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An Estimation of Correlation between the Head length and the Stature of the Children aged between 6-10 Years

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Abstract

The present study was conducted on 100 (50 males & 50 females) school students belonging to Bulandshahr region in Uttar Pradesh, aged between 6-10 years. The objective of this study was to find whether there is any significant correlation between the stature of an individual and the head length (in case of boys and girls of age group 6-10 years). The subjects were selected irrespective of their caste, religion, dietary habits & socio-economic status. Students having significant growth disorders, deformities, bony anomalies were excluded to rule out any gross anomaly in reconstruction of stature. The maximum height observed in case of males was 51.9 cm and minimum height was 43 cm and in females the maximum height was 53 cm and 40.5 cm. These values were used to calculate the multiplication factors, which in turn can result in estimating the stature. The anthropometric measurements were then summarized as mean and standard deviation. Multiplication factors for both males and females were calculated. These multiplication factors were used to estimate stature of the individual. These factors are specific for a particular group of population. Correlation coefficients were calculated for both males and females. A positive correlation coefficient was obtained from these measurements. A positive correlation was observed between head length and height in age group 6 - 10 years with correlation coefficient of +0.16 in males and +0.61 in females.

Keywords: Head length, Stature estimation, Anthropology, Physical Anthropology, height

Introduction

Anthropometric data is a collection of the dimensions of the human body and are useful for apparel sizing, forensics, physical anthropology and ergonomic design of the workplace Stature is one of the most important elements in the identification of an individual. Many different body parts can be used in the estimation of stature. Stature increases during childhood and through puberty, until all bone growth has closed after adulthood is reached. Growth during this period is variable and there is an individually more or less accentuated 'growth spurt'. Before estimating stature, it is therefore necessary first to determine if the individual is an adult from the point of view of skeletal growth. As for ethnic groups, body proportions may vary because of selective adaptation to different kinds of climatic zones characteristic of each group[1].

Stature being one of the criteria of personal identification helps in narrowing down the investigation process, and thus provides useful clues to the investigating agency. Stature has a definite and proportional biological relationship with each and every part of the human body, i.e. head, face, trunk, extremities. This relationship helps a forensic scientist to calculate stature from dismembered and mutilated body parts in forensic examinations. Estimation of stature is an important tool in forensic examination especially in unknown, highly decomposed, fragmentary and mutilated human remains[2]. In such cases while conducting a medico-legal autopsy, forensic pathologist is often asked to opine about the identity of the deceased.

It is a fact that no two persons are ever alike in all their measurable characters. Every person tends to undergo change in varying degrees from birth to death, in health and in disease. Since persons living under different conditions, and members of different ethnic groups and the offspring of unions between them, present interesting differences in bodily form and proportions frequently. Anthropometry constitutes the means of giving quantitative expression to the variations which different individuals or traits exhibit. 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. Physical anthropology, the study of man's behavior in time and space is not only concerned with the origin and the evolution of mankind, but also with the growth and development[3-5].

An individual's stature is a result of both genetic and environmental (including nutrition) factors in a way which is not fully understood. Differences in skeletal body proportions in relation to stature may depend on each of these facts in combination. Stature is not a fixed value for any individual at any age but is influenced by different factors[6,7]. Every individual's stature tends to decrease during the period from

getting up to going to bed. This decrease is due to the elasticity and compression of the inter-vertebral disks and joint cartilages and the load carried by the body during walking upright or sitting. Such a load may be due to the body weight and the actual loads carried or lifted. Extreme reduction of stature as a result of carrying heavy loads have been reported up to some 10 cm in some cases although a decrease of 1-2 cm may be regarded as normal. The time lapse or repeatability of exposure to the load is an important factor in the decrease, as is the period of rest for the body to restore the amount of vertical elasticity.

Another important factor is age, because the elasticity of the inter-vertebral discs and cartilage decrease by age. With increase in age there is general tendency towards stature decrease. The decrease is generally regarded to be approximate 6 mm per decade after the age of 30. When estimating stature, the age factor may be counted for by first calculating the maximum stature attained by the individual and then adjusting for decrease due to age. However stature decrease due to age may not be completely regular and individual variations occur.

For instance, in old age stature decrease may be substantial during a short period of time, owing to changes in posture or gait that may affect some individual more than others. This means that information of stature given in, for example passports, driving license or military records are at most fair approximations of a feature which is not fixed. Sometimes, recorded stature may not even be measured but have been entered on the basis of oral information. Nevertheless, stature or estimates of stature provide important information for identification purposes[8,9,12].

