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Prediction of stature by the measurement of head length and head breadth in Prayagraj Region, Uttar Pradesh

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Abstract
Background: Stature can be expressed as stable proportional relationship with other body part measurements of the human body like hand, feet, head, face and other extremities.
Aims: The present study was conducted in Prayagraj city of Uttar Pradesh to find a correlation between stature and head measurements and to derive the regression formula.
Materials and methods: Among all 508 female samples of Prayagraj were selected. Head length, head breadth and stature were measured.
Results: mean height was 154.95±5.47cm, and mean for head length & head breadth was similarly found 17.81±0.70cm, 13.73±0.81cm. In present study for head length Pearson correlation coefficient (r) was 0.146 with ±5.4 SEE and for head breadth r was 0.094 with ±5.4 SEE which was significant for head length and head breadth in female subjects.
Conclusion: Findings suggested that head measurement gives positive correlation with stature. Both simple linear regression equation and multilinear regression equation were derived to calculate height of unknown individual from head length and head breadth. Multilinear regression model gives better correlation with stature where r=0.74 than simple linear regression model.

Keywords: Head length, head breadth, stature, estimation, regression

Introduction

In forensic anthropology stature estimation is one of the key parameters (identifying age, sex, stature and ancestry or race). It helps in initial but crucial phases of personal identification of unidentified suspected victims from dismembered and mutilated body parts [1]. The stature is the height (from vertex to floor) of a person in standing position, which is varied in different ethnic groups and population [2]. In medico-legal forensic examinations stature is an important and crucial biological parameter. It often happens that that severely decomposed, mutilated bodies or fragmentary remains of skull are brought for medico-legal examination [4]. Anthropometric study of stature and per-cutaneous measurements from different body parts for estimation of stature is a point of interest not only to Anthropologist and Forensic expert but also to Anatomist [5]. Stature or body height is most important parameter to determine the physical identity of an individual. There is a definite and proportional biological relationship between stature and all body parts such as extremities of skull, upper limb and lower limb and for such estimation the best and most reliable method is regression analysis [14]. This relationship helps a forensic scientist to calculate or estimate stature from dismembered and mutilated body parts in forensic examination [15].

There are two basic methods for calculating height from skeletal remains. The mathematical method i.e., also called as regression method based on proportionality between height and the length of long bones and the anatomical method i.e., also called as multiplication method based on the measurements of the whole skeleton, including the spinal column, and adding the dimensions of the soft parts [16].

Due to scarcity of studies [4, 17] on estimation of stature from head measurements in Uttar Pradesh population and its usefulness in medico–legal investigations, the present study was undertaken with an aim to estimate stature from Head length and Head breadth to derive the correlation and regression formulae between them.

Material and Methods

The present study was conducted in Prayagraj city of Uttar Pradesh. Samples of 508 female subjects between age group of 20 year to 45 years from different parts of Prayagraj city were taken. The objectives and methods of study were explained to the sample population and informed consent was obtained. Apparently all healthy and asymptomatic subjects were included in this study. Subjects with any type of physical deformities and /or having systemic illnesses affecting stature and craniofacial measurements, and having age below 20 years and above 45 years, were excluded. The instruments used in the study were stadiometer to measure stature and spreading caliper to measure maximum head length and maximum head breadth. The measurements were taken using anthropometric instruments in centimeters according to methods described by Vallios HV and Singh & Bhasin [18, 19]. Ethical approval to undertake this study was provided by the Institutional Ethics Review Board (IERB) with IERB ID: 2019-132 University of Allahabad, Allahabad (Prayagraj) Uttar Pradesh, India.

Measurement of Stature [18]

Stature (height) is a measure of vertical distance from vertex to floor.

Vertex: Is the highest point on the head in the mid-sagittal plane, when the head is held erectly or in Frankfurt's plane.

Height was measured from vertex to floor by stadiometer with subject standing barefooted, erect on an even floor, in the Frankfurt's plane. The distance was measured from the highest point on the subjects head to the ground.

Frankfurt's plane: The plane passing through the lowest points on the infraorbital margins and the tragion (the notch immediately above the tragus of the ear). This corresponds almost exactly to the plane of visual axis, which is obtained when the subject is looking straight ahead of him.

Measurement of Maximum Head Length [19]
It measures the straight distance between glabella and inion.
Glabella: The most prominent point on the frontal bone above the root of the nose, between the eyebrows.

