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Original Research Article

An Observation Study to Estimate the Stature from Length of Arm in Persons (both male and female living adults) Belonging to 20-50 years Age group: Metrical Assessment

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Abstract

Aim: To estimate the stature from length of arm in persons (both male and female living adults) belonging to 20-50 years age group

Methodology: The present research activity was performed in the Department of Anatomy, Santosh Medical College, Ghaziabad, Uttar Pradesh, India. The subjects enrolled in study were asymptomatic 200 healthy students (adult males and females) between 20 to 50 years of age. The length of arm was measured in 90 degrees bended elbow in persons with standing position. The length of arm was defined as the distance between acromion end of clavicle and olecranon process. During the stature evaluation, subjects were in standing barefoot position and were on the platform of the stadiometer with the upper back buttock and heels pressed against the upright position of the instrument. The correlation between height and arm length was evaluated, and the simple linear regression model was used for describing the formula of the population. Then standard error of estimate (SEE) and coefficient of determination (R2) were calculated for the relation.

Results: The mean age of cases was 22±1.90 years. Mean age of male cases was 21±1.8 years and female cases was 20±2.42 years and there wasn't significant difference in the age of sex groups (P=0.196). Mean height of all subjects was 173.38±3.64 m. Mean height of males and females was 178.46±3.02 cm and 159.98±6.45 cm, respectively. Significant differences were observed in the height between the two sexes (P=0.0001). There was a significant difference in the UAL of sex groups (P=0.0001). There was a correlation between stature and UAL of cases (P=0.0001). There was a correlation between height and FAL of male cases (P=0.0001). However, this correlation wasn't significant for female cases (P=0.098). According to the linear regression, there was a relation between height and UAL of all cases (SEE=7.32, R2 =0.502) and male cases (SEE=4.48, R2 =0.410).

Conclusion: From this study, it can be concluded that there was relationship between the UAL and height; and UAL can be a moderate predictor for stature estimation. This fact can be of practical use in medico legal investigations and anthropological and archeological studies where the stature of a person can be found out if the lengths of upper arm and or forearm long bones is known.

Keywords: Extremity, Acromion, Regression, Height.

Introduction

Assessing height of an individual from measurement of different parts of the body has always been one of the most interests of anthropologists. Stature has been one the most important factor in the description of the individual characteristics for a long time [1-3]. The estimation of height from various parameters has been performed in various studies [4-6]. Anthropometric data from different races, age and sex groups can be useful in designing a product and in addition it can reduce human errors [7, 8]. The results of these studies are helpful in different branches such as forensic medicine, surgery, ergonomics and biomedical engineering [9].

Pearson K., *et al* (1898-99) [10] was first to introduce the co-relational calculus for height estimation from the measurements of different long bones. Telekka *et al* [11] were of the view that each racial group needed a different formula for the approximation of stature. In the past many researchers worked on cadavers and or on skeletal remains. But the cadavers represent just a small subset of any given population, since they usually belong to persons of older age, and or to those who have suffered from chronic, morbid incapacitating diseases. Furthermore, according to Trotting M. *et al* [12] there is an increase in the height of 2.5 cm after death, when the measurement is taken in the recumbent position.

Stature is normally estimated by making use of the mathematical or the anatomical methods. While employing the anatomical method for calculating the living stature of an individual, it is necessary to add correction factors that can compensate for soft tissue [13, 14]. However, the main disadvantage of anatomical method is its requirement of a nearly complete skeleton for stature estimation. The mathematical method, in comparison, makes use of one or more bone lengths to estimate the stature of a person. This method incorporates use of stature tables, bone lengths and regression formulae to estimate stature of a living person from long bone lengths [13, 14].

Furthermore, identification of dismembered human remains that are frequently found in cases of mass disasters and criminal is a challenging task for the medico legal experts [15]. Also, the living stature can be predicted by anatomical and mathematical techniques [16]. Bones as the body segments were mostly used for stature estimation in different studies [17-19], however percutaneous length of bones was evaluated in several studies [20, 21]. Some researches could evaluate the relation between stature and upper arm length (UAL) or percutaneous humerus length and define formulas for this relationship in different age groups. According to the results of these studies, the reliability and prediction power of the derived formulae were different [22, 23]. Arm morphology is an important element to determining upper limb movement behavior [24]. The design of devices for orthopedic goals depends on the anatomical and physical characteristics of the bones. Also, measurements of arm dimensions in the different populations can be assigned in design of industry products such as orthopedic prostheses [25]. These researches can be helpful for prediction of stature in individuals with disproportionate growth abnormalities and skeletal dysplasia or height loss during surgical procedures on the spine [26]. The purpose of this study was to estimate the stature from length of arm in persons (both male and female living adults) belonging to 20-50 years age group.

Materials and Methods

The present research activity was performed in the , Department of Anatomy, Santosh Medical College, Ghaziabad, Uttar Pradesh,

India. The subjects enrolled in study were asymptomatic 200 healthy students (adult males and females) between 20 to 50 years of age.

The length of arm was measured in 90 degrees bended elbow in persons with standing position. The length of arm was defined as the distance between acromion end of clavicle and olecranon process. During the stature evaluation, subjects were in standing barefoot position and were on the platform of the stadiometer with the upper back buttock and heels pressed against the upright position of the instrument. In addition, the subject's head was positioned in the Frankfort horizontal plane, the shoulders were relaxed, the back was straight, upper surface of the thighs was horizontal, the feet supported and the back of the knee joint was clear of the stool and then the head vertex was contacted to firm and the number was recorded. The correlation between height and arm length was evaluated, and the simple linear regression model was used for describing the formula of the population. Then standard error of estimate (SEE) and coefficient of determination (R2) were calculated for the relation.

