



Height prediction from external ear morphometry; a pilot study

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Abstract:

Background: Anthropometry for several decades has been proved to be useful tool for determination of height and other parameters of individual. The study was designed to determine the level of correlation between ear length, width and index for both left and right side of the body. The regression model was provided for prediction of height from ear dimension. The level of accuracy was also determined for each ear dimension. **Methods:** A total of 219 subjects consisting of 137 males and 82 females were recruited among university students for the study. The height was measured using stadiometer and dimensions (length and width) were taken using transparent graduated ruler. The Pearson correlation and linear regression model were used to establish the relationship and formula for prediction between variables. The percentage accuracy of each formula was calculated as the actual height /predicted height $\times 100$. The data was analysed using SPSS version 16 and $P < 0.05$ was considered as level of significance. **Results:** The result shows higher correlation with height in right ear width ($r= 0.346$, $p=0.000$) and the least was found in length of ear index ($r= 0.090$, $p>0.05$). A linear equation model for prediction of height from given ear dimension was generated. **Conclusion:** The present study reveals the potential of ear morphometry as an additional tool in the prediction of height form linear ear dimension. The formula favors the female subject more than the male counterpart.

Key words: :- External ear, Hausas, Height, morphometry, Nigeria.

Introduction:

Anthropometry for several decades has been proved to be useful tool for determination of height of individual. Height anthropometry is one of the important tool for growth and nutrition evaluation [1-3], calculation of medication dose [4], glomerular filtration [4-5], and predicting normal ranges of pulmonary function tests [6-9]. The need for height prediction can be seen in people whose height is difficult to measure including those with cerebral palsy, neuromuscular disorders, spinal deformity, and lower limb amputation or deformity [10-12].

The variables commonly reported for estimation of height includes arm span [13-15], segmental bone length [16], ulna length [17], knee height [18] hand and foot dimension [19], but there is scanty of data in the utilization of external ear anthropometry for estimation of the height of individuals. The accuracy of medical assessment most a times depends on the height of the individual

The aim of the study was to determine the level of correlation between ear length, width and index for both right and left side of the body. The regression model was provided for prediction of height from ear dimensions.

Materials and Methods

A total of 219 subjects consisting of 137 males and 82 females were recruited among Bayero university students. A written informed consent was sought from the participant. Any participant with physical deformity in the external ear form and lower limbs was excluded from the study.

The ear length was considered as the distance from the caudal most projection of the lobule to the cephalic most projection of the helix. Ear width was considered as distance between the most anterior and posterior point of the external ear. Ear index was calculated as ear width/ ear length $\times 100$. The length and width anthropometry were taken by transparent graduated ruler using repeat measurement by

investigators and the average value was recorded as the actual measurement.

The height was measured using stadiometer with movable horizontal bar which was adjusted to touch the vertex of the participant's head.

The data were expressed as mean ± standard deviation. The Pearson correlation was used to establish the relationship between height and ear variables. The linear regression model was used to provide the formulae for prediction of height from given ear dimensions. The data was analysed using SPSS version 20 and P < 0.05 was considered as level of significance.

Results

Table 1 reveals the general nature of the study population with mean age of 20.41± 2.94 in the all variables. Right side of the body shows higher mean values and the higher value of standard deviations were also obtained in the right side of the body than the left

Table 1: General characteristic of the study population (n =219)

Variables	Mean	SEM	SD	Range	Min	Max	Variance
Age	20.41	0.19	2.94	24.00	16.00	40.00	08.67
REL	60.31	0.27	3.93	20.00	50.00	70.00	15.47
LEL	59.95	0.25	3.66	20.00	50.00	70.00	13.37
REW	30.46	0.17	2.52	15.00	23.00	38.00	06.36
LEW	29.54	0.16	2.33	12.00	24.00	36.00	05.41
REI	50.59	0.27	3.94	23.79	40.00	63.79	15.55
LIE	49.36	0.25	3.69	24.04	37.50	61.54	13.60

REL; Right ear length, LEL; Left ear length, RWL; Right ear width, LWL; Left ear width, REI; Right ear index, LEI; Left ear index, SEM; standard error of mean, SD; standard deviation

A higher correlation is observed in the right ear width (r = 0.35) and the least was found in left ear index (r = 0.09). The correlation is statistically significant (P< 0.001) in all the variables with exception of REI (p< 0.065) and LEI (p< 0.185) (Table 2).

