EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 8
Issue: 5
353-359
Year: 2021

ESTIMATION OF STATURE FROM CRANIOFACIAL VARIABLES IN HAUSAS OF NIGERIA

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Article Received on 19/03/2021 **Article Revised on 09/04/2021** **Article Accepted on 29/04/2021**

ABSTRACT

Stature is one of the "big four" of forensic anthropology. It makes up a very important aspect of personal identity when there is an identity crisis. The anatomy of the craniofacial complex is relatively resistant to taphonomic changes because of its osseous component. The landmarks are easy to locate and make them suitable for the anthropological assessment of stature. There are insufficient studies on the estimation of stature from craniofacial variables in the Nigerian population. This study aimed to estimate stature from craniofacial variables of the Hausas of northern Nigeria. 504 students and staff (331 males and 173 females) of the Ahmadu Bello University, Zaria, Nigeria within the age range of 18 - 55 participated in the study. 12 craniofacial variables and living stature were taken on each participant following standardized anthropometric procedures. Karl Pearson's correlation and stepwise multivariate regression analysis were carried out on the data to estimate stature. The results from the univariate analysis revealed weak correlations of craniofacial variables with stature and cannot be used for the estimation of stature. However, stepwise multivariate regression analysis produced better results. From this study; we conclude that using stepwise multivariate regression analysis, stature can be inferred from craniofacial variables but with caution because it is a population-specific approach.

KEYWORDS: stature, craniofacial, variables, Hausas.

INTRODUCTION

The establishment of personal identity essentially comes from a detailed comparison and matching of tangible antemortem records and Postmortem findings. The key approach towards the identification process is by estimating and detecting features of the remains that limit probable matches to the individual.[1, 2] An individual's stature is an inherent feature and which is genetically predetermined[3] and a significant aspect of individuation that contributes to the creation of a tentative identity.[4, 5] Stature can be inferred from the craniofacial complex because it has been found to be easily assessable and relatively resistant to taphonomic changes.[6, 7, 8]

The estimation of stature is sequel to the determination of age, sex and race as it have been reported that stature varies with these variables.[9, 10] Previous studies have reported that stature is explicitly proportional to various regions of the body including the craniofacial complex.[11]

Regression analysis is the method of choice often employed in the estimation of stature.[11, 12, 13] Regression equations for stature estimation for males and females have been published for different population groups including Brazilian, [14] South African,[15, 16, 17, 18] Saudi Arabian,[19] Filipino,[20] Indians,[21,22, 23] Chinese,[24] Nigerian [25] etc.

Due to paucity of studies on the estimation of stature from craniofacial variables in Nigeria, this study was designed to estimate stature from craniofacial variables and derive sex specific regression models for the estimation of stature for Nigerians belonging to the Hausa ethnic group.

MATERIALS AND METHODS

Sample

504 students and staff (331 males and 173 females) of the Ahmadu Bello University, Zaria, Nigeria within the age range of 18 - 55 participated in the study. The study participants all belong to the Hausa ethnic group having both parents up to their grandparents belonging to the Hausa ethnic group. Participants having any significant disease, orthopedic deformity, metabolic or developmental disorders which could have affected the general or bony growth were not included in this study.

Anthropometric Data Collection
A semi-structured questionnaire was developed and administered to the study participants for the purpose of collecting socio-demographic data. Direct measurements were carried out on each participant after the administration of the questionnaire and reception of a signed informed consent letter.

Stature was measured as the vertical distance from the vertex on the head to the floor with subject standing barefooted. Twelve craniofacial variables were measured on each subject. Measurements were taken in accordance with the methods suggested by Martin and Saller (1957) and Singh and Bhasin (1989).[26, 27]

