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Research Article

Developing a predictive model for estimation of height of a normal child using head length in south Indian children

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ABSTRACT

Background: Estimation of height from length of head has been done in many races but very few studies have been done using Regression Model in South Indian children. Hence an attempt is made to develop a model based on regression for deriving height from head length in a normal child.
Methods: The present study is conducted on 318 apparently normal children of both sexes attending schools in Ranga reddy District between 8 to 12 yrs of age. Regression is used to derive the predictive model for Height and Head length in both boys and girls. Pearson's correlation has been used to find the degree of relationship between various parameters.
Results: Positive strong relationship exists between Height and Head length with r= 0.733 (P<0.0001). The Regression model equation is derived as Height =11.602 × (Head Length) - 66.309. This model explains that all the variability of the response data around its mean is up to 53.70 % with r square (coefficient of determination) 0.537.
Conclusions: From present study it was concluded that the head length can be used for estimation of height in medico-legal cases and other issues related to identity. As regression equations are known to be population and sex specific, there is a need for similar equations to be derived for other ethnic groups.

Keywords: Predictive model, Regression model, Correlation, Height, Head length

INTRODUCTION

Anthropometry is measurement of human body parts. Anthropometric indices display the status of nutrition both in adults and in children. In children especially, both girls and boys the data comprises of status of health, nutrition and growth considering the time.[1] Many studies have been done in the past to derive a formula for estimation of the stature or height from the head dimensions like head length, head circumference or head breadth.[2] The main aim of such studies was not only to calculate the measurements from one another which can be used in forensic research, surgical repairs, and anthropology but also to detect any deviation from the normal which can be useful in as a guide for clinical treatment.[3]

The estimation of height from various parameters has been done by various workers.[4-10] Each worker has derived his own formula for calculating the stature from long bones, but no universally applicable formula has been derived, as the relationship between height and long bone differs according to ethnicity, race, age, sex & side of the body. It is proved that each ethnicity requires its own model.

Estimation of height from length of head has also attracted many workers to derive a formula.[10] Very few

studies have been done using Regression to derive height from head length in South Indian children. Hence an attempt is made to develop a model based on regression for deriving height from head length in a normal child.

The objective of the study was to develop a model based on regression for deriving height from head length in a normal child in south Indian population.

METHODS

The present study is conducted on 318 apparently normal children of both sexes attending schools in Ranga reddy District between 8 to 12 yrs of age. All schools in Ranga reddy District were enumerated randomly out of which by lottery method 8 schools were selected, 4 private schools, 2 Government schools and 2 Zillaparishad schools.

Materials used

Non elastic measuring tape, spreading calipers, Stadiometer.

Methodology

The child is made to feel comfortable. The Head Length is taken after the child is made to sit on a stool. The child made to stand bare foot in anatomical position on the base board of a Stadiometer. The head is held in Frankfurt's plane, i.e., imaginary horizontal plane passing through the infra orbital margins straight behind through the upper margin of Tragion, i.e., the notch present above the tragus of the ear. The plane corresponds to the visual axis, the eyes looking straight. The spine is held straight, this can be done by applying upward pressure on the child's mastoid processes on either side. Measurement are taken from vertex to floor on the vertical meter rule held against the wall with the help of horizontal head board held on the vertex of the head and noted down to the nearest 0.1 cm. Head length is measured with the help of Spreading calipers from the Glabella to Opisthocranion.

Three hundred and eighteen consenting, apparently normal children of both sexes between the age group 8 to 12 yrs were selected after obtaining permission of the school authorities. A simple questioner was developed with required anthropometric details apart from basic demographic details. The data from questioners is entered into MS Excel 2007 and analysed using SPSS 23.0 Version. The following statistical techniques were used. Regression is used to derive the predictive model for Height and Head length. Pearson's correlation coefficient has been used to find the degree of relationship between total body height and head length. Student t test (Two tailed, independent) has been used to find the significance of study parameters between boys and girls. Student t test (Two tailed) for correlation has been used to find the significance of degree of correlation.

RESULTS

Demographic and anthropometric characteristics of the study population (Table 1 & 2)

In the study total 146 boys (46.89%) and 169 girls (53.14%) were enrolled. Among them 82 students were 8 years age group, 87 students belongs to 9 years age group, 84 students are age 10 years and 65 students are age 11 years. In the study participants 256 students were belonging to nuclear family and remaining 62 students are belonging to joint family. The age ranges from 8 years – 11 years with mean age 9.42 years with 0.06 standard error, head length ranges from 16.4 cm – 18.5 cm with average head length 17.46 ± 0.53, height ranges from 120 cm – 156 cm with average height 136.31 ± 8.38.

Table 1: Demographic characteristics of the study population.