Relation of Anthropometry to the Present Study: Estimation of stature forms important criterion for establishing individuality of a person, so it requires special attention. Stature is one of the various parameters of identification for establishing individuality of the person. 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 upper and lower limbs. 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.

Dimensional relationships between the body segments and the whole body have been of interest to artists, scientists, anatomists, anthropologists and medico legists for long time. Artists use dimensional relationships in depicting the ideals of beauty, and this has resulted in creation of the rules of body proportions. The earliest evidence of the use of such rules comes from the ancient Egyptians. Richer and Hale based on the studies on the estimation of stature from skeletal remains or mutilated limbs, mostly of long bones.

The stature prediction occupies relatively a central position both in the anthropological research and in the identification necessitated by the medical jurisprudence or by the medico-legal experts. Estimation of stature of an individual from the skeletal material or from the mutilated or amputated limbs or parts of limbs has obvious significance in the personal identification in the events of the murders, accidents or natural disasters mainly concerns with the forensic identification analysis.

The significant body segments for estimation of stature are length of foot, hand, hand with forearm, arm, upper extremity, length of head, height of head, distance between sterna notch and pubic symphysis, etc Crown to rump and rump to heel ratio is also a significant dimensional relationship. It is known that body segments exhibit consistent ratios among themselves and relative to the total body height. The ratios between body segments are age, sex and race dependent (Jantz and Jantz, 1999; Williams et al., 2000). Reconstruction of stature from various bones of the human skeleton has been achieved by many scientists with varying degree of accuracy (Krishan, 2007). Establishment of alternative methodologies for personal height estimation is important for a number of reasons

Evidence shows a clear racial variation in the cranial dimensions among different populations such as Koreans, Caucasians, Indians, Turkman and native Fars groups, Turkey, Zulu populations and Mapuche individuals in Chile. Therefore, knowledge on the cranial morphometry 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. The problem of correlating the various metric traits of the skeletal remains with the stature of an individual has confronted scientists for a long time. Although a wide variety of long bones have been employed for stature estimation only few studies have utilized the cranial dimensions in this regard. Cranial dimensions have been shown to be a reliable and precise means in predicting the stature in Italian, Japanese, Indian and South African populations. 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. 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.

Methodology

Objective: The objective of this study is to find whether there is any significant correlation between the stature of an individual and the head length (in case of boys and girls of age group 6-10 years).

Hypothesis: i. Significant correlation may be found between head length and stature of an individual person. ii. Stature of a person may be calculated using head length if there is any significant correlation between head length and stature.

Sample: The present study was conducted on 100 (50 males and 50 females) school students belonging to Bulandshahr region in Uttar Pradesh, aged between 6-10 years. The subjects were selected irrespective of their caste, religion, dietary habits and socio-economic status. Students having significant growth disorders, deformities, bony anomalies were excluded to rule out any gross anomaly in reconstruction of stature. Consent of the head of the school was taken before taking the measurements.

Sample Collection: Data was collected on 21 Feb, 2011 at a fixed time of day between 12:00 - 4:00 p.m. to eliminate the discrepancies due to diurnal variations. Anthropometric measurements of stature and head length were taken of both males and females. Both measurements were taken in centimeters. Head length was measured when the subject was made to sit on a stool. Stature is measurement of vertical distance from vertex to floor.

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. Three measurements were taken to avoid measuring errors. Mean of three measurements were calculated and noted.

Vertex: It is the highest point on the head in mid sagittal plane, when the head is held erectly or in Frankfurt's plane. Height was measured from vertex to floor with subject standing barefooted, erect on an even floor, in the Frankfurt's plane. Subject's head was positioned parallel to the floor with heels together and weight evenly distributed between both feet. The distance was measured from the highest point on the subject's head to ground.

Frankfurt's plane: The plane determined by the lowest points on the infra orbital 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 individual is looking straight in front of him.

Head length is the measurement of the distance between glabella and opisthocranion

Glabella: It is the point on protuberance of lower forehead above nasal root and between the eyebrow ridges intersected by mid-sagittal plane.

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

Sample Analysis: In this study, measurements of height and head length were taken of 100 students aged between 6-10 years. These anthropometric measurements were then summarized as mean and standard deviation. Multiplication factors for both males and females were calculated.

These multiplication factors were used to estimate stature of the individual. These factors are specific for a particular group of population. Correlation coefficients were calculated for both males and females. A positive correlation coefficient was obtained from these measurements.

