.)

**Graph 1: Showing Comparison of mean height in male and female.**
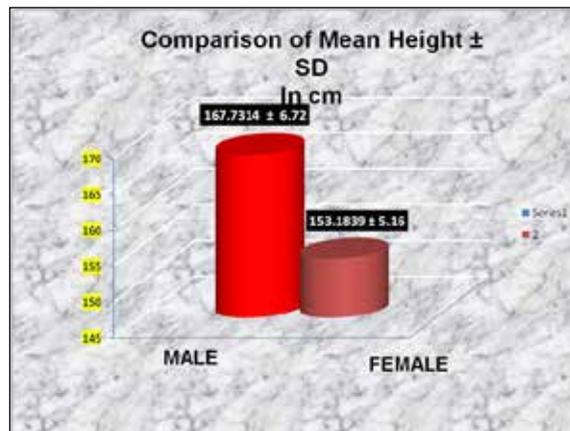
Table 2: Table Showing Data of Females

N	Mean height in cm	Mean humeral length in cm	Co-efficient of significance	P value
48	153.18±5.16	28.01±1.29	0.6651	<0.0005

- Mean height of females was found 153.18±5.16 and the mean humeral length was found 28.0161±1.29.
- Co-relation between two values were 0.66 (p=<0.05).

Graph 2: Showing Comparison of mean humeral length in male and female.
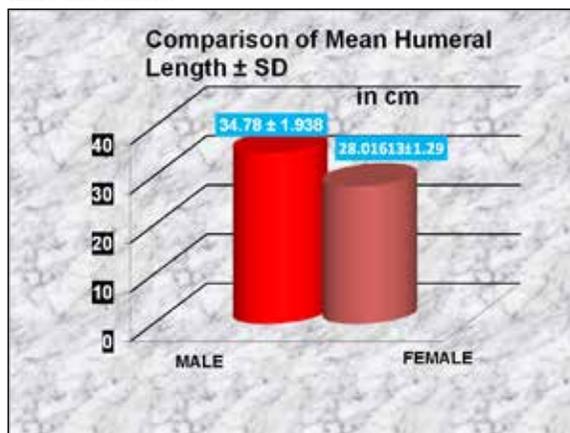
- The results obtained were verified by the actual height of the individual which were measured earlier.
- Every measurement was repeated for 3 times in order to ward off any errors.

DISCUSSION
During identification of remains, general demographic, characteristics are determined first. These characteristics include the age, sex and race of the individual. To narrow the number of possibilities further, and thus increase the possibility of identification, factors of individualization are determined, which include stature.

- According to William PL, Warwick R, Dyson M, Banister (1989)[5] humerus being the longest and largest bone of upper limb, it is very important to identify the humeral length from the remains.
- Willey P,Fasletti T(1991)[6] said that stature may vary from person to person throughout the day and according to different population.
- In this study, the standard error of estimates ranged from 1.29 to 1.93 cm for the long bones, while other studies of long bones show standard errors of estimates that are com-

parable or slightly higher; for example, the study by (Trotter and Gleser, 1951)[7]display values of 2.99 to 4.45 cm, 2.25 to 3.09 cm by (Dupertuis and Hadden, 2009)[8], and 2.77 to 3.83 cm by (Lundy and Feldesman, 1987)[9]. The results from other studies using the other bones of the body include standard errors of estimates of 5.89 to 7.28 cm for the skull, 5.30 to 5.49 cm for the vertebral column, 5.10 to 8.14 cm for metacarpals, 4.65 to 7.60 cm for metatarsals, and 4.13 to 6.07 cm for the talus and calcaneus.

This indicates that the long limb bones produce the lowest error of estimates (from single elements) and therefore should be used as the first preference to estimate stature whenever possible. The standard error of estimates reported here (for our study) is low because it applies to total height of an individual.

The anatomical method estimates total height, and was initially introduced by Dwight[10] in 1894 .To calculate the living stature of an individual using the anatomical method, correction factors that compensate for soft tissue also need to be added. The main disadvantage of the anatomical method is that a nearly complete skeleton is needed for stature estimation.

When comparing similar studies in literature no exact work was found. The related works on humerus of living individuals for determining stature of an individual in different studies by various scientists showed quiet a variable data and the standard deviation recorded were also quiet large as compared to our study.

CONCLUSION

The present study could be a boon when instead of dry skeletal remain an entire soft tissue fragment with the muscles intact on the bone is found. It would be a great time saving method for anthropologist, Forensic etc to determine the height of the individual from the existing specimen without processing it further in order to extract the dry bone from it. With the above derived regression equation it was found that the Equation worked almost perfect for males however for females the equation was bit variable which may be due to ethnicity, age, sex, race, culture etc., along with environmental influence affecting bone growth such as nutrition, physical development and genetic factors. Moreover these diversities also relay on the differences in the reference points taken for the study. So these various factors should be kept in mind and further studies should be encouraged to determine the stature of an individual based on morphometry and to refer this to a population as a whole.

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