		Number of students	%
Sex	Boys	149	46.86
	Girls	169	53.14
Age	8 years	82	25.78
	9 years	87	27.36
	10 years	84	26.42
	11 years	65	20.44
Type of Family	Joint Family	62	19.5
	Nuclear Family	256	80.5

Mean differences of height, head length and weight in both the sexes (Table 3)

The mean height of boys and girls, head length and weight were compared. The mean height of boys and girls vary significantly at 10% level of significance. Head length is not affected by the gender difference. Weight varies significantly at 10% level of significance.

Table 2: Anthropometric characteristics of the study population.

Parameters	Age (Years)	Head Length (cm)	Height (cm)
Range	8 - 11	16.4 - 18.5	120 - 156
Mean	9.42	17.46	136.31
S.D	1.08	0.53	8.38
S.E	0.06	0.03	0.47

Correlations between age, height and head length (Table 4)

Positive strong relationship exists between Height and Head length with r= 0.733 (P<0.0001). Positive relationship exists between age and height with r = 0.609

(p < 0.001) and positive strong relationship exists between age and head-length with r = 0.861 (P <0.001). Also there existed a strong positive relationship between height and Weight with r = 0.884 (P<0.0001).

Table 3: Mean differences of height, head length and weight in both the sexes.

Parameters	Boys (n = 149) Mean±SD	Girls (n = 169) Mean±SD	t	P Value
Height (cm)	137.26 ± 8.69	135.47 ± 8.04	1.89	0.06
Head Length(cm)	17.44 ± 0.51	17.49 ± 0.55	-0.845	0.399
Weight (kg)	35.16 ± 6.97	33.78 ± 6.88	1.779	0.07

Predictive model for estimating the height, based on head length for all Students (n=318) (Table 5 & Figure 1)

Considering height as the dependent variable and head length is an independent variable we developed a regression equation for considering all the students.

Height =11.602 × (Head Length) - 66.309

The model explains that all the variability of the response data around its mean is up to 53.70 % with r square (coefficient of determination) 0.537. The equation shows that the coefficient for head length is 11.602 with significant p value. The coefficient indicates that for every additional centimeter in head length you can expect height to increase by an average of 11.602 centimeters.

Table 4: Correlations between age, height and head length.

Parameters	Pearson correlation coefficient value	P Value
Height and Head Length	0.733	< 0.001
Age and Height	0.609	< 0.001
Age and Head Length	0.861	< 0.001
Height Vs Weight	0.884	< 0.001

Predictive model for estimating the height based on head length for boys (Table 6 & Figure 2)

Considering that height is the dependent variable and head length is an independent variable we developed a regression equation (n=149).

Height =12.631 × (Head Length) – 82.983

This model explains that all the variability of the response data around its mean is up to 54.30 % with r square (coefficient of determination) 0.543. The equation shows that the coefficient for head length is 12.631 with significant p value. The coefficient indicates that for every additional centimeter in head length you can expect height to increase by an average of 12.631 centimeters.

Table 5: Model parameters for considering all the students.

Term	Coefficient	Std. Error of Coefficient	T	P value
Constant	-66.309	10.587	-6.263	<0.001
Head length	11.602	0.606	19.148	<0.001

Predictive model for estimating the height based on head length for girls (Table 7 & Figure 3)

Considering that height is the dependent variable and head length is an independent variable, we developed a regression equation for considering only girls (n=169).

Height =11.017 × (Head Length) – 57.172

This model explains all the variability of the response data around its mean is up to 56.70 % with r square (coefficient of determination) 0.567. The equation shows that the coefficient for head length is 11.017 with significant p value shown in the table7. The coefficient indicates that for every additional centimeter in head length you can expect height to increase by an average of 11.017 centimeters.

Table 6: Model parameters for only boys.

Term	Coefficient	Std. Error of Coefficient	T	P value
Constant	-82.983	16.681	-4.975	<0.001
Head length	12.631	0.956	13.208	<0.001

Table 7: Model parameters for only girls.

Term	Coefficient	Std. Error of Coefficient	T	P value
Constant	-57.172	13.045	-4.383	<0.001
Head length	11.017	0.746	14.775	<0.001

DISCUSSION

The mean height and weight of boys and girls vary significantly at 10% level of significant.

There are various methods to estimate stature from bones but the earliest and reliable method is by regression analysis.[2] Height estimation by measurements of various long bones, head measurements, hand, foot length etc. has been attempted by several workers with variable degree of success.

