Determination of stature from combined maxillary anterior teeth and head dimensions among the Efik and Ibibio of South-South Nigeria

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ABSTRACT

Background: Studies on human identification by stature from combined width of maxillary anterior teeth and head dimensions have been carried out for forensic reasons. **Materials and Methods:** Body height, head circumference, head length, and width were measured in centimeter. Mesiodistal crown widths of central and lateral incisors, as well as canines of both sides, were also measured in centimeter. **Statistical Analysis:** Statistical analysis was carried using descriptive statistics, *t*-test, linear multiple regression analyses where $P \leq 0.05$ was considered statistically significant. **Results:** In general, body height, head dimensions, and combined width of maxillary anterior teeth showed males had significantly higher values than females ($P < 0.05$). In the majority of data studied, the correlations between stature and head dimensions; stature and combined teeth dimension were statistically significant ($P < 0.05$). Coefficients of correlation were very low and reliability of the models were on the low side in the majority of the data studied. **Conclusion:** Based on the poor reliability of the models, these parameters can be employed only as supportive tools in stature estimation using regression analyses.

Key words: Forensic anthropology, head dimensions, maxillary anterior teeth, stature estimation

INTRODUCTION

Forensic anthropology involves estimating a biological profile in situations in which autopsy could not be performed on skeletonized and soft tissue remains.[1] It also entails "personal identification, trauma analysis, taphonomic analysis, estimating the postmortem interval, investigation of mass disasters and violation of international law as well as analysis of recently deceased individuals and investigation involving the living."[1]

Studies on human identification by stature from head dimensions abound,[2-13] but those involving teeth dimensions are scarce.[14-17] Among these, some have noted that cranial dimensions could be used to determine stature[2,10] while some others have reported the contrary.[3,18] On height versus teeth dimensions, Kalia *et al*.[14] observed a significant correlation between body height and combined mesiodistal width of maxillary anterior teeth (CACW), though the coefficient was poor. Khangura *et al*.[15] noted that combined width of maxillary anterior teeth could not be used to determine stature. Gupta *et al*.[16] reported that "combined mesiodistal width of maxillary anterior teeth had no significant contribution to height estimation." Yadav *et al*.[17] posited that "tooth dimensions could be used only as a supplementary approach for the estimation of stature but with caution."

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Bones and indeed teeth are the most highly durable of all human tissues, withstanding bacterial and taphonomic degradations long after others have decayed. In spite of studies, utilizing head dimensions for determination of stature in various ethnic groups in Nigeria, no study has combined head and teeth dimensions for this purpose in this part of the world. The purpose of this study was to carry out stature estimation from the head circumference, length, and width, as well as combined crown width of maxillary anterior teeth in young adults of the Efik and Ibibio people of South-South Nigerian. This study will provide a necessary clue in the human identification process, especially in the situation of natural disasters, auto, and air crashes, as well as in genocide.

MATERIALS AND METHODS

This is a part of a serialized study.[19] This descriptive study comprised young adults, 18–30 years, of Efik and Ibibio. The population came from membership of the respective registered ethnic associations in the six sampled universities; one from each state of the zone. Four hundred and ten subjects: Efik (males = 108, females = 94) and Ibibio (males = 106, females = 102) were recruited for the study [Figure 1], based on the proportional stratified sampling technique. Subjects were apparently healthy with no evidence of head trauma, endocrinal, metabolic, or developmental disorders; and parents from the same ethnic group for up to two generations.

- Stature was measured as the vertical distance from the vertex of the head to the floor with the subject barefooted using the anthropometer calibrated in centimeter
- Head circumference was measured as maximal fronto-occipital circumference using the nonelastic tailor tape calibrated in centimeter just on the occipital prominence and the supraorbital ridges[14,20] [Figure 2]
- Head length: Maximum linear distance between glabella and the opisthocranion using the spreading caliper (ORION, Japan)[21] [Figure 3]
- Head width: "Maximum biparietal diameter, the distance between the most lateral points of the parietal bones" using the spreading caliper (ORION, Japan) [Figure 4]
- For teeth measurements, the greatest mesiodistal crown width of six maxillary anterior permanent teeth including central incisor, lateral incisor, and canine of both sides were measured in millimeter directly on the subjects between anatomic contact points of each tooth using a divider with fixing devices [Figures 5 and 6]. This is based on standard practice.[14,22] The sum of all six mesiodistal crown widths is the combined maxillary anterior crown width [Figure 6].

Descriptive statistics, *t*-test (to compare mean between genders) and linear regression analysis of height to head circumference, length, and width were conducted. Moreover, multiple regression of height to all head and teeth dimensions was carried out with SPSS 20 (Armonk, New York). $P \leq 0.05$ was considered statistically significant.

