

Estimation of Stature from Head Length and Head Breadth by Regression Analysis in South India Population

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Abstract

Background: In Legal investigations like in crimes resulting in fatalities or when unknown skeletal human remains are being recovered by investigating agencies, it is the forensic pathologist who is often asked to give his opinion regarding personal identification for the deceased. Stature is considered to be one of the most valuable parameter to determine the physical identity of an individual.

Aim and objective: To find out correlation between Head length and Head breadth with stature of the individual and to devise a linear regression equation to determine stature from Head length and Head Breadth.

Type of Study: Descriptive cross sectional study with analytical and comparative components.

Place of Study: Department of forensic medicine and Toxicology Narayana Medical College, Nellore District of Andhra Pradesh State.

Material and Method: Present study comprised of total 300 young and healthy subjects in the age range 18-25 years, of Nellore region of south India. The subjects were studied for the following parameters: Stature, maximum head length and head breadth.. The measurements were tabulated and statistically analyzed.

Observation and Discussion: The Mean height of males was 166.3 ± 5.92 and that of females is 154.9 ± 5.53 . Mean Head Length and Head Breath in males are 18.62 ± 0.55 , 13.62 ± 0.52 and that in females are 17.77 ± 0.44 , 13.22 ± 0.27 . The Pearson correlation of stature with head length and head breadth in male is $r = 0.315$, $r = 0.227$ which is significant with p-value is 0.00043, 0.0026 and that in females are $r = 0.276$, 0.148 is significant with p-value is 0.00032, 0.03536 and in combined (Male and Female) $r = 0.619$, $r = 0.431$ is significant with p-value is 0.000001, 0.000001.

Conclusion: We conclude that the regression equations presented here can be used to estimate ante-mortem stature, with reasonable accuracy of unknown mutilated or dismembered human remains from Head Length and Head Breadth in medico-legal cases, particularly from Nellore district of State Andhra Pradesh.

Keywords: Head length; Head Breadth; Regression equation; Stature.

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Introduction

In Legal investigations like in crimes resulting in fatalities or when unknown skeletal human remains are being recovered by investigating agencies, it is the forensic pathologist who is often asked to give his opinion regarding personal identification for the deceased.¹⁻³ Stature is considered to be one

of the most valuable parameter to determine the physical identity of an individual. As such there is a definite biological relationship of stature with various body parts for example extremities, head, trunk, vertebral column and so on. Various studies had been conducted in past to determine stature from percutaneous measurements of various body parts which includes arms, legs, feet, hands etc.⁴⁻¹³

As such there are two methods to determine stature, Anatomical and Mathematical method, Anatomical method is also called as Folly method and it was traduced by Dwight and developed by Fully as reported by,¹⁴ it determines stature in living subjects using length of bones in body, together with correction factors and adjusting depreciation pattern of stature on ages to attain estimation of living stature.¹⁵ It reconstruct stature by adding measurements of skeletal elements that contribute to stature and adding a correlation factor for soft tissue and this method is being considered as highly accurate, but similarly it is time consuming. In mathematical method to estimate stature from few pieces of bone, it considers the linear correlation between long bones and stature. Commonly used bones that present high accuracy are long bones of upper and lower extremities. Approximate stature can be estimated by using this technique but it always remains a daunting task for any anthropological examiner.¹⁶

From south India population, very few studies are there for stature estimation from skull alone; as well it is proved beyond doubt that each race requires its own formula for determination of stature. Dietary habits and climate of different regions of India are variable, racial and ethnic variations also exist in different geographical regions. Hence conclusions based on the results of studies done in one population cannot be entirely be applicable to other population.¹⁷ Several studies have been conducted on stature estimation by percutaneous measurements of various body parts which includes arm, leg, feet etc. so considering the current scenario of scarcity in studies on this topic a need of systematic study to determine stature from skull dimensions, the present study was undertaken to determine stature amongst south India population of Nellore region using head length and head breath.

Aim and Objective

The present study was undertaken with an aim and objective to obtain a specific regression equation for stature estimation from Head length and head

breadth among male and female population of Nellore district of state Andhra Pradesh, To find out correlation between Head length and Head breadth with stature of the individual and to devise a linear regression equation to determine stature from Head Length and Head Breadth.

Material and Method

In the present study was conducted at Narayana Medical College, Chinthareddy Palem, Nellore State Andhra Pradesh by the Department of forensic medicine and Toxicology on the Consenting volunteers of Nellore District of State Andhra Pradesh. The research was with the aim of estimation of stature from Head Length and Head breadth measurements collected in 300 adult volunteers with age of 18 to 40 years.