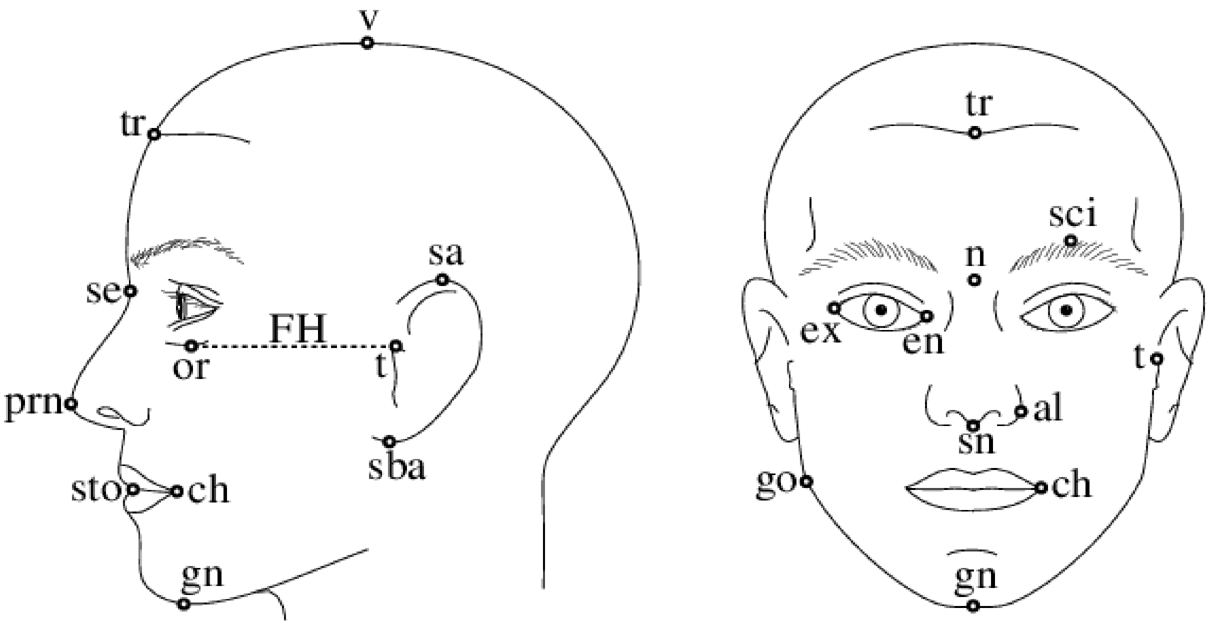

Figure 1: Some craniofacial somatometric landmarks.[28]

Maximum Head Length (MHL): The straight distance between glabella (g) and opisthocranion (op). Maximum Head Breadth (MHB): The straight distance between the two eurya (eu1-eu2). Bizygomatic breath (BZB): The lateral aspects of the bizygomatic arches (zy1-zy2) Bi-gonial breadth (BGB): The straight distance between the two gonia (go1-go2). Biocular breadth (BOB): The straight distance between the two external canthi (ectocanthion). Physiognomic Facial Height (PFH): The straight distance between trichion (tr) and gnathion. Morphological Facial Height (MFH): The straight distance between nasion (n) and gnathion (gn). Total Head Height (THH): The distance between the vertex and the gnathnion. Nasal height (NH): The distance between the nasion and the pronasale. Nasal width (NW): The distance between the two alares. Physiognomic Ear Height (PEH): the distance between the superaurale (sa) and the subaurale (sba). Physiognomic Ear Width (PEW): the distance between the tragion and the opposite lateral margin of the ear (helix). These variables were measured as subjects were made to sit comfortably on a stool, with ends of the caliper placed at the respective landmarks. The instrument was held in such a way that undue pressure was minimized.

Equipment
These variables were measured with a stature meter, spreading caliper (Biotech Ltd., Agra, India). And digital vernier caliper (Microtech, Ukraine, precision, ± 0.01 mm).

Data Analysis
Data was first entered into Microsoft excel sheet (version 2019), inspection was done for errors and outliers. Data was later imported into "Statistical Package for the Social Sciences" (IBM® SPSS version 25.0, Armonk, New York, USA). Significance criterion was set at 95%; hence $p < 0.05$ was considered significant. Continuous variables were expressed as Means$\pm$SD (standard deviation). Sex differences was established using student's t-test. Correlation analysis (karl pearson was done to correlate craniofacial variables, stature and body mass index. Univariate regression was also done to determine relationship between craniofacial variables, stature and body mass index. Scatterplot was produced and linear equation derived; such that $y = a + b(x)$; where y = estimated stature (m), x = craniofacial variable, a = intercept, b = regression coefficient. Multivariate regression was done to predict stature using values of craniofacial variables that significantly contributed to the model.