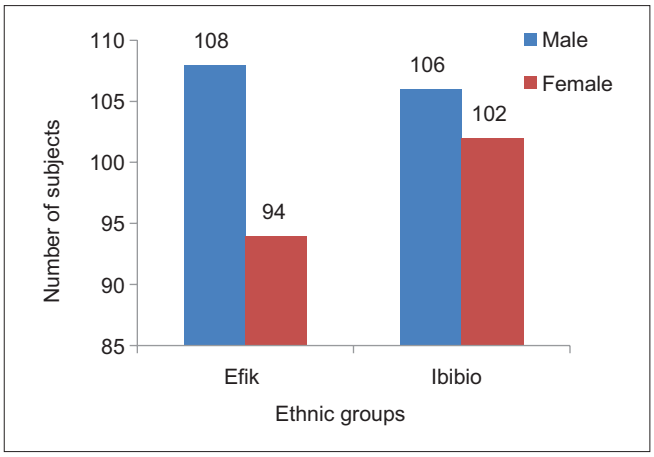

Figure 1: Distribution of study subjects by gender

Figure 2: Measurement of head circumference

Figure 3: Measurement of head length

Informed consent was obtained from subjects, in accordance with World Medical Association Declaration of Helsinki.[23] In addition, the Research Ethics Committee of the College of Health Sciences also approved the research methods.

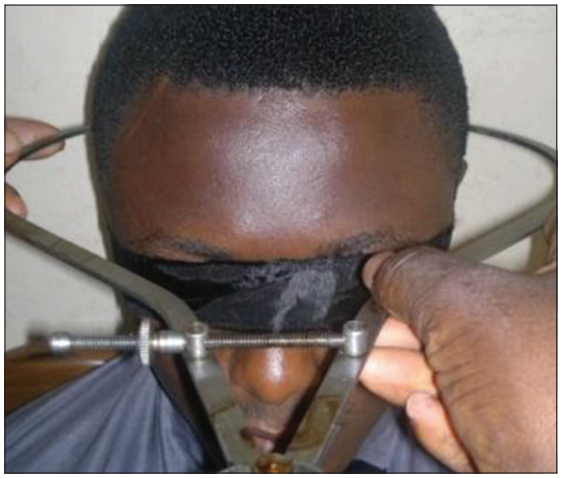

Figure 4: Measurement of head width

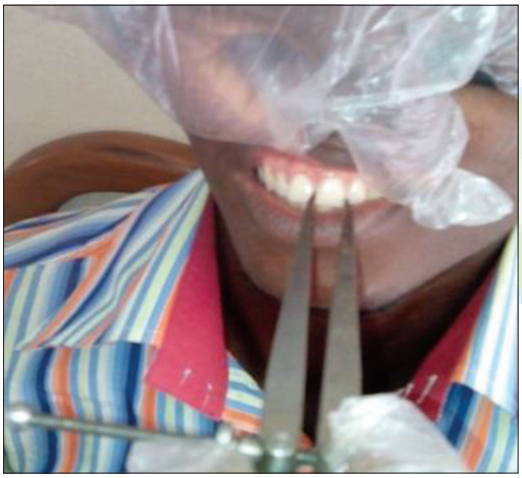

Figure 5: Measurement of central incisor

Figure 6: Six maxillary anterior teeth measured. CI = Central incisor, LI = Lateral incisor, C = Canine

RESULTS

Results indicate that a total of 410 subjects, 18–30 years with mean age 22.31 (SD 4.36) years, participated in the study. The mean age and range for the Efik was 22.17 (SD 3.3.74) years and 18–30 years, respectively; while for the Ibibio, it was 22.45 (SD 4.89) years and 18–30 years, respectively. The distribution of subjects gender-wise is shown in Figure 1.

In Table 1, the mean body height, head circumference, length, and width, as well as combined width of maxillary anterior teeth, were significantly higher in males than in females ($P < 0.05$) among the Efik. In Table 2, both the body height and head dimensions were significantly higher in males than females ($P < 0.05$), but the difference between the genders was not statistically significant in the case of combined maxillary anterior crown width ($P > 0.05$) among the Ibibio.

Pearson's correlation and regression analysis between body height and head circumference were as shown in Table 3. Except for female data among the Ibibio, in all data in both the Efik and Ibibio, there was a significant correlation between body height and head circumference ($P < 0.05$). The values of the variation in the dependent variable (body height) explained by the independent variable (head circumference) (R Square) in both ethnic groups were very low; the highest was in female data among the Efik. The values of the standard error of estimate (SEE) were low among the Efik while they were relatively high among the Ibibio. The regression equations derived from head circumference are shown in Table 4.

