Facial Anthropometry And Sex Discriminatory Characteristics Among University Of Ilorin Students

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Abstract

Prediction of sex from different dimensions has considerable forensic value, not only for the identification of human remains but also in estimating sex from evidence at disaster sites and in corroborating reports from scientists. This study investigated the facial parameters and sexual dimorphism among University of Ilorin students.

A total of 376 students consisting of five major divisions in a university setting (sciences, social sciences, health sciences, technology and humanities) were used in the study. Standard anthropometric methods were used to measure facial height (LFH) and Bizygomatic Width (BZW) from a frontal repose photograph. Six different facial parameters were calculated. Data was analyzed using SPSS version 23statistical software. Confidence level was set at 95%; as p-values ≤ 0.05 were considered significant.

Discriminant function analysis, mean standard deviation of mean and chi-square of the studied population were presented with $P<0.05$. For LFH in both sexes, a significant value of 0.010 was recorded indicating a statistically significant difference. For BZW in both sexes, a significant value of 0.039 was recorded also indicating a statistically significant difference. For TFH in both sexes, 0.039 value was recorded also indicating a statistically significant difference in the measured facial parameters. UFH, MFH and F.I were found to be non-significant with recorded values of 0.077, 0.082 and 0.277 respectively. The p-value recorded for this non-significant values were greater than 0.05 ($P>0.05$).

The findings from this study clearly showed sex-associated difference in facial parameters but argue that a single set of facial parameters may not be applicable in sex grouping. Therefore, facial parameters can serve as adjunct in sex differentiation.

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Introduction

Sexual dimorphism is the expression of secondary sexual characteristics that are defined after puberty and during adolescent years which helps to distinguish between male and female individuals[1].The study of sexual dimorphism is important as a tool for diagnostic studies and criminal investigation in forensic anthropology and craniometry[2]. Sex determination from skeletal remains is one of the most important aspects of the osteological analysis of a given population [3]. Sexual dimorphism has been of great interest for many years and such data have been used to analyze size differences between males and females as well as the social implications thereof[4].

Variation is one of the most important phenomena occurring in human population on the globe. Variations are present not only between individuals but also within individuals from time to time. The importance of anthropometric measurements as a means of studying variation in human population [4-6]. Facial beauty arises from symmetric, balanced and harmonious proportions [7].

Discriminant function analysis is an entirely objective statistical technique for sex determination [8]. This is the most widely applied statistical method for sex determination. The morphological traits are more subjective and sex determination depends on the skill of the researcher, as unskilled investigator may lead to the inaccurate findings due to lack in knowledge while taking the measurements. It is therefore important to make available novel, standard and simple techniques that can be used for accurate craniometrics. Despite the overwhelming literature of craniofacial metrics, there is brevity of data available of the sexual dimorphism of this anthropometric measure within Ilorin metropolis as well as University of Ilorin. This study aimed to characterize the dimorphic variation and craniofacial morphometric discrepancies between male and female student within the University of Ilorin campus.

Materials and Methods

A total of 376 subjects (final year students) consisting of 187 males and 189 females from the selected Faculties in the University of Ilorin were used for the study. The sample size was determined using the fischer`s formula for large population[9] (> 10,000) or infinite population, $S = \frac{Z^2 \times P \times Q}{D^2}$

Subjects were classified using stratified sampling techniques. An informed consent letter was filled by each participant. All subjects were healthy individuals without craniofacial abnormalities and previous craniofacial surgery.

Frontal repose photographs of all participants were taken by positioning them in natural head position and orbitomeatal plane. The pictures were taken using a Nikon D-5300 camera with lenstamron 18-200mm, focal length 3.5-5.6 and umbrella flash lights. The camera was mounted on a tripod stand at a fixed distance of 10 inches from the participant. The Total Facial Height (TFH) and Bizygomatic width (BZW) was obtained with Adobe Photoshop Ruler Software. The Facial Index was mathematically calculated as the ratio of the Total Facial Height with the Bizygomatic Width (TFH/BZW).

The following facial measurements were taken, UFH (Upper Facial Height), MFH (Middle Facial Height), LFH (Lower Facial Height) and BZW (Bizygomatic Width). The Upper facial height was defined as the distance from the trichion to the glabella (tr-gl), the Middle facial height was defined as the distance from the glabella to the subnasale (gl-sn), the Lower facial height was defined as the distance from the subnasale to the menton (sn-me) and the Bizygomatic width was defined as the distance between two zygia (zy-zy) [Figure 1]. Measurements were taken twice and the average tabulated as the value for the measured height and width as well as the facial index.

Statistical Analysis

Statistical Package for Social Sciences version 23 (IBM® Armonk, New York, USA) was the statistical packages used in analyzing the obtained data for assessing the sex differences in the measured parameters, and DFA was used to ascertain the possibility of classifying the parameters into group membership. Only statistically significant variables or close to significant variables were selected for DFA. The confidence level was set at 95%, hence, $P \leq 0.05$ was considered to be statistically significant.