RESULTS

Table 1: Descriptive and inferential statistics of age among subjects.

Variable	Sex	N	Min	Max	Mean±SD	T-test			
						df	t-value	p-value	Inference
Age (years)	Male	331	18.00	44.00	26.53±6.50	254.39	-11.62	0.00	***Sig***
	Female	173	20.00	52.00	36.07±9.73				
	Total	**504**	**18.00**	**52.00**	**29.80±8.98**				

Note: N *= amount,* ***min*** *= minimum,* ***max*** *= maximum,* ***Sig*** *= Significant,* ***Not sig*** *= Not significant,* ***SD*** *= Standard deviation.*

The results in Table 1 represents the study population of 504 with mean age (Mean±SD) of 29.80±8.98 of unequal proportion of males 26.53±6.50 and females 36.07±9.73. The age range of the Hausa ethnic group was Males (minimum age = 18 and maximum age= 44) compared to the females with (minimum age = 20 and maximum age= 52). This represents a significant difference in age of between the two sexes, showing that the female population were older than that of the males.

Table 2: Descriptive statistics and sex differences in the stature of subjects.

Variables	Sex	N	Min	Max	Mean±SD	T-test			
						df	t-value	p-value	Inference
Height (m)	Male	331	1.55	1.81	1.68±0.07	502.00	7.21	0.00	***Sig***
	Female	173	1.50	1.79	1.63±0.07				
	Total	**504**	**1.50**	**1.81**	**1.66±0.07**				

Note: N *= amount,* ***min*** *= minimum,* ***max*** *= maximum,* ***Sig*** *= Significant,* ***Not sig*** *= Not significant,* ***SD*** *= Standard deviation*

The result shows significant differences in height (m) between male and female subjects (t=7.12, p=0.00) [M=1.68±0.07; F=1.63±0.07].

Table 3: Descriptive statistics and sex differences in craniofacial variables.

Craniofacial variables (mm)	Sex	N	Min	Max	Mean±SD	T-test			
						df	t-value	p-value	Inference
MHL	Male	331	12.00	24.00	19.95±1.74	473.91	-24.76	0.00	***Sig***
	Female	173	21.00	23.90	22.64±0.68				
	Total	**504**	**12.00**	**24.00**	**20.87±1.95**				
MHB	Male	331	10.00	17.00	11.35±0.90	502.00	20.78	0.00	***Sig***
	Female	173	8.00	11.00	9.64±0.84				
	Total	**504**	**8.00**	**17.00**	**10.76±1.20**				
BZB	Male	331	10.00	18.00	11.68±1.20	496.24	8.00	0.00	***Sig***
	Female	173	10.00	12.00	11.05±0.56				
	Total	**504**	**10.00**	**18.00**	**11.47±1.07**				
BGB	Male	331	7.00	13.00	9.98±1.16	502.00	0.05	0.96	Not sig
	Female	173	8.00	12.00	9.98±1.04				
	Total	**504**	**7.00**	**13.00**	**9.98±1.12**				
BOB	Male	331	10.11	17.50	11.95±1.05	500.78	13.43	0.00	***Sig***
	Female	173	10.00	12.00	10.98±0.58				
	Total	**504**	**10.00**	**17.50**	**11.61±1.02**				
THH	Male	331	15.30	27.50	20.76±2.04	440.52	-13.28	0.00	***Sig***
	Female	173	21.00	23.50	22.39±0.66				
	Total	**504**	**15.30**	**27.50**	**21.32±1.86**				
PFH	Male	331	15.50	26.00	19.19±1.60	480.60	14.14	0.00	***Sig***
	Female	173	16.00	20.00	17.52±1.03				
	Total	**504**	**15.50**	**26.00**	**18.62±1.63**				
MFH	Male	331	9.00	11.80	10.27±0.71	502.00	9.95	0.00	***Sig***
	Female	173	8.00	11.00	9.60±0.73				
	Total	**504**	**8.00**	**11.80**	**10.04±0.78**				

