PREDICTION OF STATURE BY THE MEASUREMENT OF HEAD LENGTH IN POPULATION OF RAJASTHAN

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ABSTRACT: BACKGROUND: Estimation of stature has a significant importance in the field of forensic anthropometry for the identification of an individual. **AIMS:** Study was carried out to assess and correlate head length and the stature and to predict the stature of an individual by head length using regression analysis. **MATERIALS & METHODS:** Total 300 (150 males and 150 females) medical students of S.M.S medical college, Jaipur (Rajasthan) were selected. Head length and height of the individual were measured. **RESULTS:** Correlation coefficient between height & head length were r=0.941 for Male & r= 0.85 for Female suggestive of strong positive correlation. Regression equations were derived to calculate height of unknown individual from head length. **CONCLUSION:** Present study has established definite correlation between stature and head length. If either of the measurement (total height or head length) is known, the other can be calculated. It will help in medico-legal cases in establishing identity of an individual when only some remains of the body are found as in mass disasters, bomb explosions, accidents etc.
KEY WORDS: Anthropometry, Body Height, Cephalometry, Identification.
MESH TERMS: Anthropometry, Body Height, Cephalometry, Identification.

INTRODUCTION: Anthropometry, the typical and the traditional tool of physical anthropology, provides the scientific methods and the techniques for estimating the various measurements and the observations on the living as well as the skeleton of man. Human body height (Stature) is one of the most important elements in the identification of an individual. To assess the height of an individual, from measurements of different parts of the body, has always been of immense interest to Anatomists, Anthropologists and Forensic experts.

It is well known that there is a definite relationship between the height of the person and various parts of the body like head, trunk and lengths of extremities. The relationship between body segments has been used to compare and highlight variations between different ethnic groups and to relate them to locomotor patterns, energy expenditure, and lifestyle.[1,2] Reconstruction of stature from various bones of the human skeleton has been achieved by many scientists with varying degree of accuracy. Establishment of alternative methodologies for personal height estimation is important for a number of reasons. Firstly, in instances where height estimates needed to be made from fragments of bones in archeological procedures or in forensic examinations after mass disasters or genocide.[3] Secondly, estimates of pharmacokinetic parameters and evaluation of nutritional status rely on accurate measurement of not only body

weight but also height. However, a number of common disease or deformities of the vertebral column make it difficult to accurately measure standing height in many patients.[4]

Knowledge on the cephalometry is important in the study and comparison of the crania of populations from different racial, geographic and dietary backgrounds. Such information is also useful in studies of primate phylogeny. In clinical practice, population and age specific data on cranial dimensions gives an indication of growth and development of an individual and also any abnormalities of cranial size and shape.[5] Although a wide variety of long bones have been employed for stature estimation only few studies have utilized the cranial dimensions in this regard.[6,7,8,9] Although many formulae for stature estimation have been proposed, there is concern regarding the accuracy of the use of population specific formulae on other human populations.[10,11] It is obvious that there are no universally applicable formulae as the relationship between head dimensions and cranial capacity is influenced by the race, sex and age of an individual. Thus, the need for race, age and sex specific stature estimation formulae is proved beyond doubt.[3]

Despite its significance and potential practical utility, little is known concerning the relationship between head length and stature among population of Rajasthan (India). Hence, this study was carried out to assess and correlate the head length & the stature and to propose population and gender specific regression equations for stature estimation using the head length.

