Original Research Article

Somatometric Estimation of Stature Using Head Length and Height Measurements in Male and Female Youths from a Rural Population in Mangalore

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ABSTRACT

Studies done by earlier researchers have shown the importance of stature in the determination of race, age, and sex especially when disaster strikes. In countries like India which shows diversity not only in culture, religion but also in the physical appearance of Individuals which vary from state to state, makes it important to have age and sex specific stature estimation formulae. There is no study based on Mangalore population. The present study was an attempt to find out the stature of an individual from head length (Glabella to Opisthocranion) and head breadth (Euryon to Euryon) measurements and to derive regression formulae to estimate the height in the rural population (age 18-21 years) in Mangalore. It was found that for every unit increase in head length there was a 1.491 unit increase in stature in females and for every unit increase in head breadth there was 0.972 unit decrease in stature. In the males for every unit increase in head length there was a 3.36 unit increase in stature and for every unit increase in head breadth there was 0.962 unit decrease in stature

Key words: Glabella, Opisthocranion, Euryon, Stature

INTRODUCTION

The height of an individual has always been important in the estimation of stature when seen from the eyes of Forensic expert, an Anthropologist or an Archaeologist. [1] The importance becomes even more evident at the time of Mass disaster's like Earthquake, Flood/Tsunami or air crashes when identifying individuals becomes the most important and difficult task. The knowledge of head dimensions of individuals also helps in determining to which different racial, geographic background they belong to and is specific to that country. [2,3] Studies have shown the need for race, age, and sex specific stature estimation formulae. [4,5] In India not only the language, but also the physical features of individuals like height, skin color vary as we move from one state to another, unlike other countries, the diversity seen in Indian population makes it important to have age and sex specific stature estimation formulae. [6,7] There is no study based on Mangalore population, This study is a step taken to estimate the stature of an individual from a rural population in Mangalore using the head length and head breadth so as to formulate population and gender specific regression equation.

RESEARCH QUESTION

Can the distance between Glabella and Opisthocranion help in estimating the

stature of males and females in a rural population in Mangalore?

OBJECTIVE-
To estimate the stature from head length and head breadth in males and females.

MATERIALS AND METHODS
This study was done as a part of the Post Graduate Diploma in Forensic Anthropology & Odontology (PGDFAO) conducted annually by Forensic Medicine Department of Yenepoya University, Mangalore.

Sample Size-
 167 participants (81 males & 86 females) from the age group of 18-21 years using the formula

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2}{[FZ(\rho_1) - FZ(\rho_0)]^2} + 3$$

$$FZ(\rho_1) = 1/2 \ln\left[\frac{1+\rho_1}{1-\rho_1}\right]$$

$$FZ(\rho_0) = 1/2 \ln\left[\frac{1+\rho_0}{1-\rho_0}\right]$$

$\rho_0 =$ Population Corelation coefficient

$\rho_1 =$ Sample Corelation coefficient

$Z_{1-\alpha/2} =$ Desired confidence level

$1 - \beta =$ Power

Sample correlation Coefficient: 0.93
Population Correlation: 0.9 (Ref 8: Singh R. Estimation of stature and age from head dimensions in Indian population. *Int. J. Morphol., 2013;31(4)*:1185-1190.)
Power : 80%
Level of Significance: 5 % (significance p < 0.05)

METHODOLOGY
The study commenced after getting ethical clearance from Yenepoya University Ethics Committee. The participants in the study were 167 Students between the age group of 18 to 21 from two colleges in Mangalore, selected irrespective of their caste and creed. The students were native of

Bantwal, Belthangady, Kotekar, Harekala Pavoor in Mangalore. The participant information sheet was given to each student and their role in the study was explained to them. All the participants signed the informed consent form and then the data was collected.

INCLUSION CRITERIA-
All the healthy males and females between the age group of 18 - 21 years from rural population in Mangalore.