The subjects were confirmed to be descent from Nellore district and were specifically selected with residence of Nellore district only, irrespective of their caste, religion, dietary habits and socio-economic status. The study was a predominantly descriptive cross sectional study with analytical and comparative components. Sufficient permissions and consents are procured before the measurements of the volunteers are taken and clearance from the Institutional Ethical committee is obtained in advance. Measurements taken by single investigator and with the same instrument to avoid any technical or inter observer error and to maintain reproducibility and measurements were taken thrice and their mean value were considered for stature estimation.

Stature: Using the stadiometer, the subject was made to stand barefoot in the standard standing position on its baseboard. Both feet are in close contact with each other and head oriented in Frankfurt's plane. The height was then recorded in centimeter from the standing surface to the vertex in the weight bearing position of foot.

Head Length (HL): It is the distance between Glabella to Inion. Glabella; most prominent point on the frontal bone above the root of the nose, between the eyebrows to Inion; most prominent posterior point on the occipital protuberance of head in the mid-sagittal plane.

Head Breath (HB): The maximum transverse diameter on the head is from euryon to euryon. Euryon is bilaterally paired point that forms the terminus of the line of greatest breadth of the skull. Both measurements were taken with spreading calliper.

All the above measurements were taken by principal Investigator at a fix time between 2 to 5 pm only to eliminate the discrepancies due to diurnal variation. The measurements were taken three times and their mean value was taken as a final measurement. The data were analyzed using regression analysis and correlation coefficient.

Exclusion Criterion: Those with any apparent disease, orthopedic deformity, morphologically showing the congenital malformations, Dwarfism / Achondroplasia, features of nutritional deficiencies and injuries to extremities, using medication thought to alter growth, neuromuscular weakness or abnormal tone or with any other major medical illnesses or growth disturbance were excluded from the study.

Statistical Part: Descriptive statistics like min., max., mean, and standard deviation etc. of stature and head length and breadth of male, female and combined group was done. Association between stature on head length and breadth were positively correlated and it is shown by scatter diagram and checking the significance of correlation between stature and head length and breadth by using correlation t-test. So, on the basis of that we calculated the simple regression equations of stature on head length and breadth and by using regression equation we can predict the stature on the basis of independent variable head length and breadth, as well evaluated the significance at 5% level of significance. The complete statistics was done in MS-Excel.

Results

In our study Mean age of subjects (n=300) was 22.14 with Standard Deviation (SD) of 2.66. The Minimum age of subjects was 18 and maximum age was 27. The Pearson correlation coefficient was used to find the relation between head measurements and height and regression analysis was done. The Statistical analysis was presented in tabular form. As per Table 1 it presents mean, SD, and range in male and female subjects. The Mean height of males was 166.3±5.92 and that of females is 154.9±5.53. Mean Head Length and Head Breath in males are 18.62±0.55, 13.62±0.52 and that in females are 17.77±0.44, 13.22±0.27.

As per Table 2 it shows the correlation between stature with head length and stature with head breadth. The Pearson correlation of stature with head length and head breadth in male is $r = 0.315$, $r = 0.227$ which is significant with p-value is 0.00043, 0.0026 and that in females are $r = 0.276$, 0.148 is significant with p-value is 0.00032, 0.03536 and in combined (Male and Female) $r = 0.619$, $r = 0.431$ is significant with p-value is 0.000001, 0.000001. All correlations are positively associated. From this one can conclude that Pearson’s correlation coefficient is significant for Head Length and Head Breath in both male and female subjects. The equations show the effect of head length on stature and head breadth on stature in male, female and combined group. As per Table 3 it shows the multiple correlations between stature with head length and head breadth

Table 1: Descriptive statistics of stature and head measurement.

Gender	Parameter	Minimum	Maximum	Mean ± SD
Male	Age	18	26	21.9 ± 2.59
	Stature	156	176	166.3 ± 5.92
	Head Length (HL)	17.63	19.49	18.62 ± 0.55
	Head Breadth (HB)	12.3	14.5	13.62 ± 0.52
Female	Age	18	27	22.4 ± 2.73
	Stature	145	163	154.9 ± 5.53
	Head Length (HL)	16.9	18.6	17.77 ± 0.44
	Head Breadth (HB)	12.4	13.8	13.22 ± 0.27
Combined	Age	18	27	22.14 ± 2.66
	Stature	146	176	160.57 ± 8.07
	Head Length (HL)	16.9	19.49	18.2 ± 0.66
	Head Breadth (HB)	12.3	14.5	13.42 ± 0.46

Table 2: Pearson correlation between stature and head length and head breadth.

Gender	Variable	Correlation (r)	t - test	P - Value	Significance
Male	Head Length (HL)	0.315	4.04	0.000043	Highly Significance
	Head Breadth (HB)	0.227	2.84	0.0026	Significance
Female	Head Length (HL)	0.276	3.49	0.00032	Highly Significance
	Head Breadth (HB)	0.148	1.82	0.03536	Significance
Combined	Head Length (HL)	0.619	11.095	0.000001	Highly Significance
	Head Breadth (HB)	0.431	6.724	0.000001	Highly Significance

in male, female and combined is 0.368, 0.279 and 0.647. All are positively correlated and highly significant with p-value is 0.000002, 0.000287 and 0.000001. The equations show the effect of head length and head breadth on stature in male, female and combined group.