Inion: It is the most prominent posterior point on the occipital protuberance of head in the mid-sagittal plane. This point is determined where the HL shows maximum reading.

Measurements will be taken using blunt ended spreading caliper.

Measurement of Maximum Head Breadth [19]
With the help of spreading caliper the distance between the most lateral points of the parietal bones were recorded.

Statistical Analysis
The data obtained was analyzed using SPSS 16.0 software as follows: Regression analysis and regression formulae were obtained. Pearson's correlation coefficient, coefficient of determination and standard error of estimate were obtained.

Results
The result shows that the mean age of subjects (N=508) was 26years with standard deviation of ±1.10. Minimum age of subjects was 20. Pearson correlation coefficient was used to find the relation between head measurements and stature and regression analysis was also calculated. Statistical analysis was presented in tubular form.
[Table 1] presents mean, SD and range in sample subjects. Mean height of females was 154.95±5.74cm, mean Head L was 17.81±0.70cm and mean Head B was 13.73±0.81cm.

Table 1: Descriptive statistics of Observed Height and Head Length and Head breadth of females (measurements are in centimeters)

(N= 508)	Mean	±SD	Range (in cm)
Age (in years)	26	1.10	20-40
Stature	154.95	5.47	140.8-169
Head Length	17.81	0.70	14.3-19.8
Head breadth	13.73	0.81	10.4-18.7

From [Table 2] we can conclude that correlation (r) is statistically significant and p <0.001 for head Length and head Breadth.

Table 2: Pearson correlation of Height with Head Length and Head Breadth in Female

Parameters	Pearson correlation (r)	Significance value (p)
Head length	0.146	0.000
Head Breadth	0.094	0.001

[Table 3] shows the regression equation for calculating height from head L and head B.

Table 3: Regression equation for Height with Head Length and Head Breadth

Parameter	Regression equation	Coefficient of determination (r^2)	±SEE
Head length	S=134.643+1.140*HL	0.021	5.4
Head Breadth	S=146.002+.651*HB	0.008	5.4

Table 4: Multilinear regression equation for height with Head Length (HL) and Head Breadth (HB)

Parameter	Regression equation	Coefficient of determination (r^2)	Pearson correlation (r)	±SEE	P Value
HL+HB	S=126.436+1.120*HL+0.624*HB	0.030	0.74	5.3	0.000

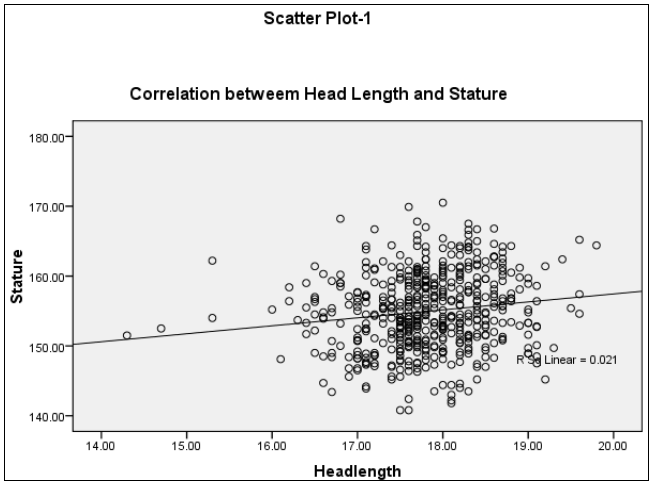

Fig 1: Correlation between Head Length and Stature

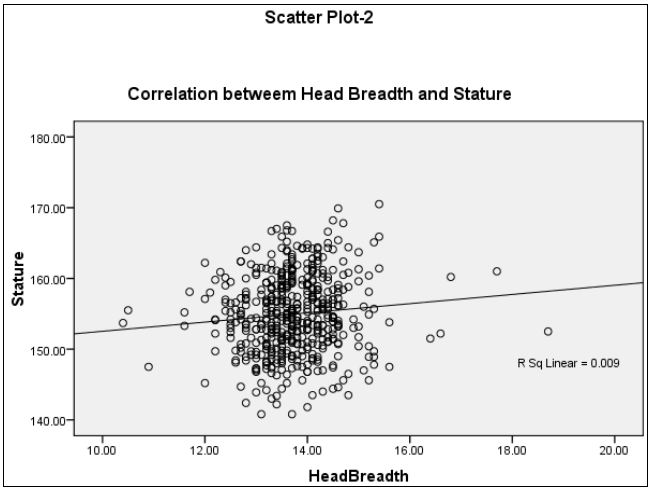

Fig 2: Correlation between head breadth and stature

In Fig1. Scatter Plot first is denoting the correlation between stature and head breadth on the other hand in Fig 2 scatter second is denoting the correlation between stature and head length. Head length is exhibits better correlation with stature.