EXCLUSION CRITERIA-
People suffering from congenital disorders, dwarfs, giants or having any other physical deformation.

First stature was measured in centimeter unit using the stadiometer (from vertex to floor in Frankfurt's horizontal Plane) using all the standard precautionary measures and the reading was recorded (fig 1).
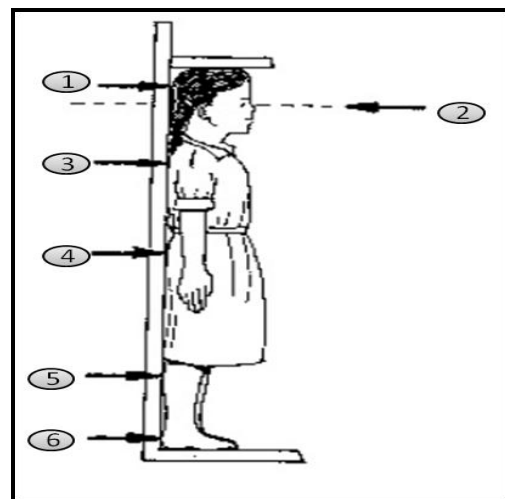

Fig 1: Measurement of stature using stadiometer. 1- Back of the head, 2- FH plane, 3- Shoulder blade, 4- Bottom, 5- Back of the leg and 6- Heel (https://www.slideshare.net/reinaramesh/basic-anthropometry-ppt)

For the measurement of head length (from Glabella to Opisthocranion) and Head breadth (from Euryon to Euryon) spreading caliper (Fig 2, 3 & 4) was used.

Before taking the measurements a straight line was drawn from the tragion to the infra orbital margin using a lip liner on the participant to ensure they are in the Frankfurt's Horizontal Plane. The data collected was then analyzed by mean,

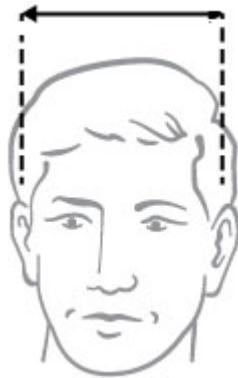standard deviation, Correlation coefficient and by regression analysis.

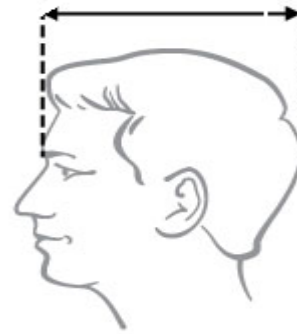Fig 2 Head Breadth Measurement (Euryon to Euryon)

Euryon

Fig 3 Head Length Measurement (Glabella to Opisthocranion)

Glabella

Opisthocranion

Fig 4- Spreading caliper with rounded ends, Researcher taking Head length measurement

Statistical Analysis:
The data collected was analyzed using IBM SPSS 22. Descriptive statistics was reported as Mean (SD) for continuous variables. Simple linear regression analysis was used to to predict stature from Head length and Head breadth for males and females separately.

RESULT
Total numbers of participants were 167, the distribution of male and female is as shown in Fig 5.
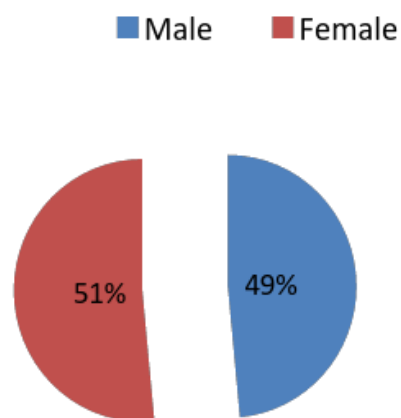

Fig 5: *Pie chart showing gender distribution of participants*

Table no.1 Descriptive statistics in male with respect to stature, head length & head breadth

Descriptive Statistics					
MALE	n	Minimum	Maximum	Mean	Std. Deviation
Stature (in cm)	81	149.0	178.0	163.253	6.8405
Head Length(in cm)	81	13.0	19.5	16.738	1.0694
Head Breadth (in cm)	81	11.0	16.5	13.094	1.1542
Age	81	18.0	23.0	18.901	.9435

Descriptive statistics for stature, head length, head breadth among males and females is shown in Table 1 and 2

The mean height in both the genders was significantly different and head length, head breadth was found to be larger in males compared to females. Correlation coefficient between the stature, head length and head breadth in both the genders was found to be statistically significant.