Regression analysis

Male Stature (cm) = 103.65 + 3.36 * Head Length

Male Stature (cm) = 131.21 + 2.57 * Head Breadth
 Female Stature (cm) = 93.66 + 3.45 * Head Length
 Female Stature (cm) = 114.34 + 3.07 * Head Breadth
 Stature (cm) = 22.59 + 7.58 * Head Length
 Stature (cm) = 59.01 + 7.57 * Head Breadth

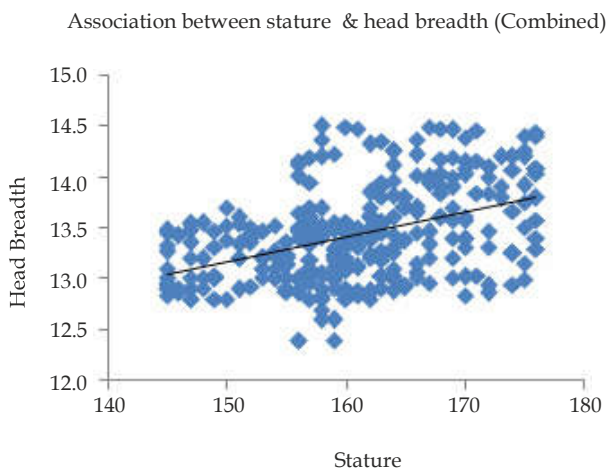
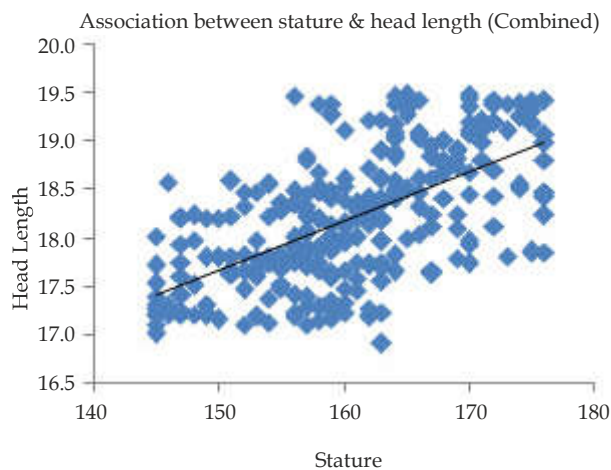
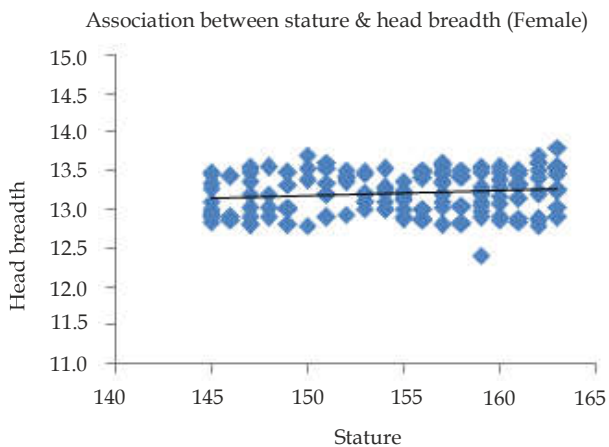
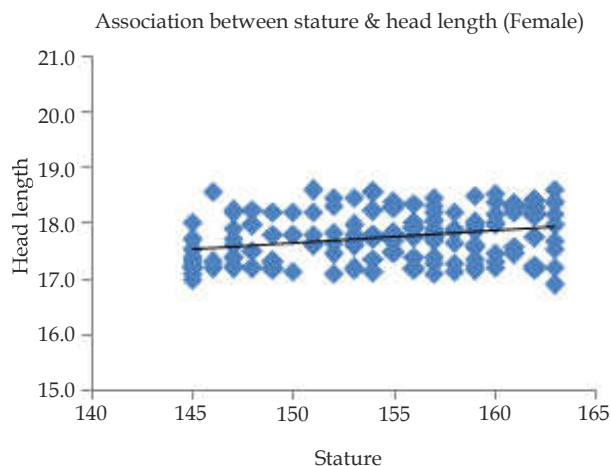
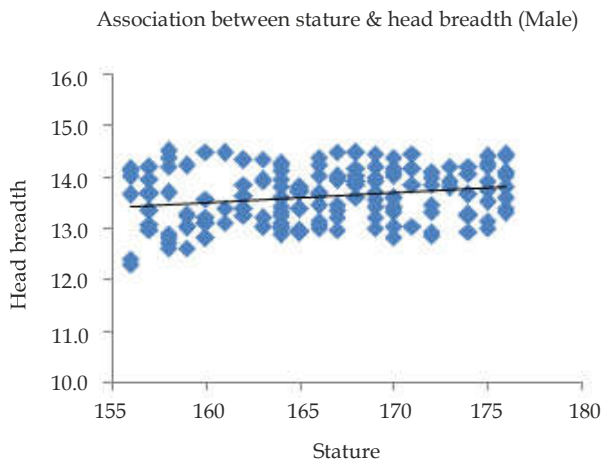
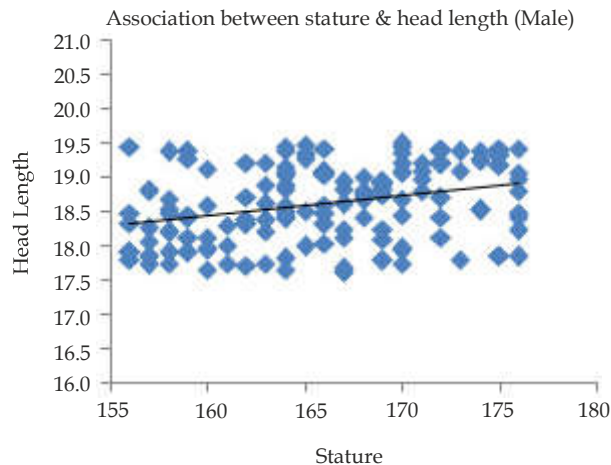


