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A Study on Height of Human Being in Relation to Length of Radius

Barnali Das[1], Rupsekhar Deka[2], K L Talukdar[3]

[1]Postgraduate Trainee, Anatomy, Gauhati Medical College, Guwahati-32

[2]Associate Professor, Department of Anatomy, Gauhati Medical College

[3]Ex Professor and HOD, Department of Anatomy, Gauhati Medical College, Guwahati-32

Abstract: ***Height of a human being in an upright position is defined as the distance from crown to heel. Height is an important factor in describing human population. Estimation of height of an individual based on length of different parts of body e.g. foot length, foot breadth, length of superior extremity, length of inferior extremity and different bones of the body.The study was done to assess the correlation between length of radius and height . The study was conducted on 100 subjects in the age group of 20—40 years. An anthropometer was used for measuring the height of the subjects and a spreading callipers was used for measuring the length of radius percutaneously. Height showed strong correlation with length of left (r = 0.692, p < 0.001) and right (r = 0.677, p < 0.001) radius for males and length of left (r = 0.940, p < 0.001) and right (r = 0.937, p < 0.001) radius for females. Since they approached +1, it is concluded that height and length of left and right radius are highly correlated and there is positive correlation between height and length of radius.***

Keywords: Height of human being, Radius

1. Introduction

Height of a human being in an upright position is defined as the distance from crown to heel. Height is an important factor in describing human population. It varies with age, sex and race. Estimation of height of an individual based on length of different parts of body e.g. foot length, foot breadth, length of superior extremity, length of inferior extremity and different bones of the body[1-3]. It has been done by various physicians and anthropologists since ancient time. Each of them showed significant correlation between height and different parts of body. Height is estimated by employing either the anatomical or the mathematical method. The anatomical method estimates total skeletal height and is based on the summed height of skeletal elements that contribute to height in humans. The mathematical method makes use of one or more bone length to estimate a height of an individual.

Forearm length is one of the important parameters used to determine the height. Radius is a forearm bone of which upper end (head) and the lower end (styloid process) are subcutaneous, so, it is easier to measure the length of radius. Ossification of radius is usually completed by 20 years of age. After the age of 50 years due to some degenerative changes there is probability of change of height. Therefore, in this research work we have taken the subjects from 20 to 40 years of age.

The aim of the present study was to assess the correlation between human height and length of left and right radius.

2. Materials and Method

The study was conducted on 100 subjects in both male and female in the age group of 20—40 years. An anthropometer was used for measuring the height of the subjects and spreading callipers was used for measuring the length of radius percutaneously.

All measurement were taken at a fixed time between 11am to 3pm to eliminate the discrepancies due to diurnal variation of height.

Exclusion criteria: Subjects with any visible deformity of spine and limb bones, pregnant woman and persons on corticosteroid therapy which might affect height was excluded.

3. Results and Observations

Data on height, radius length (left & right) and age were summarized by descriptive statistics. In addition to total sample statistics, data analysis have been presented for male and female cohort as well as two different age groups 20-30 yrs and 31-40 yrs.

Table 1: Sample size: Age and Gender

	Male	Female	Total
20-30 Years	31	31	62
31-40 Years	16	22	38
Total	47	53	100

Table 2: Statistic of whole cohort {N=100}

	Valid N	Mean	Std. Deviation	Median	Minimum (cm)	Maximum (cm)
Height	100	158.77	9.00	159.25	139.9	191.0
RadL_L	100	24.67	1.70	24.80	20.6	29.3
RadL_R	100	24.80	1.72	25.00	20.8	29.5
Age	100	27.24	3.470	23.00	20	40

Table 3: Statistics of Male cohort (N= 47)

	Valid N	Mean (cm)	Std. Deviation	Median	Minimum (cm)	Maximum (cm)
Height	47	164.165	7.5938	162.0	150.9	191.0
RadL_L	47	25.677	1.2336	25.6	23.5	29.3
RadL_R	47	25.821	1.2336	26.0	23.7	29.5
Age	47	27.17	3.158	23.0	20	40

Table 4: Statistics of Female cohort (N= 53)

	Valid N	Mean (cm)	Std. Deviation	Median	Minimum (cm)	Maximum (cm)
Height	53	153.995	7.3266	154.0	139.9	167.0
RadL_L	53	23.779	1.5495	23.7	20.6	26.4
RadL_R	53	23.887	1.5758	23.9	20.8	26.7
Age	53	27.30	3.755	23.0	20	40

Table 5: Statistics of age group 20-30 years (N=62)

	Valid N	Mean (cm)	Std. Deviation	Median	Minimum (cm)	Maximum (cm)
Height	62	157.68	8.20	158.60	139.9	172.7
RadL_L	62	24.52	1.75	24.75	20.6	29.3
RadL_R	62	24.67	1.76	24.95	20.8	29.5

In the 20-30 year age group height, mean left and right radius were 157.68 cm, 24.52 cm and 24.67 cm respectively. SD for same parameters was 8.20 cm, 1.75 cm and 1.76cm respectively.