In males the stature of the participant was in the range of 149-178, mean height is 163.2 with Standard deviation 6.84. The mean head length and head breadth were 19.5, 16.5 with standard deviation 1.0 & 1.1

Regression equation to predict stature in males

Stature = 119.525 + (- 0.962) Head breadth + (3.365) Head length

For every unit increase in head length there is a 3.36 unit increase in stature and for every unit increase in head breadth there is 0.962 unit decrease in stature

Table no. 2 Descriptive statistics in female with respect to stature, head length & head breadth

Descriptive Statistics					
FEMALE	n	Minimum	Maximum	Mean	Std. Deviation
Stature (in cm)	86	142.5	169.5	154.213	5.4543
Head Length(in cm)	86	13.0	17.5	15.669	.9475
Head Breadth (in cm)	86	10.0	13.5	12.109	.7773
Age	86	17.0	21.0	19.163	.8382

In females the stature of the participant was in the range of 142.5 -169.5. The mean height was 154.2 with a standard deviation of 5.4544. The mean head length and head breadth was 15.6, 12.10 with standard deviation 0.9 & 0.77

Regression equation to predict height in Females

Stature = 142.619 + (- 0.972) Head breadth + (1.491) Head length

For every unit increase in head length there is a 1.491 unit increase in stature in females and for every unit increase in head breadth there is 0.972 unit decrease in stature

SCATTER PLOT SHOWING CORRELATION BETWEEN HEAD LENGTH AND STATURE IN MALES

$r = 0.424$; $p \leq 0.001$

SCATTER PLOT SHOWING CORRELATION BETWEEN HEAD LENGTH AND STATURE IN FEMALES
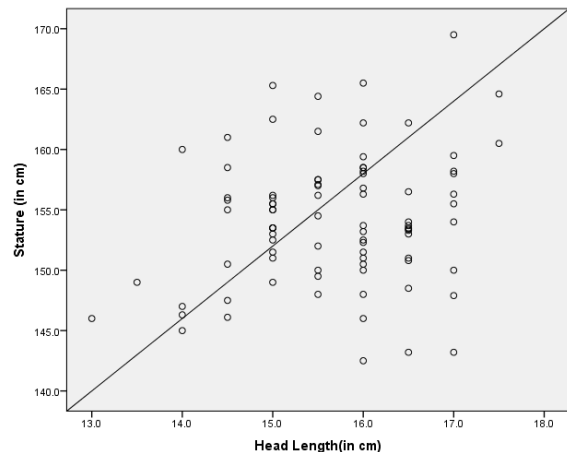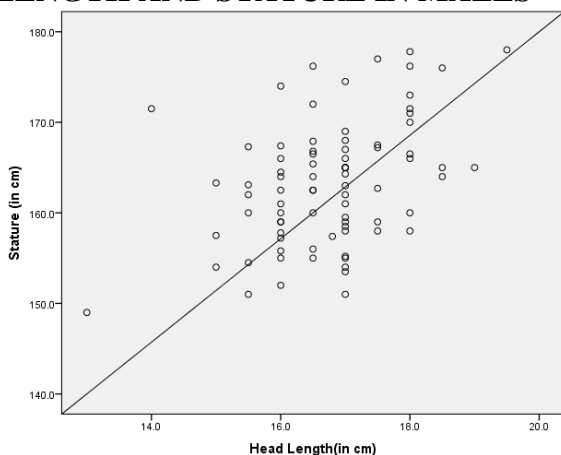