MATERIALS & METHODS: For present study, total 300 subjects (150 males and 150 females) asymptomatic, apparently healthy medical students of S.M.S medical college, Jaipur (Rajasthan) were selected. The age ranged between 18-25 years. Head length was measured between two craniometric points- glabella and inion. Inion is the most prominent projecting point of occipital bone at base of skull and glabella is the point on protuberance of lower forehead above nasal root and between the eyebrow ridges intersected by mid sagittal plane. This was measured by placing the anterior caliper tip on glabella while allowing the posterior caliper tip to slide inferiorly along the median plain of the occipital bone until the maximum length was reached. Measurements were taken using blunt ended spreading caliper. Instrument was held in such a manner that the tips of the caliper were free to touch the head. Undue pressure was avoided while taking the measurement. [Figure] Height of the individual was measured in standing erect anatomical position. It is the vertical distance between vertex and heel touching the floor (ground surface). The measurements were taken at fixed time between 2 to 5 p.m. to eliminate the discrepancies due to diurnal variation and by the same person to avoid personal error in methodology. To minimize subjective errors, all the measurements were taken three times and then mean was taken. The armamentarium comprised of stature meter, spreading caliper (blunt ended).

The obtained data was analyzed to find out mean, standard deviation (S.D.), coefficient of correlation. Regression equations were derived to calculate height of unknown individual from foot length and hand length.

RESULTS: Linear regression analysis was done to estimate the stature from Head length as independent variables. Pearsons correlation coefficient was used to find the relation between the Head length & personal height. Correlation coefficient between height & head length ($r=0.941$ for Male & $r= 0.85$ for Female). It means that there is strong positive correlation between height & head length of study population. The regression equation for height & head

length was found to be Y=138.87+1.87X for male & Y=128.07+1.82X for female, where Y= total body height in cm, X= head length in cm. [Table-1, Graph]

DISCUSSION: In forensic examinations and anthropological studies, prediction of stature from incomplete and decomposing skeletal remains is vital in establishing the identity of an unknown individual.[12] There are various methods to estimate stature from the bones but the easiest and the reliable method is by regression analysis.[13] Height estimation by measurement of various long bones, head measurements, hand, foot length etc. has been attempted by several workers with variable degree of success. Each researcher has derived his own formula for calculating the stature from these parameters. However, hand and foot measurement has not frequently been used for this. It was Rutishauser who for the first time showed that reliability of prediction of height from foot length was as high as that from long bones.[14]

Various workers have shown significant correlation between height and different parts of the body. Singh and Sohal[15], Jit and Singh[16] have shown a significant correlation between height and length of clavicle. Charnalia[17], showed the significant correlation between height and foot-length, where correlation coefficient was 0.46. Athawale[18], derived a regression equation between total height and forearm bones. Shroff and Vare[19], have also derived the height from the length of superior extremity and its segments.

It is stated that the racial characters are best defined in the skull.[3] As a result cranial dimensions constitute one of the most important characters for determining the racial difference.[3,20] Variety of non-metric and metric parameters has been utilized in the assessment of ethnic and gender differences in cranio-facial morphology. The non-metric parameters are subjective as no quantitative techniques are devised. On the other hand, features that can be expressed as actual measurements, like cranial dimensions, provide more objective racial and gender diversity assessment of the crania.[3]

Correlation coefficients between the total height and head length among population of Rajasthan were found to be statistically significant and positive indicating a strong relationship between the two parameters. Previous studies have shown correlation coefficients of 0.62 (Sudhir PE et al.)[7], 0.53 (Jadav HR et al.)[6] & 0.52 (Seema and Mahajan A)[9] between head length and height, whereas in the present study it was 0.94 for males and 0.85 for females which is suggestive of strong positive correlation between these two parameters. [Table-2] Regression equations for their respective population were also derived by previous workers.[6,7,8,9] Regression equations for stature prediction were formulated using head length and estimated statures in present study for study population and were compared with the actual statures to check the accuracy. The results further confirmed that head length provides an accurate and reliable means in stature prediction.

In forensic examinations and anthropological studies, prediction of stature from incomplete and decomposing cranial remains is vital in establishing the identity of an unknown individual. Therefore, formulae based on the head length provide an alternative stature predictor under such circumstances. The cranium has easily identifiable surface landmarks making the measurements possible even in compromised conditions.