Table 6: Statistics of age group 31-40 years (N=38)

	Valid N	Mean (cm)	Std. Deviation	Median	Minimum (cm)	Maximum (cm)
Height	38	160.57	10.03	161.10	142.0	191.0
RadL_L	38	24.92	1.59	25.10	21.5	27.8
RadL_R	38	25.00	1.66	25.16	21.6	28.1

Table 7: Pearson's Correlation (r) between height and radius length

	Left Radius	Right Radius
Whole	.883 (**)	.878 (**)
Male	.692 (**)	.677 (**)
Female	.940 (**)	.937 (**)
Age 19-25 years	.862 (**)	.851 (**)
Age 26-30 years	.934 (**)	.933 (**)

**Correlation is significant at the 0.01 level (2-tailed)

Scatter plots were drawn to study the association between height (X- axis) and length of left and right radius (Y-axis) in the whole cohort as well as male and female subcohort separately and Pearson's[4] Correlation coefficient ('r') were estimated for individual scatter plots. Correlation coefficients were statistically significant for the whole cohort, as well as gender subgroup ($p<0.01$).

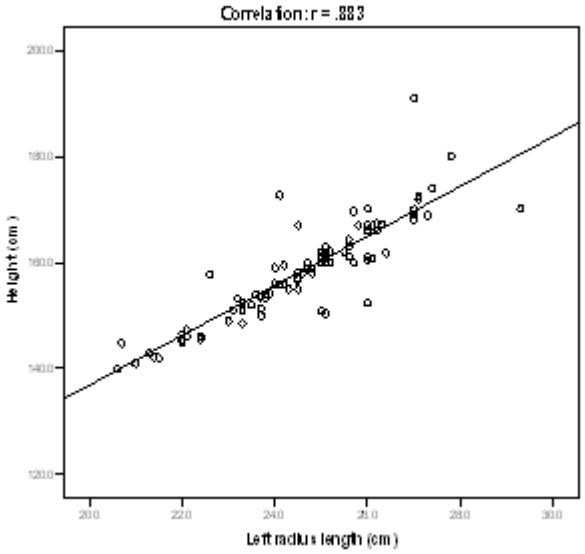


Figure 1: Association between Height and Left radius length – whole cohort (N= 100)
Height = 46.948 + 4.525*Left Radius Length

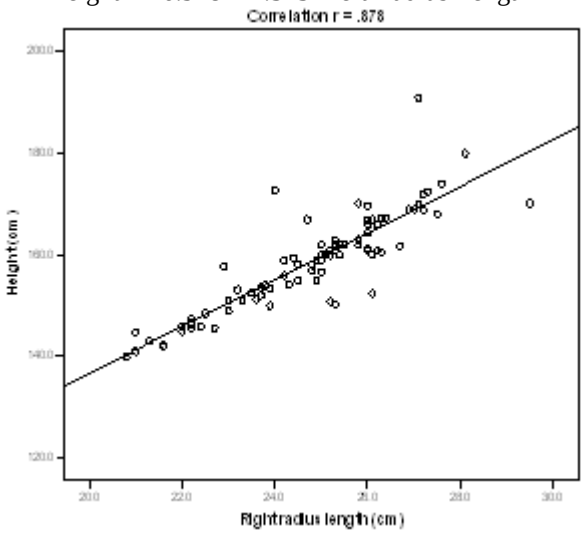


Figure 2: Association between Height and Right radius length –whole cohort (N=100)
Height = 48.452 + 4.441 * Right Radius Length

