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Stature estimation from head circumference among Bengali adolescents of Darjeeling District, West Bengal, India

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Abstract

Various studies were conducted previously to estimate stature from the lengths of different body parts including head circumference. Present study aims to estimate stature using head circumference among the adolescents (11-17 years). The study was community-based, cross-sectional in nature and the sample size was 404. Data were collected from three different Bengali-medium government schools located in the area of Matigara block, Siliguri sub-division of Darjeeling district (West Bengal, India). Statistical analysis was performed using SPSS, version 26. A significant positive correlation was observed between stature and head circumference (Combined r= 0.579; boys r= 0.636 and girls r= 0.456). Regression equations were derived in order to estimate the stature from head circumference. This study concluded that there is high positive correlation between stature and head circumference among the boys in comparison to the girls. The equations obtained can be used to estimate the stature from head circumference in Bengali adolescents of the studied region.

Keywords: Stature, Head circumference, Bengali adolescents, Correlation, Darjeeling.

Introduction

The stature or body height of an individual is a combination of the lengths of bones and appendages of the body, and it is one of the most important parameters to determine one's physical identity[1]. Height or stature also has a definite and proportional relationship with other body parts, which is also age, sex, and race-dependent[1,2]. To estimate stature, skeletal remains or long bones of decayed, incomplete, and crippled human bodies have been used[3,4] by forensic experts to establish the identity of a deceased person[5]. Stature can be estimated in a living person and from the skeletal segments long after the individual's death[6]. Various factors such as genetics, environment, or nutrition[1,7] influence the height of an individual. Variation can be observed depending on race or ethnicity[8]. Due to such variability, approaches to studying human growth and development have evolved that reflect the nutritional, genetic, and disease patterns of an individual and can also be used in calculating body surface area and assessment of pulmonary function in children[6,9]. Hence, age, sex, and ethnicity-specific regional studies worldwide are necessary. There is no universally applicable formula for estimating stature from different body parts as it varies depending on age, sex, race, ethnicity, and physical environment. In such situations, the multiplication method and regression analysis are used frequently, and regression analysis provides near accuracy in estimation in comparison to the first one[5,10].

Different studies on stature estimation among adolescents were reported by Indian as well as foreign researchers using different body parts such as index and ring finger length[11], growing foot[12], hand dimensions[13], lower limb dimensions[14], upper arm length[15], head length[16], finger and phalange lengths[17], tibial length[18], sitting height[19] or from arm span, arm length[20]. Studies related to stature estimation were mainly conducted among adults in comparison to adolescents due to the ongoing growth process and growth spurts[11]. Some mentionable studies conducted by different Indian researchers concerning stature estimation from head circumference were among young adolescents and adults (above 18 years)[1,4,5,21-23]. From the literature review, it has been found that very few studies have been conducted among Indian adolescents to estimate stature from head circumference[24] and the studies related to West Bengal was hardly found. So, the present study aims to estimate stature from head circumference among the Bengali adolescents of Darjeeling district, West Bengal, India.

Materials and Methods

Area and Participants: The study was conducted among the school-going Bengali adolescents residing in the area under Matigara block of Darjeeling district, West Bengal (India). Data were collected from three different Bengali medium government schools of that mentioned area. Prior to data collection consent was taken from the authorities of the schools as well as verbal consent also taken from the participants and one of their parents (whenever possible). The nature of the study was cross-sectional and community based. Apparently healthy individuals (without any physical deformities and illness) under the age of 10-17 years were selected using stratified random sampling methods. But, because the number of boys under 10 years were too less (only six), so all the individuals (both boys and girls) of 10

years were excluded, thus the individuals of 11-17 years were considered for this study. The final sample size was 404 (194 boys and 210 girls).

Anthropometric Measurements Recorded: Two anthropometric measurements (height and head circumference) were recorded. Stature (Height) was measured vertically in middle from heel to vertex with an anthrop meter rod (near 0.1 cm) when the individual was in erect position with bare foot. Head circumference (HC) was measured from the glabella to the area near top of occipital bone with a non-elastic measuring tape (near 0.1cm), following the standard method of Lohman et al.[25]. The study was conducted in accordance with the ethical guidelines of human experiments as laid down in the Helsinki Declaration of 2000[26].

