Estimation of human stature from ulnar length in rural region of Maharashtra

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Abstract

Introduction: Greek anthropos means "man" and metron is "measure" therefore measurement of man- provides scientific methods and techniques for taking various measurements and observation on the living being and the skeleton. The word 'Anthropometry' was first used in the seventeenth century by German physician Johann Sigismund Elsholtz (1623-88). Anthropometry constitutes the means of giving quantitative expression to the variations which different individuals or traits exhibit.

Method and Materials: The cross sectional study was carried out on 200 (100 males and 100 females) medical students of Government Medical College of rural Maharashtra in the age group of 18 – 28 years. The parameters studied were height, length of right and left ulna. The observation were analysed by Pearson's correlation to examine the relationship between length of ulna and height according to gender for right and left ulna separately.

Results: The mean ages of the study subjects (male 21.192±3.25 and female 21.02±3.22) were not significantly different between genders. Mean Ulnar lengths of the male were significantly larger than that of the females of all ages. Positive Correlation was found between total height and ulnar length 0.65 in males and 0.68 in female.

Conclusion: Definite proportion exists between the height and ulnar length in all individuals.

Keywords: Anatomist, Anthropologist, Anthropometry, Human stature and Ulna

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Introduction

Greek anthropos means "man" and metron is "measure" therefore measurement of man- provides scientific methods and techniques for taking various measurements and observation on the living being and the skeleton[1]. The word 'Anthropometry' was first used in the seventeenth century by German physician Johann Sigismund Elsholtz (1623-88)[2].

Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are intimately linked with each other and manifestation of the internal structure and tissue components which in turn are influenced by environmental and genetic factors[3]. It is a fact especially familiar not only to anatomists but also to artists that trunk and limbs exhibit consistent ratios among themselves and relative to total height. The ratios are linked to age, sex and race[4].

During growth from childhood to adulthood, stature increases with age. However, stature also tends to decrease with age due to compression of cartilage and loss of elasticity of the intervertebral disc[5].

Reconstruction of stature by way of measuring long bones has an established practical application in forensic identification. Earlier reports from Snow et al. (1971), Willey et al. (1991)[6], show that a person's stature is an extremely variable biological parameter. According to Trotter and Gleser (1951a)[7], Lundy (1988b)[8] it may vary, with the same person, throughout the day, with age and even with certain illness and anomalies, and also from person to person between different populations.

The ulna is a long bone that is often used for body height estimation, as it is mostly subcutaneous throughout its length and is easily approachable for measurement. Pan (1924)[9] derived first time relation between total ulnar length and total height of an individual.

Purpose of present study is to analyze the anthropometric relationship between lengths of Ulna with stature and to derive regression formulae to estimate stature.

Objectives

1. Assessment of stature from percutaneous le
2. ngth of ulna in rural Maharashtrian population.
3. To measure length of ulna and stature in males and females of rural Maharashtrian population.
4. To correlate the stature with ulnar length.

Materials and Methods

The present study comprised a total 200 (100 F and 100 M) asymptomatic healthy medical students of rural Maharashtrian population. **Inclusion criteria-** age - 18 to 28 years. This age range comes in an age range during which height remains more or less static. A slow decline in the height is known to occur as the age advances and therefore older subjects were not studied[10]. **Exclusion criteria**- old fractures, any significant disease, and orthopaedic deformity, metabolic or developmental disorders which could have affected bony growth. In each case, the height and length of right and left ulna were recorded. The measurements were always taken at a fixed time, between 3 – 5 pm, to eliminate discrepancies of diurnal variation.

Measurements were taken for stature from crown to heel in standing erect posture with head oriented in Frankfurt's plane with a standard height measuring instrument. Ulnar length was measured by spreading calliper (0- 600mm) with rounded ends from the tip of olecranon process to the tip of styloid process of Ulna with elbow flexed and palm spread over opposite shoulder. Measurements of length of right and left ulna were taken separately for calculation. Both the stature and the Ulnar length were measured in centimetres to the nearest millimetres.

After collected data, statistical analysis was done for calculation of mean, standard deviation, standard error, correlation coefficient, regression coefficient, value of constant and t test for correlation coefficient applied to test the statistical significance using Microsoft excel file.

Results

The observation were analysed separately for both right and left ulna in each sex on all subjects and results are tabulated. The mean ages of the study subjects (male 22.192±3.25 and female 22.02±3.22) were not significantly different between genders. Gender differences in mean height and length of ulna were found to be highly significant (P< 0.05). Mean ulna lengths of the male were significantly larger than that of the females of all ages.