Table 2: Correlation of the variable of the ear dimension with height

	REL	LEL	REW	LEW	REI	LEI
Height	0.29*	0.28*	0.35*	0.30*	0.13	0.09
P Value	0.000	0.000	0.000	0.000	0.065	0.183

**. Correlation is significant at the 0.01 level (2-tailed).

A regression formulae for estimation of the height for six ear variables is shown in Table 3

Table 3: Regression model of height prediction from ear dimensions

Equations	Adj. R ²	S.E.E	t	P
HT= 0.006(REL) + 1.264	0.082	0.081	15.081	<0.001
HT= 0.006(LEL) + 1.257	0.074	0.081	18.370	<0.001
HT= 0.012(REW) + 1.291	0.116	0.079	19.900	<0.001
HT= 0.011(LEW) + 1.332	0.086	0.080	19.074	<0.001
HT= 0.003(REI) + 1.508	0.011	0.084	20.698	<0.001
HT= 0.002(LEI) + 1.541	0.004	0.084	20.205	<0.001

Figure 1-6 show the scatter plot of relationship of height and the six variables considered in the study

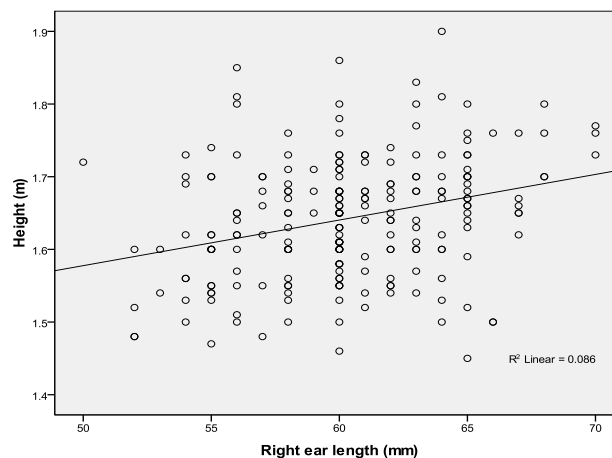


Figure 1: Correlation between height and right ear length

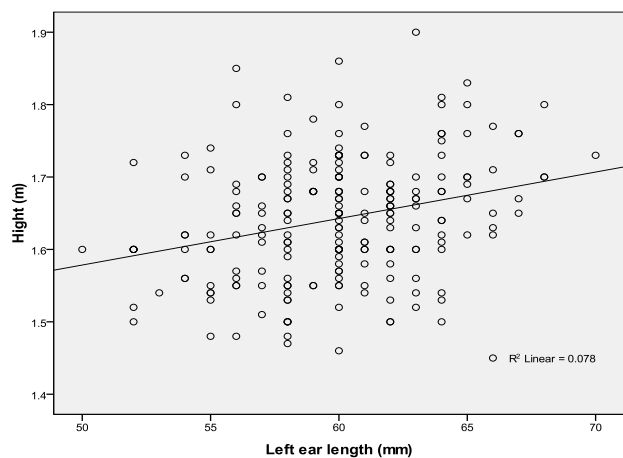


Figure 2: Correlation between height and left ear length

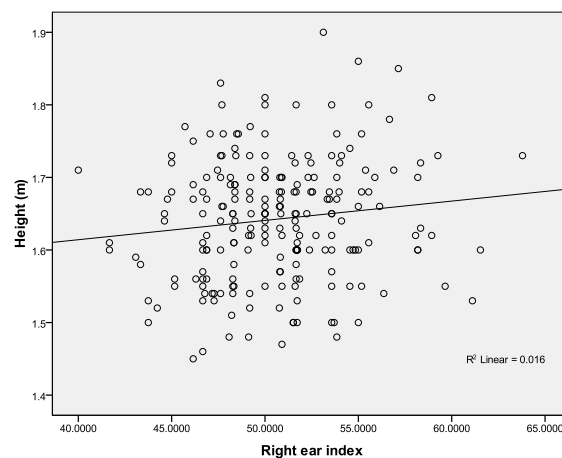


Figure 5: Correlation between height and right ear index

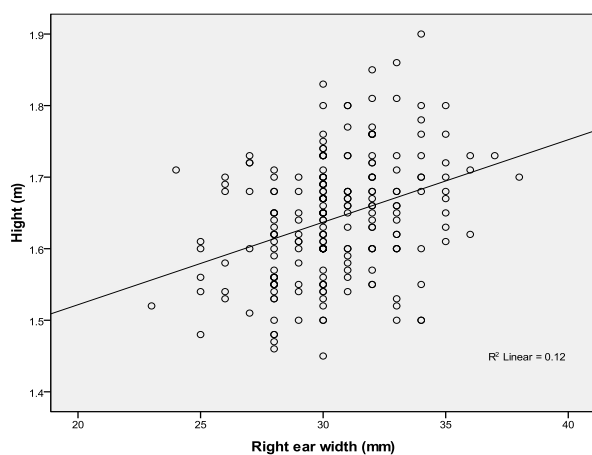


Figure 3: Correlation between height and right ear width

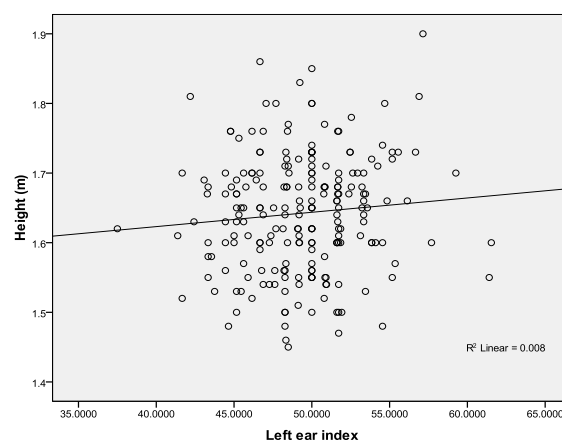


Figure 6: Correlation between height and left ear index

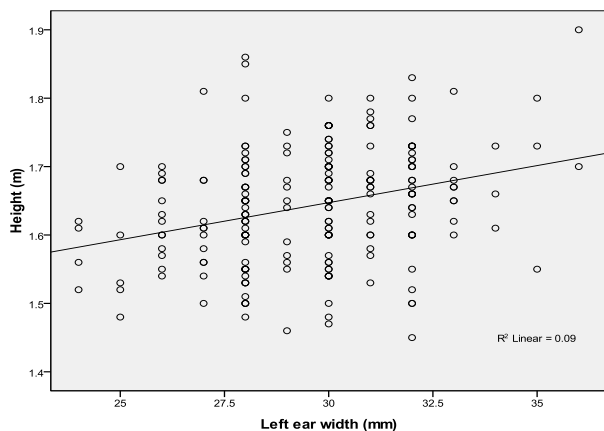


Figure 4: Correlation between height and left ear width

Discussion

Ear morphometry studies have been significantly utilized for several purposes like plastic surgery [20, 21], designing of ear related products [22], and determination of racial variation [23] among others. The utilization of ear anthropometry in correlation with height is limited in the literature. The present