$r = 0.199$ $p = 0.04$

Table no. 3 showing comparison between stature, head length and head breadth in Males and females

GENDER	STATURE			HEAD LENGTH			HEAD BREADTH		
MALES	Mean ± Std Deviation	t	p value	Mean ± Std Deviation	t	p value	Mean ± Std Deviation	t	P value
	163.25 ± 6.84	9.470	0.000	16.73 ±1.069	6.85	0.000	13.09± 1.15	6.46	0.000
FEMALES	154.21 ± 5.45	9.407	0.000	15.66 ± 0.947	6.82	0.000	12.10 ± 0.777	6.39	0.000

$P \leq 0.001$, It is significant in both males and females with respect to stature, head length and head Breadth

DISCUSSION

The biological profile of an individual is of great importance in the field of Anthropology and stature estimation is one of the most relevant parameters in building it. [8] Head length measurement by Kadagoudar (2014) was taken from nasion to inion, [9] Jadhav (2004) had measured from glabella to Inion [6] while in the present study the head length was measured from glabella to opisthocranion as it gives the maximum cranial length (ref Martin & Saller, 1957)). There is no standard method to find the relationship between head length and stature as shown by various studies done by researchers in India and abroad, giving a different regression formula for the selected population showing the need for developing population specific regression formula in a country like India. [10-12]

Only other studies to use the head length measurement from glabella to opisthocranion was done by Kumar (2013) and Wankhede (2015). [13,14]

Anthropologist should take an initiative to develop the regression formulae for population in every state of India which can be used for identification in times of disaster. In the study done by Akhtar et al (2009) and Mansur (2014) only head circumference showed significant positive correlation with stature. [1,2] The range of height seen in this study was (149 - 178) cm in males and (142.5 -169.5) cm in females, head length was in the range of (13- 19.5) cm in males and (13 – 17.5) cm in females and head breadth was from (11 – 16.5) cm in males and (10 – 13.5) cm in females.

Table no 4: Comparison of mean height, mean headlength and head breadth with other studies [3,5,8-10,14,15]

Researcher	SS/Age/SP	MHwith SD	MHLwith SD	MHBwith SD	CC (r)
Singh, R (2013)	208 17-26 yrs UttarPradesh	M - 167±7.8 F- 157±0.6	Gla - Ini M- 17±0.7 F- 16±0.8	Lat.pts on P B M- 13.1±0.6 F- 12.5±0.6	M- 0.74 F- 0.0069
Kumar M (2013)	800 >18 yrs Haryana	---	Gla-OpCr M-18.75±1.38 F- 17.75±0.84	Max BPD M-13.11 ±1.09 F- 12.95±0.83	M-0.17 F – 0.19
Chaurasia (2014)	506 18- 25 yrs Indore	M-170.9±11.3 F-153.3±20.5	Gla-Ini M- 18.4±1.2.7 F- 17.26±0.59	---	M – 0.24 F – 0.17
Kadagoudar (2014)	200 19-28 yrs South Indians	M- 172.44 F- 159.49	Nasi- Ini M– 18.18 F- 16.77	---	M – 0.50 F– 0.44
Agarwal (2014)	800 17-25yrs North Indians	M- 169.4±6.04 F- 156.93±5.05	M- 18.24±0.64 F- 17.34±0.62	M-14.86±0.71 F- 14.13±0.54	M - 0.21 F – 0.34
Prasad A 2014	250 18-28 yrs Maharashtra	M-171.93±5.9 F-165.43±3.0	Gla- Ini M-19.76±1.57 F-18.28±1.13	---	M – 0.26 F- 0.22
Wankhede (2015)	470 18-24 yrs Central Indians	M- 170.9±6.8 F- 156.89±5.8	Glab- OpCr M-18.5±0.72 F-17.53±0.81	Eu– Eu M-14.64±0.63 F- 14.16±0.66	M – 0.27 F- 0.20
Present study (2015)	167 18 – 21 yrs Mangalore	M– 163.2±6.8 F - 154±5.4	Glab- OpCr M- 16.7±1.06 F- 15.6±0.94	Eu – Eu M- 13.09±1.15 F- 12.1±0.77	M – 0.42 F – 0.19