NH	Male	331	3.02	10.40	4.34±0.68	477.74	3.82	0.00	***Sig***
	Female	173	3.40	4.90	4.15±0.45				
	Total	**504**	**3.02**	**10.40**	**4.28±0.62**				
NW	Male	331	2.50	5.40	3.56±0.61	487.06	-1.80	0.00	***Sig***
	Female	173	3.20	4.50	3.91±0.38				
	Total	**504**	**2.50**	**5.40**	**3.68±0.56**				
PEH	Male	331	3.70	6.40	4.92±0.61	407.65	1.39	0.17	Not sig
	Female	173	4.00	5.70	4.85±0.51				
	Total	**504**	**3.70**	**6.40**	**4.89±0.58**				
PEW	Male	331	2.30	4.00	3.22±0.42	502.00	3.09	0.00	***Sig***
	Female	173	2.40	3.80	3.10±0.43				
	Total	**504**	**2.30**	**4.00**	**3.18±0.42**				

***Note: N** = amount, **min** = minimum, **max** = maximum, **Sig** = Significant, **Not sig** = Not significant, **SD** = Standard deviation.*

Descriptive statistics and sex differences of the various craniofacial variables in the study population was presented in Table 4.2. The Mean ± SD of MHL (M=19.95±1.74; F=22.64±0.68), MHB (M=11.35±0.90; F=9.64±0.84), BZB (M=11.68±1.20; F=11.05±0.56), BOB (M=11.95±1.05; F=10.98±0.58), THH (M=20.76±2.04; F=22.39±0.66), PFH (M=19.19±1.60; F=17.52±1.03), MFH (M=10.27±0.71; F=9.60±0.73), NH (M=4.34±0.68; F=4.15±0.45), NW (M=3.56±0.61; F=3.91±0.38) and PEW (M=3.22±0.42; F=3.10±0.43) exhibited statistical significant differences between the sexes while BGB (M=9.98±1.16; F= 9.98±1.04) and PEH (M=4.92±0.61;F=4.85±0.51) did not show statistical significant differences.

Table 4: Correlation between craniofacial variables and stature among subjects.

Correlation		**Height (m) [M, N=331]**	**Height (m) [F, N=173]**
MHL	*r*	-0.077	-0.008
	p-value	0.160	0.920
MHB	*r*	-0.063	0.002
	p-value	0.256	0.983
BZB	*r*	0.068	0.064
	p-value	0.215	0.399
BGB	*r*	-0.058	-0.032
	p-value	0.289	0.672
BOB	*r*	-0.018	-0.109
	p-value	0.748	0.154
THH	*r*	0.045	-0.049
	p-value	0.419	0.526
PFH	*r*	-0.010	-0.043
	p-value	0.854	0.572
MFH	*r*	0.094	-0.013
	p-value	0.086	0.869
NH	*r*	0.040	0.038
	p-value	0.467	0.618
NW	*r*	0.034	-0.040
	p-value	0.543	0.597
PEH	*r*	0.015	-0.081
	p-value	0.792	0.290
PEW	*r*	0.024	-0.124

***Note: r** = Pearson correlation, **N** = number of subjects, F = females, M= males.*

To ascertain if stature and body mass index can be estimated from the craniofacial variables of the Hausa subjects, Pearson correlation (*r*) was carried out as presented in Table 4. Significant and positive *r* was not achieved.

Table 5: Model summary for the regression analysis of stature and craniofacial parameters among subjects.

Model	R	R^2	Adjusted R^2	S.E of the Estimate	ANOVA		
					Df	F-value	P-value
Height (m)	0.16	0.03	0.01	0.07	7	1.28	0.26
Height (m)	0.21	0.04	0.02	0.07	5	1.53	**0.18**

***** = *Significant,* ***R*** = *Pearson correlation,* ***R^2*** = *Coefficient of determination,* ***BMI*** = *Body Mass Index*

Predictors (H) male: (Constant), MFH, MHL, PI, MHB, BOB, BGB, PEW Predictors (H) female: (Constant), PEW, BOB, BZB, THH, PEH

Table 6: Stepwise multivariate regression analysis of stature and craniofacial parameters of male subjects.