Observations and Calculations: A study of 100 students was undertaken in order to evaluate to evaluate a correlation of body height with the head length and to estimate the height of an individual using head length.

Table-1
Representing distribution of gender in the subjects

Gender	No. of students	Percentage
Males	50	50.0
Females	50	50.0
Total	100	100.0

Table-2
Representing the age-distribution of the subjects

Age Groups	Males	Females	Total
6	10	12	22
7	23	23	46
8	11	8	19
9	3	3	6
10	3	4	7
Total	**50**	**50**	**100**

Table-3
Representing the maximum height and head length in males and females

Measurements	Males	Females
Head length(in cm) (Max-Min)	12.5 – 15.5	12 – 14.5
Height (in cm)	43 – 51.9	40.5 – 53

The maximum height observed in case of males was 51.9 cm and minimum height was 43 cm and in females the maximum height was 53 cm and 40.5 cm. These values were used to calculate the multiplication factors, which in turn can result in estimating the stature.

Multiplication factor = Height**/** stature
Standard error = standard deviation **/**√ no. of samples.

Table-4
Calculated Values of recorded observations in males

	Height	Head length
Mean value	47.69	13.4
Standard deviation	2.22	0.67
Standard error	0.31	0.94

Table-5
Calculated Values of recorded observations in females

	Height	Head length
Mean value	47.69	13.4
Standard deviation	2.22	0.67
Standard error	0.31	0.94

Table 1 is representing the number of males and females who are chosen for the study. 100 students were selected (50 males and 50 females). Table 2 is representing the age distribution of the subjects. Out of the 100 students selected, 50 boys and 50 girls are categorized on the basis of age group between 6 – 10 years. Variations are observed in height as well as in head length according to difference in age groups.
Table 3 is showing the range of maximum and minimum height and head length in case of males and females. The range of height observed was (43 – 51.9) cm. in males and (40.5 – 53) cm. in females while the range of head length was (12.5 – 15.5) cm. in males and (12 – 14.5) cm. in females.

Table 4 and 5 is representing the mean value, standard deviation and standard errors in males and females respectively. Multiplication factor for males was calculated to be 3.54 and for females, it was calculated to be 3.5

Results and Discussion

The stature of an individual mainly being genetically predetermined is an inherent characteristic, the estimate of which is considered to be an important assessment in the identification of unknown human remains. i. In present study, approximate stature has been estimated from head measurements. ii. In present study, the point opisthocranion was chosen to measure the head length, as it eliminates the human errors of judgment and therefore more accurate. The point inion taken by the other authors is not very suitable for children. Inion is difficult to locate accurately in children and women. iii. The range of height observed was (43 – 51.9) cm. in males and (40.5 – 53) cm. in females while the range of head length was (12.5 – 15.5) cm. in males and (12 – 14.5) cm. in females. iv. A positive correlation was observed between head length and height in age group 6 - 10 years with correlation coefficient of +0.16 in males and +0.61 in females.

Conclusion

In this study, a positive correlation is observed between the height and head length of the students aged between 6 – 10 years. Multiplication factors for males as well as females were calculated which will be useful for the estimation of stature from head length in children.

Stature estimation has been considered as one of the parameters of forensic anthropology and will assist in establishing the biological profile of a person. Stature is natural height of a person in an upright position. The anthropologists and forensic experts have given more importance to the various methods of stature estimation. Stature can be estimated from various parameters like bone length, head length, hand length, foot length etc. This study will provide base line information for the population of U.P. It could lead to the development of a standard for such data on various groups of the population. Some amount of comparison made with the other population could contribute to understanding of the relative status of our population in the context of anthropometric variants around the world.

Bodily proportions and absolute dimensions vary widely with respect to age, sex, within racial groups and between racial groups. In spite of this variation, height has been estimated from measuring various other parameters of the body by refining formulae. The values have become increasingly important in the identification of persons.

Some words of caution should be given when estimating stature or judging the quality of a given method. Humans of the same population vary in body proportions, even individuals are known to have same stature. This means that for every given stature, there are individuals with long trunks and short extremities or short trunks and long extremities, although the proportions are centered on mean population values. In general, the higher the correlation between the measurements and the stature, the more accurate an estimate of the stature may be. There are lot of variations in estimating stature from head length measurement of people of different regions and races. So, there is a need to conduct more studies among people of different regions and ethnicity so that stature estimation becomes more reliable and identity of an individual is easily established.

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