study found statistically significant correlation between height and the following ear variables; REL ($r=0.29, p<0.001$), LEL ($r=0.28, p<0.001$), REW ($0.35, p<0.001$), LEW ($0.30, p<0.001$). But no significant correlation was observed with ear indices of both sides.

There is also scanty of data on the use of external ear anthropometry for estimation of the height of individuals and accuracy of medical assessment mostly depends on the height of the individual. The present study demonstrated the use of linear ear dimensions in the prediction of the height by generating a linear equation model for prediction of height from given ear dimensions. This is in agreement

with several workers who use different variables to predict the height of an individual. For instance, Cheng et al. [16] used segmental bone length to estimate the height of individuals. The arm span was also used for height prediction [13-15, 24]. Other variables used include ulna length [17], knee height [18], hand and foot dimension [19, 25]. Among the six variables considered in the study right ear width is the best predictor of the height. It is also important to know that the generated formula is for Hausa ethnic groups. Therefore, the benefit associated with knowing the height of an individual is a situation where the standing position is not possible can be extended to our local community.

In conclusion, the present study reveals the potential of ear morphometry as an additional tool in the prediction of height from linear ear dimension using simple and invasive techniques. It's therefore the aim of the further study to provide different formula for different sex with large population size in Hausa ethnic groups.

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