Statistical Analysis: All the statistical analyses were performed using SPSS (v.26). Mean, t- test, Pearson's correlation and regression analysis were done. A p value <0.05 and 0.01 were considered statistically significant.

Results and Discussion

Table-1 shows the descriptive statistics of the mean and standard deviation (SD) of stature (HT) and head circumference (HC) of the studied adolescents. The total mean age (±SD) was 14.027±2.003 years and for boys the mean was 13.988±2.002 years and girls was 14.062±2.009 years. The mean (±SD) statures (combined, boys, girls) were 152.585±9.541cm, 156.058±11.067cm and 149.377±6.395cm respectively. The range of stature varies from 124.2-184.0 cm in total population and same for the boys, while in girls the ranged found to be varied from 125.0-164.5cm. The mean (±SD) of head circumference in combination was found to be 52.980±2.135cm with a range 48.2-59.9cm (same for boys). Among the boys the mean (±SD) of HC was 53.430±2.157cm and in girls it was 52.563±2.031cm with a range 48.2-59.6cm. To estimate the relationship between stature and head circumference Pearson's correlation was performed (Table-1). A significant positive correlation for combined (r= 0.579), for boys (r= 0.636) and for girls (0.456) were obtained.

The linear regression analysis (Table-1) was performed to obtain the regression equations for the estimation of stature among the studied population. The regression equations by following the model Y= a+bx (where, Y=stature, a= constant, b= regression coefficient and x= HC) are as follows:
For combined, Stature= 15.546+2.587*HC
For boys, Stature = -18.214+2.587*HC
For girls, Stature= 74.012+1.434*HC

The estimated and measured stature was compared in Table-2. The differences between the estimated and measured stature (combined, boys and girls) found to be non-significant, that indicates stature can be predicted nearly accurately from head circumference among the population (adolescents) by using those equations. Figure-1, 2, and 3 shows the scatter diagram and regression lines for boys, girls and combines respectively which explains linear relation between stature (height) and head circumference.

Table-1: Descriptive statistics of mean and standard deviation (SD) of age, stature (HT), and head circumference (HC) among the adolescents.

Variables	Combined (boys & girls) N= 404		Boys N= 194		Girls N=210	
	Measured Stature (HT) (cm)	HC (cm)	Measured Stature (HT) (cm)	HC (cm)	Measured Stature (HT) (cm)	HC (cm)
Mean (±SD)	152.585±9.541	52.980±2.135	156.058±11.067	53.430±2.157	149.377±6.395	52.563±2.031
Range	124.2-184.0	48.2-59.9	124.4-184.0	48.2-59.9	125.0-164.5	48.2-59.6
Correlation (r)	0.579**		0.636**		0.456**	
Constant [of regression equation (a)]	15.546		-18.214		74.012	
Regression coefficient (b)	2.587		3.262		1.434	

**significant at p<0.01.

Table-2: Comparison of estimated and measured stature using t-test among the adolescents.

Variables	Estimated Stature (cm) (using regression equation)			Significance of difference between the estimated and measured stature (at $p<0.05,0.01$)
	Mean	SD	Range	
Combined	152.604	5.523	140.24-170.51	0.972 (not significant)
Boys	156.076	7.039	139.01-177.18	0.985 (not significant)
Girls	149.387	2.913	143.13-159.48	0.982 (not significant)

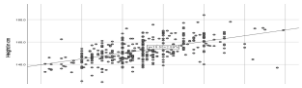

Figure-1: Scatter diagram to show the correlation between height (stature) and head circumference in adolescents (combined).

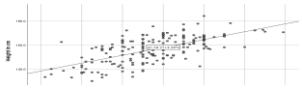

Figure-2: Scatter diagram to show the correlation between height (stature) and head circumference in boys.

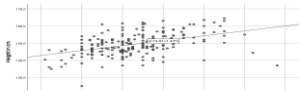

Figure-3: Scatter diagram to show the correlation between height (stature) and head circumference in girls.