Table 1: Mean, SD and Range for all the parameters

A. Male Cases

Parameter	Mean	SD	Range
Height	172.93	6.52	159-187
Length of Ulna (rt)	27.52	1.33	24–30
Length of Ulna (lt)	27.26	1.35	24–30

B. Female Cases

Parameter	Mean	SD	Range
Height	166.53	3.57	155–178
Length of ulna (rt)	21.75	0.92	20–24.5
Length of ulna (lt)	21.68	0.87	20–24

Table 1.A Shows that mean height of male subjects is 172.93±6.52. Mean of length of right and left ulna in male subjects are 27.52±1.33 and 27.26±1.35 respectively, with range of 24 to 30 cm. Table no.1.B shows that mean height of female subjects is 166.53±3.57. Mean of length of right and left ulna in female subjects are 21.75±0.92 and 21.68±0.87 respectively, with range of 20–24.5 cm.

Table 2: Comparison of length of right and left ulna

Results are presented in Mean±SD (Min – Max)

Subjects	Parameter		Z value	P value
	Length of ulna (Right)	Length of ulna (left)		
Male	27.52±1.33 (24 – 30)	27.26±1.35 (24 – 30)	0.36	P >0.05
Female	21.75±0.92 (20 – 24.5)	21.68±0.87 (20 – 24)	0.62	P >0.05

Table 2 shows Comparison of right and left ulna. From the table 2, it is found that the mean value of length of right and left ulna of study group is statistically insignificant in male, female (P >0.05). Further statistical analysis was done on left ulna, as per recommendation of the international agreement for paired measurements at Geneva (1912).

Correlation Coefficient

Pearson's correlation coefficient was used to examine the relationship between length of ulna and total stature.

Table 3: Pearson's correlation coefficient

Subjects	Correlation Coefficient (r)	Coefficient of determination (%)	P value
Male	0.65	42	
Female	0.68	46	P < 0.01

Table 3 shows that the correlation of stature with ulnar length is 0.65 in males and 0.68 in females, which are positive and statistically highly significant (P < 0.01) i.e. if length of ulna increases or decreases, the stature of the subject also increases or decreases and vice versa.

Table 4: Regression equation for height with length of ulna in male, female and both together

Subjects	Correlation Coefficient (r)	Regression Equation	P value
Male	0.65	Y = 93.45 + 2.92X	
Female	0.68	Y =113.89 + 2.37X	P < 0.01

Table 4 shows the linear regression equation for stature with ulnar length in male and female where,
Y = Height/ Stature (cm)
X = Length of ulna (cm)
93.45, 113.89 are intercept (constant) for male and female.
2.92, 2.37 are regression coefficient for male and female.

From the above table it is seen that the regression formula within a region also varies between male and female population of that region.

Discussion

All human beings occupying this globe belong to the same species i.e. Homo sapiens. No two individuals are exactly alike in all their measurable traits, even genetically identical twins (monozygotic) differ in some respects. Over the last two centuries, there has been a substantial increase in human stature. This change over time is called as secular change. A variety of epigenetic or environmental factors appear to contribute to secular change. Research indicates that, despite a trend towards increasing stature, there are occasional decreases. Negative changes appear to occur during times of economic hardship such as war and economic recession. Decreases in stature during World War II have been noted in Russia, Japan, and Germany. Secular change is noted more strongly in men than women, with environmental factors being suspected as the major contributor to the differences. Environment was also shown to impact the sexes independently of each other and in unique ways[11].

The present study was carried out over 200 medical students (100 Males and 100 Females) of rural region of Maharashtra. The parameters studied are total height of subject, length of right and left ulna. When compared between male and female we found that values are higher for male and the difference is statistically significant (p < 0.005). This statistically significant difference is because in females, oestrogen causes early closure of epiphysis with diaphysis. So there occurs early maturity of girls than boys; consequently, the boys have two more years of physical growth.

In the discussion of most of the parameters, an attempt has been made in the present study, to compare with previous workers.

Table 5: Comparison of mean of total height

Workers	Years	Gender	Age group	Mean Height(cm)	SD	Range
Athwale[12]	1965	M	25 - 30	163.13	6.34	149.2–178.1
Chiba M et al.[13]	1998	M		164.8	7.64	148–181
		F		153.0	6.81	137–169
Jadhav HR[14]	2004	M	17 - 22	165.92	8.96	141.5–189.5
		F				
Duyar. I et. al.[15]	2006	M	18 - 45	175.68	9.71	149–201
Ebite. L.E et.al [16]	2008	M	20 - 45	169.44	6.82	
		F		162.20	5.57	
Mondal.M.K et.al.[17]	2009	M	20 - 50	164.32	6.34	
IlayperumI[18]	2010	M	20 - 30	170.14	5.22	159.5–183
		F		157.55	5.75	144–168.7
Present Study	2011	M	18 - 28	172.93	6.52	159–187
		F		166.53	3.57	155–178

From the above table it is clear that mean height of subjects within an age group varies from country to country as well as within different regions of a country. It may be due to geographical, racial as well as genetic factors or may be due to dietary habits, lifestyle and physical stress. So if the differences in mean height of subjects of different population are due to geographical, racial and genetic factors, we can safely presume that it will remain constant for a long period of time. But if predominate influence is observed to be plastic ones (i.e. dietary habits, lifestyle and physical stress), it is hypothesized that the anthropometric standards will have to be evaluated from time to time in the perspective of such influences for their validity.

