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Height estimation of an individual from forearm length in medical students

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ABSTRACT

Background: Height is an important parameter of human in anthropology and forensic medicine. We can measure the height of an individual from forearm length (FAL). In this study, we found the relationship between FAL and height in medical students. **Aims and Objective:** The objective of the study was to find co-relation between FAL and height of the individuals (male and female medical students) and to obtain regression formula to determine the height from FAL. **Materials and Methods:** Height and FALs were measured in 200 medical students of 17–22 years age (100 males and 100 females) of N.R.S Medical College, Kolkata. For finding, the relationship between height and FAL linear regression analysis was used. **Results:** In our study, average height of the female students was 158.64 ± 5.28 cm, whereas in male students average height was 168.97 ± 6.33 cm. Mean FAL has been 26.63 ± 1.72 and 23.72 ± 1.44 cm, respectively, in case of male and female students. Difference of the mean height and mean length of forearm values between female and male students was statistically significant. The correlation coefficient (r) between height and FAL of dominant side has been, respectively, +0.93, +0.96, and +0.97 in case of male, female, and total students. According to the linear regression, there was a relation between height and FAL. **Conclusion**: From our study, it is evident that we may estimate the height of a person from measurement of FAL. In future studies may be carried out to estimate height of an individual from other body parameters also.

Key words: Anthropometry; Forearm length; Height; Medical students

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INTRODUCTION

Anthropometry is a series of systemized measuring techniques that express quantitatively the dimensions of human body and skeleton.[1] Estimation of height is important to establish identification of a person. Height is usually measured as standing height of the individual. However, when height cannot be estimated directly, as in bedridden, old patients, persons with vertebral column or limb deformity, an indirect estimation can be done by correlating the height with other skeletal parameters.[2] Relationship that exists between height and different parts of the body of an individual is of great interest for anthropologist, forensic medicine, and medical scientist. In different catastrophic events such as earth quake, flood, plane crashes body fragments, and soft tissue remains can be used for predicting the biological characteristics of the individuals, especially heights in forensic medicine.[3-6] In the present study, length of the forearms was measured in different subjects anthropometrically and height were estimated from forearm length (FAL).

Aims and objectives

The objective of the study was to find co-relation between FAL and height of the individuals (male and female medical students) and to obtain regression formula to determine the height from FAL.This study will guide us to estimate height indirectly from femur length which is important for bedridden patient, person with skeletal deformity and in different catastrophic events.

MATERIALS AND METHODS

The materials used in the present study are as follows: 2 m Stature meter for (Figure 1) measurement of heights, measuring tape, skin marking pencil, pen, pencil, eraser, consent form, case record Form, Digital camera,

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participants (total 200 [100 females and 100 males] medical students of N.R.S. Medical College, Kolkata, between 17 and 22 years of age irrespective of caste, religion, socio-economic status, dietary habits, etc.). All participants were healthy and had no symptoms or signs of relevant pathologies affecting the shoulder, elbow, and wrist joints.

This study received approval from the local Institutional Ethical Committee and written informed consent was obtained from all participants. Total study period was 1 year. Samples were obtained by simple random method. Heights of the students were measured from vertex to heel standing on floor using 2 m Stature meter (in cm) in standard anatomical position with head oriented in eye to eye (Frank-Furt) horizontal plane. FAL (in cm) of the right and left side were measured in 200 students (100 males and 100 females) from the tip of olecranon process of ulna to the midpoint between radial and ulnar tuberosities where arm was flexed and forearm pronated. FAL was measured using measuring tape (Figure 2). Skin marking pencil has been used for marking points of reference. All the measurements were taken between 12.30 pm and 2.30 pm to avoid diurnal variation. All the measurements were taken by a single person to avoid interpersonal error.

RESULTS

After obtaining the values of the variables (height and FAL) their mean, standard deviation and range have been calculated. From these data, the correlation coefficient (r) of the variables obtained shows the behavior of change in one variable when other variable changes. Then, "t" value of student t-test, degree of freedom (df), and "P" value have been estimated. From these values, we could understand whether the tests are statistically significant or not. ($P<0.05$ is statistically significant).