The present study for the first time documents gender specific regression models for stature prediction in adult population of Rajasthan. These formulae are valid for the age group (18-25 years) of the subjects. It is widely accepted that cranial morphology varies with the age of an individual.[21] In addition the height is also shown to progressively decrease with advancing age due to spinal cord shrinkage.[10] The population and gender specific regression equations

proposed will be of immense practical use in medico-legal, anthropological and archeological studies where the total height of a subject can be calculated if the head lengths are known. It will help in medico-legal cases in establishing identity of an individual when only some remains of the body are found as in mass disasters, bomb explosions, accidents etc. It will also help in establishing identity in certain civil cases.

CONCLUSION: The present study has established definite correlation between stature & head length and also regression equations have been established. It will help in medico-legal cases in establishing identity of an individual when only some remains of the body are found as in mass disasters, bomb explosions, accidents etc. If either of the measurement (head length or total height) is known, the other can be calculated and this would be useful for Anthropologists and Forensic Medicine experts. It will also help in establishing identity in certain civil cases. There are lot of variations in estimating stature from cranial measurements among people of different region & race. Hence there is a need to conduct more studies among people of different regions & ethnicity so that stature estimation becomes more reliable & identity of an individual is easily established.

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Table-1: Observations of Head length, Correlation coefficient and Regression equation.

	HEAD	
	MALE	FEMALE
Mean length(cm.)	18.047+/-2.54	16.921+/-1.56
Correlation Coefficient (r)	0.941	0.85
Regression analysis	Y*=138.87+1.87X†	Y=128.07+1.82X

Here * Estimated body height, †head length (cm).

Table-2: Estimation of stature from Head length (Comparative Analysis).

	Jadav HR et al.[6]	Sudhir PE et al.[7]	Ilayperuma I[8]	Seema, mahajan A.[9]	Present study
No. of cases	728(M*-468, F†259) Gujrat region	406(M-198,F-208) Maharashtra region	400(M-220,F-180) Sri Lankans	400(M-210, F-190) Punjab zone	300(M-150,F-150) Rajasthan region
Age group	17-22	17-22	20-23	18-23	18-25
Year	2004	2010	2010	2011	2012
Mean head length(cm.)	17.65+/-0.97	17.92+/-0.83	18.0+/-1.1(M) 17.19+/-1.01(F)	17.81+/-0.96	18.047+/-2.54(M) 16.921+/-1.56(F)
Mean total height(cm.)	165.92+/-8.96	163.29+/-9.36	162.95+/-9.025(M) 152.48+/-11.498(F)	166.93+/-8.94	170.432+/-4.6(M) 157.32+/-3.58(F)
Correlation coefficient(r)	+0.53	+0.629	0.715(M) 0.470(F)	+0.52	+0.941(M) +0.85(F)
Regression equation	Y‡=138.77+1.77X§(M) Y=128.03+1.72X(F)	Y=58.15+6.11X(M) Y=71.21+4.87X(F) Y=38.03+6.99X(T⍰)	Y=101.83+3.69X(M) Y=226.60+3.86X(F) Y=103.72+3.38X(T)	Y=136.88+1.89X(M) Y=127.05+1.81X(F) Y=77.89+4.98X(T)	Y=138.87+1.87X(M) Y=128.07+1.82X(F)

HERE * Male, † Female, ‡ Estimated body Height, § head length (cm), ⍰ Total population (Male & Female).

Graph: Pearson correlation between head length and body height (Total population including male & female) r=0.685; p<0.001(N=300)

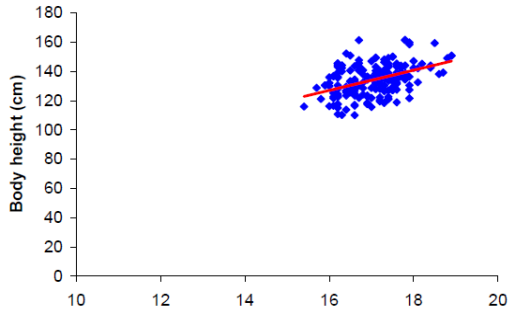

Figure: Method of measuring Head length