Discussion

The findings of the current study indicate that stature can be estimated using head or cephalic dimensions through derived regression equations. A statistically significant positive correlation was observed between stature and head measurements. In this study, the mean head length and head breadth were 17.81cm and 13.73cm. Previous research has consistently demonstrated a strong relationship between stature and various body segments, which is frequently utilized in medico-legal investigation. [Table-5] provides evidence of the correlation between stature and head dimensions in different populations [4,12,14,17, 20, 23, 25, 27, 28, 29]. Based on these findings it is apparent that variations in regression equations across populations highlight differences in body structure and proportions. This necessitates the development of population specific regression models for more accurate stature predictions. Factors such as environmental influences, dietary patterns, lifestyle, and genetic makeup also play significant role in shaping the stature of a population.

When comparing head breadth head length, the latter shows a stronger correlation with stature across numerous studies. For instance, a research by the Ahmed AA & Taha S on Sudanese population recorded the highest correlation for both head L (r=0.978) and head breadth (r=0.978) measurements after El- Kelani's study on Bengali population.

In this study from Table 4; in multilinear regression by using both head measurements (HL and HB) we obtained that there is higher correlation (r=0.74) between head measurements and stature than linear regression. Therefore in such conditions where it is possible to take both measurements we can use multilinear regression formula for stature estimation.

Table 5: Showing correlation and linear regression equation of stature with head length and head breadth

Author	Country/Population	Co. Coe. (r HL	Co Coe. (r HB	Regression Eq. (HL	Regression Eq. (HB
Agnihotri S *et al.* [14]	Indo Maurition	0.159	0.193		
Prasad AK *et al.* [27]	Madhya Pradesh	0.259	0.160	S=121.88+2.08*MHL	S=141.04+1.27*MHB
Jehan M *et al.* [17]	Malwa Region, MP	0.516		S=96.31+3.59*MHL	
Agarwal S *et al.* [23]	Western UP	0.341	0.291	S=121.54+2.03*MHL	S=114.88+2.58*MHB
Ilayeruma [12]	Srilankan population	0.312	0.454	S=226.6+86*MHL	S=111.76+3.33*MHB
Ewunonu EO *et al.* [20]	South eastern Region	0.34	0.39	S=102.75+3.4*MHL	S=105.59+4.07*MHB
Wankhede KP *et al.* [4]	Central India	0.206	0.262	S=133.76+1.49HL	S=123.9+2.33HB
Kamal R *et al.* [25]	Kori Population of North India	0.355	0.162	S=112.2+2.20HL	S=168.3+1.33HB
Ahmed AA & Taha S [28]	Sudanese population	0.967	0.978	S=1072.13+2.92*MHL	S=1268.29+2.49*MHB
El-Kelani *et al.* [29]	Bengali population	0.89	0.75	S=67.09+5.17*MHL	S=129.54+2.21*MHB
El-Kelani *et al.* [29]	Egyption population	0.21	0.08	S=117.81+2.59*MHL	S=144.65+1.28*MHB
Present study	Uttar Pradesh, Prayagraj	0.146	0.094	S=134.643+1.140*HL	S=146.002+.651*HB

Limitation

Within different geographical populations body and physical dimensions of those inhabitants also changes over time due to variation in their diet, life style, socio- economic conditions and other biological factors therefore there should be specific regression formulas for different populations with readjustment over time.

Conclusion

Presents study establish that in the absence of long bones or body parts like hand and feet stature estimation is possible by using head length and head breadth (head dimensions). It will help in medico-legal cases in establishing identity of and individual in some cases. According to present study multilinear regression is established better correlation with stature. By comparing of different regression equation from other workers there is variation in regression formula and correlation it may be due to geographical differences & isolation, genetic differences, differences in bio-cultural lineage.

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