In Table 1 we found that, among male students height mainly vary between 160 and 170 cm, average168.97±6.33 cm and in major percentage of female, height ranges between 150 and 160 cm, average 158.64±5.28 cm. If all the students 44 are taken into account average height is 163.81±7.79 cm. The mean height values are higher in male students and difference of the mean height values between female and male students is statistically significant.

In table 2 we found that mean length of the forearm has been 26.63±1.72 and 23.72±1.44 cm, respectively, in case of male and female students taking under consideration all of them. Length of the forearm in male has been 26.56±1.71 cm on dominant side whereas in female it is 23.73±1.42 cm (as shown in Table 3). If all the students are considered together, this value is 25.14±2.11 cm. The mean length of forearm values has been higher in male students. Difference of the mean length of forearm between female and male students has been statistically significant.

From the present study, in table 4 it has been observed that the height and FAL both are more in male than in female student. The correlation coefficient (r) between height and FAL of dominant side has been, respectively, +0.93, +0.96, and +0.97 in case of male, female, and total students.

Appropriate statistical significance tests have been done to find out the relation between the dependent variable (here, height of the individual) with the independent variables FAL. Hence, it can be said that the FAL of a person increases as the value of height of the person increases

Table 1 : Relationship between height of male students (Ht- male) and height of female (Ht-female) students

Name of parameter	Mean (cm)	SD	Significant test
Ht-male	168.97	6.328	t=12.53
Ht-female	158.64	5.283	df=198
			P=0.000

Ht: Height

Table 2: Relationship between FAL of male students (FAL-male) and FAL of female students (FAL-female) in dominant side (right side)

Name of parameter	Mean	SD	Significant test
FAL-male	26.555	1.705	t=18.03
FAL-female	23.725	1.422	df=398
			P=0.000

FAL: Forearm length

Table 3: Relationship between height (Ht.) and FAL in dominant side (right side)

Name of parameter	Mean	SD	Significant test
Ht (cm)	163.805	7.785	t=243.10
FAL (cm)	25.14	2.113	df=398
			P=0.000

FAL: Forearm length, Ht: Height

Table 4: Calculated values of range, mean, and standard deviation of the variables (height and forearm length) in the dominant side (D=right side) of the present study

Variables	Male			Female		
	Range	Mean	SD	Range	Mean	SD
Height (cm)	154–183	168.97	6.33	143–171.5	158.64	5.28
FALD (cm)	23–30	26.56	1.71	21–27.5	23.73	1.42

FAL: Forearm length

and this is statistically significant. According to the linear regression, there was a relationship between height and femur length.

The regression equation is,

Height of the individual Y = intercept + slope(X)

Where X = FAL of the individual

For our data, for male students (shown in Figure 3) students the regression equation for Y is:

Y = 2.35648X + 105.09578

Sum of X = 2646.5

Sum of Y = 16746

Mean X = 26.465

Mean Y = 167.46

Sum of squares (SS_x) = 287.1275

Sum of products (SP) = 676.61 Regression Equation = $\hat{y} = bX + ab = SP/SS_X$ = 676.61/287.13 = 2.35648

$a = M_Y - b$

M_X = 167.46–(2.36*26.47) = 105.09578

$\hat{y}$ = 2.35648X + 105.09578

From our data, for female students, the regression equation for Y is is (shown in Figure 4):

Figure 1: 2 m stature meter for measurement of heights

Figure 2: Measurement of forearm length by measuring tape

Y = 2.33201X + 104.40362

Sum of X = 2372.5

Sum of Y = 15973.05

Mean X = 23.725

Mean Y = 159.7305

Sum of squares (SS_x) = 200.1875

Sum of products (*SP*) = 466.8388

Regression Equation = $\hat{y} = bX + a$

$b = SP/SS_X$ 466.84/200.19= 2.33201

$a = M_Y - bM_X$ = 159.73–(2.33*23.73) = 104.40362

DISCUSSION

Estimation of height is important for medico-legal examination and in anthropology. The study was carried out to determine the relation between height and FAL. In the previous studies, it was found that height of adult male is higher than female.[7,8] In the present study, it has been observed that the height and FAL both