Data analysis: Data were collected for each sex and analyzed by SPSS version 22.0. Mean Standard Deviation (SD) was used for descriptive analysis. T-test was used for evaluation of differences between groups.

Results

The mean age of cases was 22±1.90 years. Mean age of male cases was 21±1.8 years and female cases was 20±2.42 years and there wasn't significant difference in the age of sex groups (P=0.196). Mean height of all subjects was 173.38±3.64 m. Mean height of males and females was 178.46±3.02 cm and 159.98±6.45 cm, respectively. Significant differences were observed in the height between the two sexes (P=0.0001).

According to Table 1, there was a significant difference in the UAL of sex groups (P=0.0001). There was a correlation between stature and UAL of cases (P=0.0001). There was a correlation between height and FAL of male cases (P=0.0001). However, this correlation wasn't significant for female cases (P=0.098). According to the linear regression, there was a relation between height and UAL of all cases (SEE=7.32, R2 =0.502) and male cases (SEE=4.48, R2 =0.410).

Table 1: Comparison of height and upper arm length in males and females

	Sex					
	Male			Female		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
Height	179.63	195.42	162.48	161.94	170.84	152.48
Upper Arm Length	32.54	38.22	27.96	29.80	34.26	23.88

Table 2: Linear regression for estimation of stature from upper arm length of medical students.

Regression equation	±SEE	R^2	P-Value
S=91.641+2.509×UAL (cm)	7.32	0.502	0.0001
SM=127.197+1.581×UAL (cm)	4.48	0.410	0.0001
SF=not defined	4.32	0.042	0.098

Discussion

Identification is the most important issue in forensic. The long bones and their relation with stature can be useful in forensic identifications. In living populations percutaneous length of bones can be used for prediction of stature in different populations and different age groups [27-29]. Dr. BalkrishnaThummar *et al* [30] formulated regression equation by working on 310 subjects (males and females) between 20-40 years of age belonging to the state of Gujarat for estimation of height from the length of ulna. Trotter M. and Glesser G.C. [12] in their research work performed on Whites and Negroes of America, estimated height from long bone lengths. They tried to find out association between long bone lengths and height. They were of the view of having different regression equations for different races. Furthermore, for height estimation using different parameters, subjects of a particular age

The results of other studies were similar to the present study in the evaluation of length of arm. In Croatia, cadavers of 21 males and 19 females have been studied extensively by Petrovečki *et al*. (2007). They have determined the relationship between the length of the long bones and the height with the help of radiographic images. The results showed that there was a significant difference in the stature and maximum length of long bones between female and male cadavers. The correlation between the stature and long bone length was best for the humerus in females and the tibia in male [31]. In another study in China, Zheng *et al*. (2011) evaluated the relation of upper limb bones including tibia and fibula with stature. The measurements were taken from computed radiography and mathematical models were used to establish the formulae in teenagers population (from 14 to 18 years old) [32].

De Mendonça *et al*. (2000), conducted on 200 individuals (100 male and 100 female) from the northern districts of Portugal. In this study, height and bones length were measured directly. Estimation of stature is obtained by applying a mathematical method based on a multivariable linear regression between the height of lengths of humerus and femur. Due to high values of standard deviation, their results weren't applied [33]. In this study, there was correlation between height and UAL and this factor was a predictor for height estimation (SEE=7.16, R2 =0.513) in Iranian population. In addition, correlation between stature and UAL in males was significant. However, it was a poor predictor for stature estimation (SEE=4.52, R2 =0.398, Table 2). Nath and Krishan (1990) could formulate multiplication factors for predicting the stature from UAL in 276 Hindu (Baniya) females of Delhi (ages 15-22 years). The SEE was 4.95 whereas in comparison to our study the SEE was 7.16 for Iranian population [34].

Anitha M. R. *et al* [35] studied 300 adult males, and measured heights of study subjects and bilateral ulnar lengths to find out the correlation coefficient (r) between them. They also derived the simple regression formula to show correlation between ulnar length and height of an individual. In an another study, Maloy Kumar Mondal *et al* [36] studied 300 Bengali female subjects and estimated their stature from the lengths of their ulna and formulated a linear regression equation. The Correlation coefficient (r) was found to be 0.82 (P=0.002) for left ulna with stature and it was 0.67 (P=0.001) for right ulna with stature. Athawale M.C. [37] studied one hundred Maharashtrian males of age ranging from 25 to 30 years. With the help of various graphs, he highlighted that there exists a correlation between the height of a person, lengths of radius and ulna, and upper limb length. They put forth the following

regression formula for height estimation from the lengths of long bones [Stature (in cms) = 59.2923 + 4.1442 x avg. length of rt&lt radius (in cms) +/- 3.66. Stature (in cms) = 56.9709 + 3.9613 x avg. length of rt&lt ulna (in cms) +/- 3.64].

Conclusion

From this study, it can be concluded that there was relationship between the UAL and height; and UAL can be a moderate predictor for stature estimation. This fact can be of practical use in medico legal investigations and anthropological and archeological studies where the stature of a person can be found out if the lengths of upper arm and or forearm long bones is known.

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