Term	Unstandardized Coefficients		Standardized Coefficients	t-value	P-value
	B	S.E.	Beta		
Stature estimation model					
(Constant)	1.74	0.11		16.53	**0.00**
MFH	0.01	0.01	0.15	2.17	**0.03**
MHL	0.00	0.00	-0.06	-1.16	0.25
PI	0.00	0.00	-0.10	-1.47	0.14
MHB	0.00	0.00	-0.05	-0.96	0.34
BOB	0.00	0.00	-0.05	-0.85	0.40
BGB	0.00	0.00	-0.05	-0.81	0.42
PEW	0.01	0.01	0.04	0.79	0.43

Regression equation: All craniofacial parameters that contributed to estimating stature. The unstandardized coefficients were used to generate the multivariate regression equation as presented below.

Height (m) = 1.74 + 0.01 (MFH) + 0.00 (MHL) + 0.00 (PI) + 0.00 (MHB) + 0.00 (BOB) + 0.00 (BGB) + 0.01 (PEW).

Table 7: Stepwise multivariate regression analysis of stature and craniofacial parameters of female subjects.

Term	Unstandardized Coefficients		Standardized Coefficients	t-value	P-value
	B	S.E.	Beta		
Stature estimation model					
(Constant)	1.95	0.25		7.65	**0.00***
PEW	-0.02	0.01	-0.14	-1.77	0.08
BOB	-0.01	0.01	-0.11	-1.40	0.16
BZB	0.01	0.01	0.09	1.21	0.23
THH	-0.01	0.01	-0.07	-0.96	0.34
PEH	-0.01	0.01	-0.07	-0.91	0.36

Regression equation: All craniofacial parameters that contributed to estimating stature. The unstandardized coefficients were used to generate the multivariate regression equation as presented below.

Height (m) = 1.95 - 0.02 (PEW) - 0.01 (BOB) + 0.01 (BZB) - 0.01 (THH) - 0.01 (PEH).

DISCUSSION

The mean stature of the male was 1.68m and the female was 1.63m for males and females respectively (Table 1). From our results, the highest correlation of craniofacial variable and stature was found to be with MFH (r = 0-094) for males and BZB (r = 0.064) for females. These positive correlations did not achieve significance and are therefore not suitable for stature estimation for this study population. In accordance with present results, previous studies have demonstrated that craniofacial variables are not good estimators of stature in different populations. Bi-zygomatic distance, nasal length and facial height did not sufficiently predict stature in Idoma males and females of Benue state Nigeria. [29] Agnihotri and collegues reported that for an Indo-Mauritian population, morphological facial height (R = 0.328) was the best predictor of stature among male and female in Indo-Mauritian population but showed weak significance and could not be regarded as good stature estimators. [4] Similar findings have also been reported in Gujarati population;[30] in Turkish population, [31] in Ogoja teenage population of Nigeria.[32]

Further analysis was carried out using stepwise multivariate regression analysis. Following the exclusion of noncontributory elements, the resultant stepwise multivariate equations for stature are:

Height (m) = 1.74 + 0.01 (MFH) + 0.00 (MHL) + 0.00 (PI) + 0.00 (MHB) + 0.00 (BOB) + 0.00 (BGB) + 0.01 (PEW) for males and

Height (m) = 1.95 - 0.02 (PEW) - 0.01 (BOB) + 0.01 (BZB) - 0.01 (THH) - 0.01 (PEH) for females.

CONCLUSION

Regression equations derived from craniofacial variables can be used as adjunct to or in place of extremities for the estimation of stature in occasion of unavailability or mutilation of desired anatomies.

A combination of variables sufficiently estimated sex for the study population. Thus, this study suggests the use of stepwise multivariate regression analysis as it yields better results.

The regression equations are sex specific and borne from the Hausa ethnic group of Nigeria and should not be used in other populations.

ACKNOWLEDGEMENT

We are grateful to the Head of Department of Anatomy, Ahmadu Bello University, Zaria Nigeria Dr. Z. M. Bauchi for giving us an enabling environment to carry out this research. Special thanks goes out to all those who participated in the study.

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