Correlation and regression analysis between body height and head length among the Efik and Ibibio were as presented in Table 5. In both ethnic groups, all the data showed a correlation between body height and head dimensions as well teeth dimensions ($P < 0.05$). The highest value of Pearson's correlation coefficient was in female data among the Efik. In both ethnic groups, the highest value of R square was in the female data among the Efik. Moreover, Table 6 revealed that the minimum value of standard error of estimates was ≈ 5 in both ethnic groups studied. The regression equations derived from Table 5 are shown in Table 4.

Pearson's correlation and regression analysis between body height and head width were as presented in Table 6. Across the two ethnic groups, all the data, except male and female among the Ibibio, there were significant correlations between body height and stature ($P < 0.05$); though the values of Pearson's correlation coefficient were very low. The values of R square in all cases were very low. The values of the standard error of the mean were relatively low. The regression equations are shown in Table 4.

In Table 7, Pearson's correlation and regression analysis between body height and combined maxillary anterior teeth are shown. Only female data among the Efik, as well

Table 1: Descriptive statistics and comparison between genders of the parameters measured among the Efik

Parameters	Data	Minimum-maximum	Mean	SD	t	df	P
Body height (cm)	Male	152.00-174.00	163.74	5.06	5.05	200	0.001
	Female	147.00-174.00	159.79	6.08			
	Combined	147.00-174	161.90	5.89		-	-
Head circumference (cm)	Male	51.50-59.20	55.29	1.77	5.60	200	0.001
	Female	50.90-58.10	54.10	1.90			
	Combined	50.90-59.20	54.74	1.92		-	-
Head length (cm)	Male	17.20-19.70	18.53	0.61	3.71	200	0.001
	Female	17.20-19.30	18.24	0.52			
	Combined	17.20-19.70	18.39	0.59	-	-	-
Head width (cm)	Male	13.90-16.70	15.03	0.56	3.42	200	0.001
	Female	13.60-15.90	14.73	0.67			
	Combined	13.60-16.70	14.89	0.63	-	-	-
CACW (cm)	Male	4.80-6.10	5.28	0.28	3.85	200	0.001
	Female	4.70-5.40	5.16	0.19			
	Combined	4.70-6.10	5.22	0.25	-	-	-

CACW=Combined maxillary anterior crown width; SD=Standard deviation

Table 2: Descriptive statistics and comparison between genders of the parameters measured among the Ibibio

Parameters	Data	Minimum-maximum	Mean	SD	t	df	P
Body height (cm)	Male	148.40-172.00	166.34	6.87	5.52	206	0.001
	Female	145.00-172.00	161.46	5.82			
	Combined	145.00-182.00	163.95	6.82	-	-	-
Head circumference (cm)	Male	52.10-58.10	54.74	1.54	3.76	206	0.001
	Female	51.10-57.80	53.96	1.45			
	Combined	51.10-58.10	54.36	1.54	-	-	-
Head length (cm)	Male	16.80-20.60	18.74	0.75	4.97	206	0.001
	Female	16.50-20.00	18.25	0.67			
	Combined	16.50-20.60	18.50	0.75	-	-	-
Head width (cm)	Male	13.20-16.20	14.85	0.65	6.73	206	0.001
	Female	13.00-15.80	14.27	0.60			
	Combined	13.00-16.20	14.57	0.69	-	-	-
CACW (cm)	Male	4.60-5.80	5.18	0.36	0.06	206	0.94
	Female	4.70-5.90	5.18	0.27			
	Combined	4.60-5.90	5.18	0.32	-	-	-

CACW=Combined maxillary anterior crown width; SD=Standard deviation

Table 3: Regression analysis between stature and head circumference in the Efik and Ibibio

Ethnicity	Data	R	P	R^2	SEE	Constant	Slope
Efik	Male	0.34*	0.001	0.11	4.78	110.37	0.97
	Female	0.65*	0.001	0.43	4.63	46.54	2.09
	Total	0.56*	0.001	0.31	0.49	68.73	1.70
Ibibio	Male	0.36*	0.001	0.13	6.43	77.19	1.63
	Female	0.18**	0.069	0.03	5.75	122.21	0.73
	Total	0.35*	0.001	0.12	6.41	80.29	1.54

* Significant; **Not significant. SEE=Standard error of estimate

as male and female data among the Ibibio, were correlation significant ($P < 0.05$). Correlation coefficients were low. The values of *R* square were quite low in all data studied in the two ethnic groups, but SEE was high. Table 4 shows the regression equations derived from Table 7.