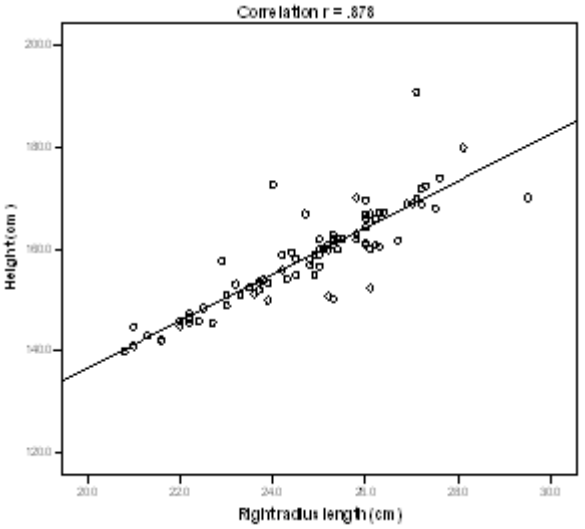


Figure 3: Association between Height and Left radius length Male cohort (N=47)
Height = 64.020 + 3.884 * Left Radius Length

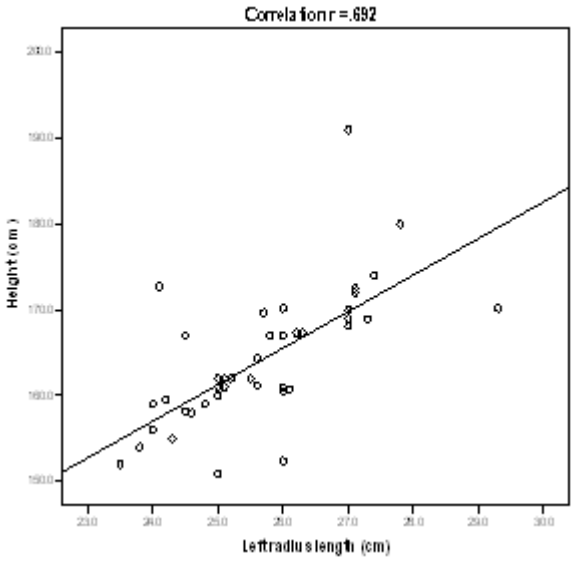


Figure 4: Association between Height and Right radius length Male cohort (N=47)
Height = 65.584 + 3.801 * Right Radius Length

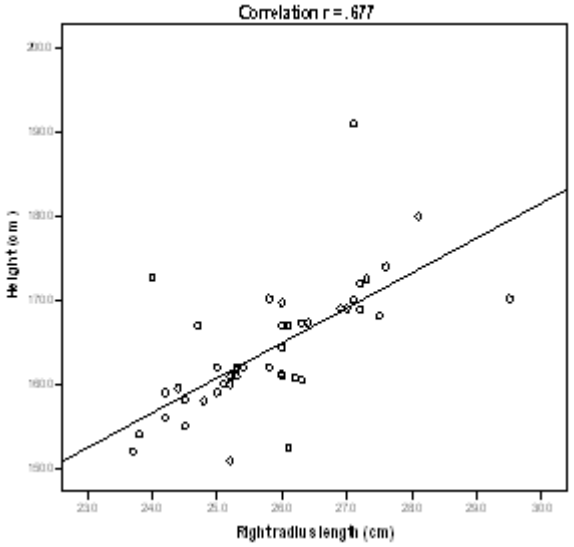
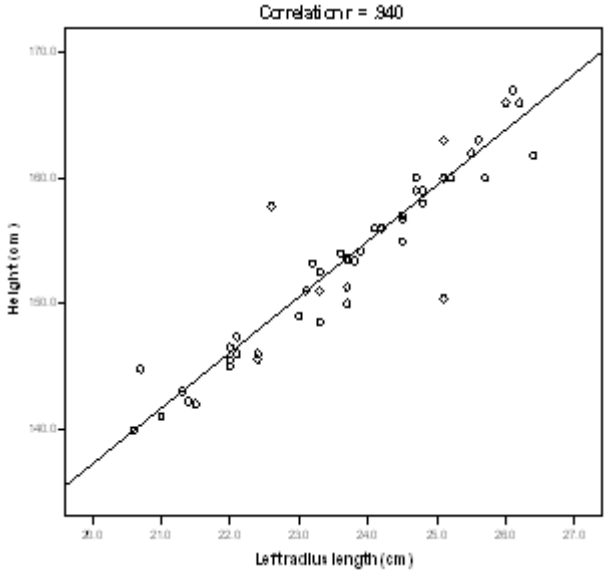


Figure 5: Association between Height and Left radius length Female cohort (N=53)
Height = 48.296 + 4.445 * Left Radius Length