Table 3: Combined effect of head length and breadth on stature.

Gender	Correlation (r)	t - test	P - Value	Significance
Male	0.368	4.794	0.000002	All are highly significance
Female	0.279	3.519	0.000287	
Combined	0.647	14.629	0.000001	

Multiple regression equations:

Male Stature (cm) = 3.1 * Head Length + 2.17 * Head Breadth + 79.02

Female Stature (cm) = 3.22 * Head Length + 0.953 * Head Breadth + 85.12

Combined Stature (cm) = 6.515 * Head Length + 3.643 * Head Breadth - 6.849

Discussion

Present study is a cross sectional study which comprised of 300 young healthy subjects and parameters studied were Stature, Head Length and Head breadth. In our observation when we compared both sexes it was found that values were more for males and it was found that differences were statistically significant. In our observation it clearly reflects that stature can be estimated from Head dimensions by applying regression equation. Positive correlation was found between stature and head length and head breadth in both sexes and was statistically significant.

In present study, mean HL in males and females were 18.62 ± 0.55 and 17.77 ± 0.44 and HB were 13.62 ± 0.52 and 13.22 ± 0.27 respectively. The difference between mean head length and breadth of male and female subjects i.e. gender difference was statistically significant ($p < 0.001$) which coincides with that of previous studies.¹⁸⁻²¹ It was reported in study made by Glaister et. al.²² head length was 1/8th of total height of a person. Similarly Chiba and Terazawa²³ derived a regression equation for height from head length amongst the population of Japanese. He reported the regression equation has standard error of estimate of 7.09 and correlation coefficient of head length with height was 0.39 and for female standard error of estimate of 6.97 and correlation coefficient of head length with height was 0.003. While in our study correlation coefficient of head length with height was 0.315 for males and for female correlation coefficient of head length with height was 0.276.

In Study by Bardale and Dixit²⁴ they reported that in males correlation coefficient for head length

with height as 0.39 with standard error of estimate as 6.08 and In females, for the same they found correlation coefficient of 0.32 with standard error of estimate of 5.67. Similarly it was found in male correlation coefficient of head breadth with height as 0.26 and standard error of estimate for regression formula on head breadth was 6.40, and in females the correlation coefficient of head breadth with height was 0.23 and standard error of estimate was 5.81.

It was Sarangi et. al.²⁵ who reported that no significant correlation exist between stature and skull parameters, correlation coefficient of stature for skull parameters like heal length, head breath and head circumference was found in his study to be insignificant. Over a period of years close relationship between stature and various body segments are reported and the results are frequently used in medico legal investigation. Various studies in which an attempt has been made to establish the correlation between stature and skull dimensions.

Conclusion

In our study there exists a significant and positive correlation between stature and Head length and Head Breadth between both the sexes indicating strong and reliable relationship between the parameters. We conclude that the regression equations presented here can be used to estimate ante-mortem stature, with reasonable accuracy of unknown mutilated or dismembered human remains from Head Length and Head Breadth in medico-legal cases, particularly from Nellore district of State Andhra Pradesh. However the formulae derived cannot be generalized to all population groups, hence it is necessary to derive regression equations which are region wise and population specific. Thus the data of this study are recommended in anthropological studies for stature estimation amongst the ethnic group under study.

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