Multiple regression analysis between body height and combination of head circumference, length, width, and combined crown width of maxillary anterior teeth are presented in Table 8. There was a significant relationship between body height and the independent variables in all data in the two ethnic groups. *R* was highest in female and total data among the Efik. *R*-square was highest in female data in the Efik. SEEs was high except in female data among the Efik. It was observed that among the Efik, the coefficient of estimates of head circumference, width, and

Table 4: Regression equations in all data in the two ethnic groups

Ethnic group	Data	Head circumference	Head length	Head width	CACW
Efik	Male	H=106.918+1.028 C	H=97.771+3.561 L	H=121.234+2.830 W	-
	Female	H=45.417+2.116 C	H=29.760+7.135 L	H=107.943+3.524 W	H=203.255+(−8.430 T)
	Combined	H=66.926+1.737 C	H=61.034+5.487 L	H=105.683+3.779 W	-
Ibibio	Male	H=77.19+1.63 C	H=111.94+2.90 XL	-	H=138.30+5.41 T
	Female	-	H=116.45+2.47 L	-	-
	Combined	H=80.29+1.54 C	H=99.46+3.49 L	H=131.99+2.19 W	H=140.67+4.49 T
Efik	Male		H=97.59+2.32 L		
	Female		H=48.54+1.41 C+3.39 L+ (−6.87 T)		
	Combined		H=55.114+1.05 C+2.49 L		
Ibibio	Male		H=52.76+1.36 C+5.23 T		
	Female		H=101.34+2.53 L		
	Combined		H=53.89+2.40 L+4.32 T		

C=Head circumference; L=Head length, head; head width; T=Combined maxillary anterior teeth; H=Stature/body height; CACW=Combined maxillary anterior crown width

Table 5: Regression analysis between stature and head length in the Efik and Ibibio

Ethnicity	Data	*R*	*P*	R^2	SEE	Constant	Slope
Efik	Male	0.40*	0.001	0.16	4.66	102.06	3.33
	Female	0.58*	0.001	0.34	4.98	36.61	6.76
	Total	0.52*	0.001	0.27	5.04	65.77	5.23
Ibibio	Male	0.32*	0.001	0.10	6.55	111.94	2.90
	Female	0.29*	0.004	0.08	5.61	116.45	2.47
	Total	0.38*	0.001	0.15	6.31	99.46	3.49

*Significant. SEE=Standard error of estimate

Table 6: Regression analysis between stature and head width in the Efik and Ibibio

Ethnicity	Data	*R*	*P*	R^2	SEE	Constant	Slope
Efik	Male	0.31*	0.001	0.09	4.84	122.51	2.74
	Female	0.37*	0.001	0.13	5.69	110.79	3.33
	Total	0.39*	0.001	0.15	5.43	107.74	3.64
Ibibio	Male	0.13**	0.196	0.13	6.85	146.37	1.34
	Female	0.02**	0.818	0.02	5.85	158.28	0.22
	Total	0.22*	0.001	0.05	6.66	131.99	2.19

*Significant; **Not significant. SEE=Standard error of estimate

Table 7: Regression analysis between stature and combined width of maxillary anterior teeth in the Efik and Ibibio

Ethnicity	Data	*R*	*P*	R^2	SEE	Constant	Slope
Efik	Male	0.05**	0.65	0.00	5.08	168.08	−0.82
	Female	0.24*	0.02	0.06	5.94	199.36	−7.68
	Total	0.03**	0.74	0.00	5.90	165.01	−0.60
Ibibio	Male	0.28*	0.003	0.08	6.63	138.30	5.41
	Female	0.13**	0.189	0.02	5.80	147.03	2.78
	Total	0.21*	0.002	0.04	6.68	140.67	4.49

*Significant; **Not significant. SEE=Standard error of estimate

combined crown width in male data; head width in female data; and head width and crown width in combined data were not significant ($P > 0.0$) and therefore not reliable estimates of the models and were excluded in the models.

Similarly among the Ibibio, head length and width in male data; head circumference, width, and combined crown width in female data; head circumference and width in combined data; and the coefficient of estimates were not significant ($P > 0.05$) and therefore not reliable.

DISCUSSION

Various factors have been adduced to variations in body dimensions; these could be genetic, environmental, and could be factors specific to the individual population. In the present study, body height in both gender, as well as in the total population of the Ibibio, was higher than in the Efik, in spite of closeness of these ethnic groups. These variations may be multifactorial.