(*SS- Sample size, SP- Study Population, MH – Mean Height, SD- Standardd Deviation, MHL- Mean head length, MHB- Mean head breadth, CC- Correlation coefficient, Glabella-Inion- GI, Lat.pts on P B – Lateral points on parietal bones, Maximum Biparietal diameter- MBPD, Euryon – Euryon- Eu- Eu, Glabella –Opisthocranion – Gla- Op Cr, Nasion – Inion Nasi-Ini, M- Male, F- Female*).

The mean stature in male was 163.25 ± 6.84 and females was 154.21 ± 5.45, mean head length in males was 16.73 ± 1.069 while in females it was 15.66 ± 0.947 and mean head breadth in males was 13.09 ± 1.15 which was more compared to the females mean head breadth 12.10 ± 0.777. The p value was significant for both the genders with respect to stature, head length and head breadth, which is same as a study of North Indian Populations by Agarwal (2014) showing correlation coefficient between stature and head length and head breadth significant (10). In the present study the correlation between stature and head length in males was r = 0.424, p ≤0.001 in males and r = 0.199, p≤ 0.001 in females when compared to studies done by Mansur (2014) which showed the value of r = 0.0443, p< 0.001 in males and r = 0.302, p< 0.001 in females (Nepalese population), [2] by Chaurasia (2014) in Indore correlation coefficient was 0.241 in males and 0.173 in females, [3] a study done by Kumar (2013) in Rajasthan population showed correlation coefficient was 0.941 in males and 0.85 in females. [5] The correlation coefficient in Gujarat population in a study done by Jadhav (2004) was 0.53, [6] Kadagoudar (2014) studied South Indian population and found r = 0.507 in males and 0.440 in females, [9] while in a study done by Agarwal (2014) r = 0.215, p<0.001 in males and r = 0.341, p< 0.001 in females in North Indian Population. [10]

The correlation coefficient of Stature and head length of females (0.19) in the present study is same as the study done by Kumar (2013) in Haryanavi's [13] while it is slightly lower than the study done by Wankhede (2015) which was 0.20. [14] In males the correlation coefficient 0.42 of the present study was lower than the study done by Kadagoudar (2014) which was 0.50 [9] but in the present study head length was measured from glabella to opisthocranion while in the latter it was taken from nasion to inion.

There is a need for conducting research to find gender specific regression equations for the various populations in different states of India. The measurements for stature, head length, head breadth should be taken from standardized landmarks as done by anthropologists. The researcher should be either an anthropologist or one with training in anthropology to do justice to the study.

SUMMARY & CONCLUSION

- Head length measured from Glabella to Opisthocranion showed positive correlation with that of stature in both Males and females.
- The regression equation for Males is 119.525 + (-0.962) Head breadth + (3.365) Head length, For every unit increase in head length there is a 3.36 unit increase in stature and for every unit increase in head breadth there is 0.962 unit decrease in stature
- The regression equation for Females is 142.619 + (-0.972) Head breadth + (1.491) Head length, For every unit increase in head length there is 1.491 unit increase in stature in females and for every unit increase in head breadth there is 0.972 unit decrease in stature.

Limitations
1. Intraobserver error while taking the head length and breadth
2. Reliability of Instruments used for measurement

Suggestions
1. Standard method of measurement should be used by researchers all over the country. For example – Head length Measurement - Nasion to Inion or Glabella to Inion or Glabella to Opisthocranion (present study).
2. The regression equation which is gender, age, population specific should be derived for the diverse population of India.

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