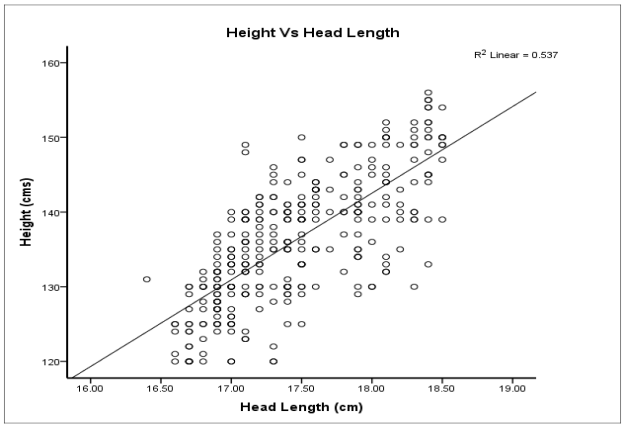

Figure 1: Correlation between Height and Head Length (n=318).

In previous studies done on different populations have shown correlation coefficients between stature and head length as +0.2048, 0.53, 0.62, 0.52, 0.94 (males), 0.85 (females), ranging from 0.343 to 0.447 for females and 0.285 to 0.357 for males & ranged between 0.40 and 0.54 respectively.[11-17]

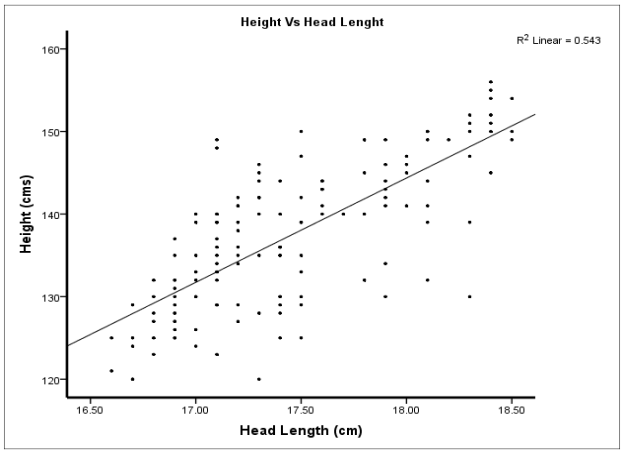

Figure 2: Correlation between height and head length for boys (n=149).

In the present study, correlation coefficient between, Height and Head length found 0.733 (P<0.0001) showing strong positive relationship and between age and head-length found to be 0.861 (P <0.001) showing very strong positive relationship. Thus significant positive correlation coefficient between Head Length and Height is evident in both boys and girls which are in concurrence with the above mentioned studies. Data regarding estimation of stature from head measurements in Indian population is scanty. According to another study head length is 1/8 of the total height of an individual.[18]

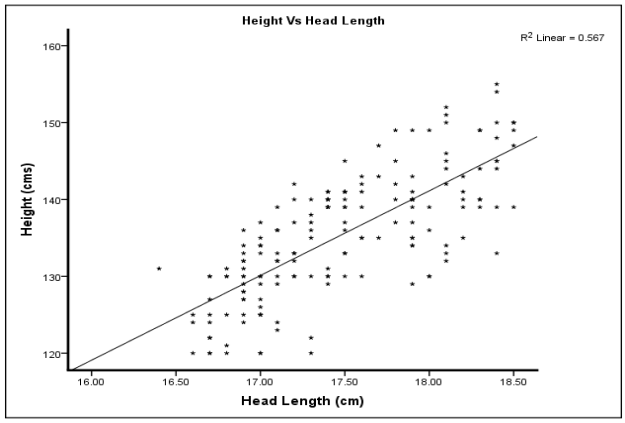

Figure 3: Correlation between height and head length for girls (n=169).

The Regression model shown in Figure 1 (both boys and girls) explains that all the variability of the response data around its mean is up to 53.70 % with r square (coefficient of determination) 0.537.

The Regression model shown in the Figure 2 (boys only) explains that all the variability of the response data around its mean is up to 54.30 % with r square (coefficient of determination) 0.543.

The Regression model shown in the Figure 3 (girls only) explains that all the variability of the response data around its mean is up to 56.70 % with r square (coefficient of determination) 0.567.

Linear regression equations using either head length was found to be helpful in estimating Height. Height and head length were significantly greater (p<0.001) in boys when compared with girls, which is in concurrence with previous studies. This suggests that the formula for one sex cannot be applied to estimate stature for the other sex. These results suggest that both Height and cranial dimensions are sufficiently precise for anthropometric research applications.

CONCLUSION

From present study it may be concluded that the head length measurements can be used for estimation of height in medico-legal cases in the south Indian children as well. The most reliable head measurements to estimate Height using regression analysis among boys and girls is maximum head length. Since regression equations are known to be population and sex specific, there is a need for similar equations to be derived for other ethnic groups. Estimation of stature from cephalofacial measurements is a supplementary approach when useful samples like extremities and other body parts are not available for examination.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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