The head dimensions and the dimension of the combined crown width in the two ethnic groups were relatively equal. This observation could be due to the close proximity of the two ethnic groups in regard to geographic location.

Across the two ethnic groups, body height, head dimensions, and combined crown width were significantly greater in males than in females, except combined crown width among the Ibibios. These observations are in agreement with Ukoha *et al*.[10] who carried out a study on stature estimation from the head circumference, length, and width. In contrast, Jervas *et al*.[11] reported no significant gender difference in head length and head width. Purohit and Khatri[13] reported a significant gender difference in body height, head length, and width. Shah *et al*.[24] reported males were significantly greater in body heights, head length, and width than females ($P < 0.05$). Ilayperuma[2] in their study of stature prediction reported that males were significantly greater in body height, cranial length, and width than females. The

Table 8: Multiple regression analysis between stature and all parameters measured in the Efik and Ibibio

Ethnicity	Data	*R*	*P*	R^2	SEE	Constant	Slope
Efik	Male	0.42*	0.001	0.18	4.68	97.59	0.24**, 2.32*, 1.00**, −0.98**
	Female	0.73*	0.001	0.53	4.26	48.54	1.41*, 3.39*, 0.57**, −6.87*
	Total	0.60*	0.001	0.36	4.77	55.114	1.05*, 2.49*, 0.86**, −1.74**
Ibibio	Male	0.47*	0.001	0.11	5.60	52.76	1.36*, 1.05**, −0.54**, 5.23*
	Female	0.33*	0.022	0.22	6.20	101.34	0.30**, 2.53*, −1.12**, 2.67**
	Total	0.46*	0.001	0.21	6.13	53.89	0.71**, 2.40*, 0.32**, 4.32*

*Significant, **Not significant. SEE=Standard error of estimate

observation regarding the combined mesio-distal width of maxillary anterior teeth in this present study is comparable to some previous studies.[14,25,26] The above concordance in the majority of the study confirms that the dimensions of body parts in males are higher than in females.

In the present study, regression models were derived from linear regression analyses of stature, with head dimensions and also combined width of maxillary anterior teeth. These regression models were derived only if the linear regression correlation coefficients were significant. In a related study, Ukoha *et al*.[10] reported a significant correlation between stature, head length, width, and circumference. Purohit and Khatri[13] reported a significant correlation between body height and head length, but the correlation between body height and head width was noted not to be significant. Shah *et al*.[24] in a related study reported that the correlation between body height and head length, as well as head width, was significant across the population, but similar data in males and females were not significant.

Kumar and Gopichand[5] reported a significant correlation between body height and head length, head width, as well as head circumference. Ilayperuma[2] reported a correlation between stature and cranial dimensions to be statistically significant ($P < 0.05$). In the majority of data, in this present study, the observation is in accordance with the aforementioned previous studies[2,5] except head circumference in female data among the Ibibio, head width in male and female data among the Ibibio, combined maxillary anterior crown width in male and combined data among the Efik, and female data among the Ibibio. These variations could be ascribed to factors related to population differences, as well as genetic.

Kalia *et al*.[14] reported that there were significant correlations between stature and CACW in combined and male data but not significant in female data. Coefficients of correlation were also very poor. Khangura *et al*.[15] reported poor correlation coefficient between stature and CACW which was also not significant ($P > 0.05$). Body structures are known to be influenced by gender, environmental, or geographic and genetic factors.

In this present study, the correlation between body height and some parameters was not significant ($P > 0.05$). This could be due to factors inherent in the ethnic group, data collected, gender, or even unknown factors.

Across the two ethnic groups, in the present study, the proportion of the variance in body height explained by the model as represented by "*R*-square" was generally low, except head circumference in female and combined data among the Efik, that was, 43% and 31%, respectively; head length in female data among the Efik, that was, 34% and female and combine data among the Efik, that is, 53% and 36%, respectively, using multiple regression analyses. These values are on the low side. In a related study by Shah *et al*.,[24] *R*-square was also very low.

This study was limited to young adults in the respective ethnic groups and did put into consideration elderly people in the populations. It is therefore recommended that studies that will include all adult categories should be conducted to account for this limitation.

CONCLUSION

In all the parameters studied in both ethnic groups, the dimensions in males were significantly higher than females, except combined mesiodistal crown width in the Ibibio. In the majority of data studied across the two ethnic groups, there were significant correlations between body height and head circumference, length and width, as well as maxillary anterior crown width. *R*-square was generally low except in female data among the Efik using multiple regressions of all parameters. In general, the models were not reliable based on the high value of the SEEs. However, these parameters can be employed as supportive tools in stature estimation using regression analysis.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not

be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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