In the present study, mean height of subjects is 172.93 cm in males and 166.53 cm in females which are comparable with previous studies. The difference between mean height of male and female subject's i.e. gender difference are statistically significant ($P < 0.05$).

So the males of a population are taller than females. This is because maturity in females occurs earlier than males.

Table 6: Comparison of mean length of ulna

Workers	Years	Gender	Age group	Mean ulnar length(cm)	SD	Range
Athawale[12]	1963	M	25 - 30	26.79	0.42	23.15–31.30
Choi. B.Y et.al[19]	1997	M	20- 86	R 24.26	1.3	21–26.7
				L 24.7	1.3	21.3–26.7
Mall. G et.al.[20]	2001	M	46 – 108	M 26.5	1.54	
		F		F 23.8	1.07	
Celbis. O et.al[21]	2006	M	18 - 63	26.4	1.23	23.9–30.9
		F		23.6	1.2	21.0–25.4
Ebite.L.E et. al.[16]	2008	M	20 - 45	30.33	1.53	28–32
		F		28.50	1.87	26–31
Mondal. M.K et.al[17]	2009	M	20 - 50	R 27.13	1.17	
				L 27.01	1.17	
Ilayperuma[18]	2010	M	20 - 23	M 27.56	1.30	24.5–31
		F		F 27.11	1.24	22–27.5
Present study	2011	M	18 - 28	M 27.26	1.35	24–30
		F		F 21.68	0.87	20–24

In present study, mean length of ulna in males and females were 27.26 and 21.68 respectively. The difference between mean ulnar length of male and female subjects i.e. gender difference is statistically significant ($P < 0.05$) which coincides with that of previous studies.

Table 7: Showing correlation and linear regression equation of stature with length of ulna

Workers	Years	Country/ Region (sample drawn)	Correlation Coefficient	Regression equation
Athwale[12]	1963	Maharashtrian males	0.82	$S = 56.97 + 3.96X_1 \pm 3.84$
Joshi. N.B et.al.[22]	1965	Gujarati males		$S = 55.42 + 3.50X_1$
Choi. B.Y et.al.[19]	1997	Korean male cadavers	0.71	$S = 70.78 + 3.74X_1 \pm 4.97$
Mall. G et.al[20]	2001	German cadavers	0.71	$S_M = 90.48 + 3.14X_1 \pm 7.5$
				$S_F = 44.82 + 5.01X_2 \pm 7.5$
Celbis. O et. al[21]	2006	Turkish cadavers	M = 0.62	$S = 89.06 + 3.05X_1 \pm 4.8$
			F = 0.76	$S = 57.31 + 4.2X_1 \pm 4.3$
Mondal MK[17]	2009	Bengali males	R = 0.78	$S = 50.64 + 4.18X_1 \pm 7.73$
			L = 0.68	$S = 76.28 + 3.25X_2 \pm 9.08$
IlayperumaI[18]	2010	Srilankan population	M = 0.66	$S = 97.25 + 2.64X_1$
			F = 0.76	$S = 68.77 + 3.53X_2$
				$S = 57.38 + 4.04X_3$
Present study	2011	Rural Maharashtrian population	M = 0.65	$S = 93.45 + 2.92X_1$
			F = 0.68	$S = 113.89 + 2.37X_2$

From Table 7 it is observed that all workers got positive correlation between stature and length of ulna which is statistically significant (P = 0.00) indicating strong relation between the two parameters.

Regression formulae is population specific and sex specific due to genetic differences, isolation differences, differences in bio-cultural history and other factors. The researchers determined that the stature estimation formulae should be recalculated within appropriate time intervals, even for same racial populations[23]. Variety of factors such as age, race, gender, geographical, and nutritional status affect human development and growth and therefore different normograms are required for different population[18].

Body ratios within specific population groups also changes over time due to changes in diet, lifestyle and socio- economic status, and therefore the present regression formulae may need readjustment[23].

Furthermore, racial variation in the relationship between ulna length and height has been clearly demonstrated by comparative studies between Black, White and Asian subjects[18]. The present study further highlights the racial diversity in mean ulna length.

Conclusion

From the present study, it has been concluded that

1. Mean height and length of ulna is more in males than in females.
2. Gender differences in mean height and length of ulna were found to be highly significant (P <0.05)
3. There is positive correlation between stature and length of ulna.
4. Simple linear regression equation so far derived can be used for estimation of stature in rural Maharashtrian population.
5. **Regression equation derived** - Can be of help in artificial limb centers for construction of prosthesis required in cases of amputations following gangrene, trauma, frostbite etc.
6. Can be applied to calculate stature and then body surface area in patients of burns.
7. This fact will be of practical use in Medico legal investigations and in anthropometry. Study would be useful for Anthropologist and Forensic Medicine experts.

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