Discussion: Present study found that the boys were taller than the girls, and the mean head circumference was higher in boys. The study also found a significant correlation between head circumference and stature. From regression equation, a statistical significance between head circumference and height was also observed. Table-3 shows the comparison of studies done by different Indian and Foreign researchers to find the correlation between stature and head circumference of individual. Mostly the studies were conducted among young adults. Shah et al. reported a significant positive correlation between head circumference and stature among the young adults (male 0.380; female 0.260)[1]; whereas, Manasa and Jayashree, found a total correlation 0.34 which was also positively significant[8]. Some other authors also found positive significant relationship between these two parameters[4-5,27]. According to their findings the correlation among males was0.367, 0.48, and 0.542 while in females 0.255, 0.332, and 0.43 respectively. It was evident from the previous studies that the value of correlation coefficient (r) is less in females. Similar observation was reported by the present study, where the correlation in boys was 0.636 and in girls 0.456 shows a positive significance with stature. There was also a positive significance between height and head circumference among the Nepali population (Male 0.443; Female 0.302)[28]. But, a study conducted by Lukpata et al. among the adolescent population reported a significant positive correlation only among boys but there was no significant correlation between head circumference and stature among girls[2].

Krishnan and Kumar reported a very strong correlation (0.773) between head circumference and stature among the Koli male adolescents[24]. Agnihotri et al. reported that head circumference was one of the best predictors out of the 14 cephalo-facial parameters for stature among both males and females[29]. According to the previous research findings the correlation coefficient (r) values are categorized as 0<0.3 as weak or no relationship; +0.30-0.39 as moderate; +0.40-0.69 as strong positive and +0.70-higher as very strong positive relationship[22]. So, based on this classification the previous studies had (Table-3) weak to moderate relationship between stature and head circumference in case of male, whereas, present study showed a strong positive relationship for both the sexes. Present study also has some limitations such as, the age limit. Only 11 to 17 years age group was considered for the study. Secondly, the adolescents selected were apparently healthy so there is possibility that the unhealthy population of the studied age group may not fit in the equation.

Table-3: Comparison of mean (±SD) Height (stature) and head circumference (HC) and their correlation with Indian and International studies with the present study.

Study Area	References	Age-group (Sample size)	Gender	Height Mean±SD	Head Circumference Mean ± SD	Correlation
Indian Studies	1	18-22 yrs 150	M	175.947±5.917	55.629±1.626	0.380 (Significant)
			F	161.114±5.620	53.883±1.316	0.260 (Significant)
	8	18-25 yrs 200	-	-	-	0.34 (significant)
	27	18-22 yrs 200	M	172±0.54	55.35±0.15	0.542 (Significant)
			F	157±0.49	54.33±0.15	0.332 (Significant)
	5	18-25 yrs 251	M	170.45±5.83	56.29±1.47	0.367 (Significant)
			F	158.08±6.05	54.88±1.39	0.255 (Significant)
	4	18-20 yrs 70	M	173.54±3.81	55.23±2.33	0.48 (Significant)
			F	158.62±4.12	54.26±2.45	0.43 (Significant)
	Present Study	11-17 yrs 404	M	156.058±11.067	53.430±2.157	0.636 (Significant)
			F	149.377±6.395	52.563±2.031	0.456 (Significant)
International Studies	28	17-22 yrs 440	M	165.66±8.344	54.96±2.13	0.443 (significant)
			F	156.70±6.161	54.44±2.028	0.302 (significant)
	2	13-19 yrs 300	M	157.30±6.81	55.38±1.55	0.3857 (Significant)
			F	155.70±5.71	54.62±1.52	0.0068 (Non-significant)

Conclusion

To the best of our knowledge, no study has been carried out among the adolescents of Darjeeling area to estimate stature from head circumference. This study will be helpful to understand the relation between stature and head circumference of the Bengali adolescents of Darjeeling district. The equation estimated from regression analysis will help to estimate nearly accurate stature from head circumference. Also present study will be helpful for medico-legal cases in establishing identity of an individual and to the anatomist and anthropologists. This study concluded that the boys had higher positive correlation between stature and head circumference in comparison to the girls. There was no statistical significant mean difference between the measured and estimated height. More studies should be conducted based on age, sex, race or ethnicity to understand the nature of relationship between head circumference and stature of adolescents.

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