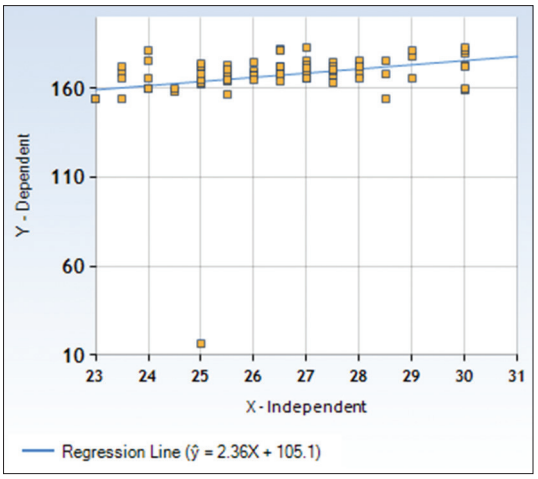

Figure 3: Relationship between independent variable (forearm length) in X-axis and dependent variable (height) in Y-axis in male students

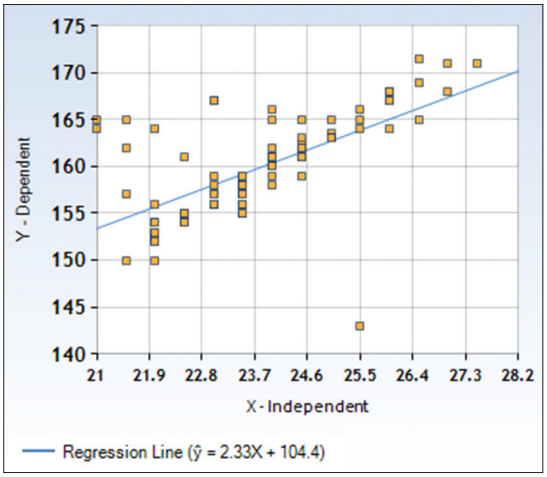

Figure 4: Relationship between independent variable (forearm length) in X-axis and dependent variable (height) in Y-axis in female students

are more in males than in females. Among a major percentage of females, height ranges between 150 and 160 cm, average 158.64±5.28 cm, whereas among the majority of male students, height varies between 160 and 170 cm, average is168.97±6.33 cm. As a whole if all the students have been taken into account average height is 163.81±7.79 cm. It has been found that the mean height values are higher in case of male students than in female students. Difference of the mean height values between female and male students is statistically significant.

From the study of Ruparelia et al.,[9] we found that the height of females range between 150 and 160 cm, in 63.3% cases, average 153.9 cm, whereas among the majority of the male students (61.3%), height varies form 160–170 cm, average 166.8 cm. According to Ruparelia et al.,[9] study average right FAL is 24.96 cm in male and 22.70 cm in female whereas on the left side this value is 24.96 cm in males and 22.68 cm in females. Difference of the length of fore-arm of right and left sides is statistically insignificant, whereas difference in the length of forearm in the male and female is statistically significant in that study.[9]

In the present study, it has been observed that the FAL s are more in males than in females. Here, in the present study, mean FAL has been 26.56 cm in males and 23.73 cm in females on the dominant side. Difference in the length of forearm in the male and female students has been statistically significant on dominant side.

In our study, it was found that FAL increases as the height increases and this is statistically significant. In the previous studies,[10] it was found that there exists a linear relationship between height and FAL. According to Akhlaghi et al., study, the correlation was found between FAL and height in male and female in Iranian population.[11] Singh et al., used FAL for finding the relationship between height and FAL in male and female of North Indian population.[12] When we calculated the linear regression equation, we found a linear relationship between height and FAL in male and female students.

Limitations of the study

We carried out our study in a particular age group.The same study should be done in different age groups to complement the result of our study.

CONCLUSION

From the regression equation in our study we found that there is a linear relationship between height and forearm length of an individual. It is evident that we may estimate the height of a person from measurement of FAL. It is recommended that similar studies may carried out in different age groups or different races.In future, studies may be carried out to estimate height of an individual from other body parameters also.

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Authors Contribution:
KB- Concept of the study, design of the study, collection of data, review of literature, preparation of the manuscript, interpretation of results, and statistical analysis; **CB-** Concept of the study, collection of data, anthropometric measurements of the subjects, review of literature, and helped in preparation of the manuscript.

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