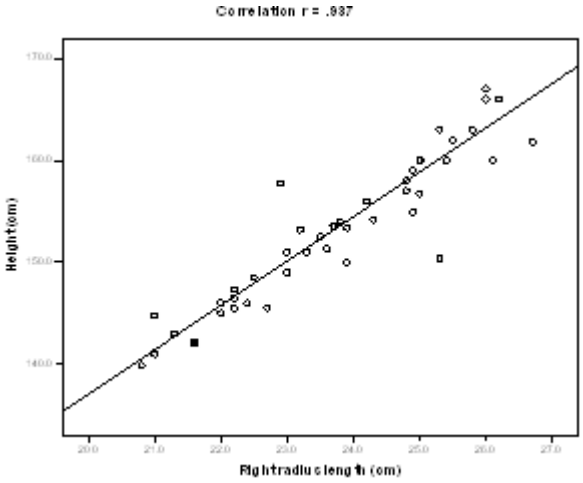


Figure 6: Association between Height and Right radius length Female cohort (N=53)
Height = 49.917 + 4.357 * Right Radius Length

4. Discussion

The height as a measure of biological development of both an individual and a population is commonly used in physical anthropology. The measurement of height is essential for the calculation of body mass index, which is one of the most commonly used nutritional assessment variable. Scientists have underlined the need for population-specific stature estimation formulae as the ratios of various body parts to height differ from one population to another. Trotter and Glesser[1] have affirmed requirement of different regression equations among different races after studying different races for relationship between lengths of long bones and height.

The present study deals with observations on correlations of total standing height with length of radius. Although variety of methodologies have been proposed to predict height from long limb bones, regression analysis proved to be the easiest and the reliable method (Meadows et al[5]). Variety of factors such as age, race, gender and nutritional status affect human development and growth and therefore, different normograms are required for different populations (Williams et al.; Joshi et al[6].). The present study documents norms for height and radius length and presents gender specific linear regression models for stature prediction in adult population. The formulae are valid for the age group (20- 40 years) of the subjects. Athawale[7] derived regression formula for estimation of height from length of long bones in Maharastrian males and showed that using the formula given by Western works involves an error of 5 -8%. He derived the regression formula for radius as—

Height = 59.2923cm + 4.1442 x average length of right and left radius in cm ± 3.66 cm.

Maloy kumar[8] derived regression equation for estimation of stature from the length of ulna in males of West Bengal in age range of 20-50 years. a) Estimation of height from right ulna; Y1 = 50.642+ 4.1896X1 ± 7.7302 b) Estimation of height from left ulna; Y2= 76.289+ 3.256X2 ± 9.082.

The present study included 100 individuals (47 males and 53 females) between 20-40 years from Guwahati. Their standing heights and length of left and right radius were recorded. For males the mean height was 164.16cm with a range from 150.9cm to 180cm .While for females mean height was 153.99 cm with a range from 139.9cm to 167 cm. Values for male nearly coincide with work of Basu[9](1963).

In males the mean length of the left and right radius was 25.68cm and 25.82 cm respectively. In case of females the mean length of the left and right radius was 23.78 cm and 23.89 cm respectively. In cases of left and right radial length too the sample standard deviation for males and females showed negligible difference with population standard deviation. Mean length of left radius and right radius did not show any significant difference between them in both males and females but, mean length of left radius was significantly difference when compared between male and female subcohort. Similarly mean length of right radius was also significantly different between males and females.

In order to find the linear relationship between height of an individual (X- axis) with length of left and right radius (Y-axis) observations were plotted on X and Y axis to obtain scatter diagrams. The correlation coefficient of height and length of left radius was 0.692 for males and 0.940 for females. The correlation coefficient of height and length of right radius was 0.677 for males and 0.937 for females. Since they nearly approach +1, it is concluded that height and length of left and right radius are highly correlated. Correlation coefficient were statistically significant not only for male and female cohort but also for the whole cohort.

5. Summary and Conclusion

Therefore from the present study, it has been concluded that mean height and length of radius is more in males than in females. Gender differences in mean height and length of radius were found to be highly significant ($P<0.05$).There is positive correlation between height and length of radius. Further regression equation can be statistically derived if either of the measurement (length of radius or total height) is known, the other can be calculated. This fact will be of practical use in medico legal investigations and in anthropological and archaeological studies where the total height of a subject can be calculated if the radius length is known.

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