Results

Data Analysis

The results were presented based on the facial anthropometric measurements. The values observed from the anthropometric measurements were tabulated and the mean (SD) was determined for both sexes (male and female) as well as the descriptive characteristics of the measured parameters and Wilki-Lambda unidimensional test of equality of the means of the groups [Table 1]. The DFA was presented in tables using facial parameters. The models are described in [Table 2], [Table 3], [Table 4], [Table 5] and [Table 6] with it summary membership classification in [Table 7].

The study comprised of 376 subjects consisting of 187 males and 189 females with mean values of the studied and the test of equality in mean

Table 1: Descriptive Characteristics of the Measured Parameters and Wilki-Lambda Unidimensional Test of Equality of the Means of the Groups

PARAMETERS	Mean±S.D			Wilks' Lambda Test of group mean			
	Male	**Female**	**Total**	**Wilks' Lambda**	**F**	**Sig.**	**Inf.**
TOTAL FACIAL HEIGHT	21.14±3.56	21.93±3.62	21.53±2.61	0.988	4.594	0.033	**S**
BIZYGOMATIC WIDTH	11.21±1.76	11.61±2.06	11.41±1.92	0.989	4.272	0.039	**S**
FACIAL INDEX	0.53±0.04	0.54±0.13	0.54±0.09	0.997	1.183	0.277	NS
UPPER FACIAL HEIGHT	6.56±1.23	6.77±1.12	6.66±1.18	0.992	3.139	0.077	NS
MIDDLE FACIAL HEIGHT	6.56±1.23	6.77±1.12	6.67±1.18	0.992	3.048	0.082	NS
LOWER FACIAL HEIGHT	8.04±1.29	8.42±1.54	8.23±1.43	0.983	6.687	0.010	**S**

Note: * Box's M within-class covariant matrices (P<0.001)

Table 2: Wilks Lamba test of equality in mean vector between the predicting groups

Lambda	0.863
Chi-square	55.662
DF	6
p-value	< 0.001

Table 3: Model canonical correlation and accuracy in prediction

Function	Eigenvalue[a]	r_c	R_c^2
F1	0.158	0.37	13.69%

Note: a. First 1 canonical discriminant functions were used in the analysis.
r_c Canonical correlation
R_c^2 Prediction model accuracy

Table 4: Variable prediction and discriminant function coefficients

Variables	F1	F2	F3
LFH	0.333	0.764	0.538
TFH	0.276	4.634	1.291
BZW	0.266	-5.559	-2.904
UFH	0.228	2.538	-2.904
MFH	0.225	-1.984	-1.686
F.I	0.140	5.815	63.201
Intercept/constant	-	-	-36.218

Note: *F1 Factors correlations*
F2 Standardized canonical discriminant function coefficients
F3 Canonical discriminant function coefficients

Table 5: Class prediction using centroids

Groups	Functions at the centroids
Male	**-0.393**
Female	**0.401**

Table 6: Classification function coefficients in the model

Variables	Male	Female
LFH	3.527	3.954
TFH	59.900	60.925
BZW	-116.658	-118.962
UFH	-3.878	-2.166
MFH	11.974	10.636
F.I	2497.111	2547.259
Constant	***-685.904***	*-714.665*

Table7: Initial classification and classification after cross-validation

Classification	Predicted Group Membership [a,c]			% Correct classification
	Sex	Male	Female	
Original	**Male (%)**	164 (84.5)	30 (15.5)	71.4%[a]
	Female (%)	81 (42.6)	109 (57.4)	
Cross-validated[b]	**Male (%)**	**165 (85.1)**	29 (14.9)	**70.8%**[c]
	Female (%)	83 (43.7)	**107(56.5)**	

Note: *a. 71.4% of original grouped cases correctly classified.*

b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

c. 70.8% of cross-validated grouped cases correctly classified.

values of groups presented with P<0.05. For LFH in both sexes, a significant value of 0.010 was recorded indicating a statistically significant difference. For BZW in both sexes, a significant value of 0.039 was recorded also indicating a statistically significant difference. For TFH in both sexes, 0.039 value was recorded also indicating a statistically significant difference in the measured facial parameters. UFH, MFH and F.I were found to be non-significant with recorded values of 0.077, 0.082 and 0.277 respectively. The p-value recorded for this non-significant values were greater than 0.05 (P>0.05) [Table 1].

The Box's M covariance matrix showed that the group variances were not equal, thus suggesting that there could be lots of noise introduced into model, thus creating discrepancies in the predictor variables [Table 1].

The group of predictor variables entered in the model (LFH, TFH, BZW, UFH, MFH and F.I) will make predictions that are statistically significant in their outcomes (Wilki's Lambda = 0.863, P<0.001) [Table 2].

The magnitude of the actual effect of the predictors (canonical coefficient) and the outcome is the square of the coefficient $(0.372)^2$; this indicates the relationship between the predictor variable and the

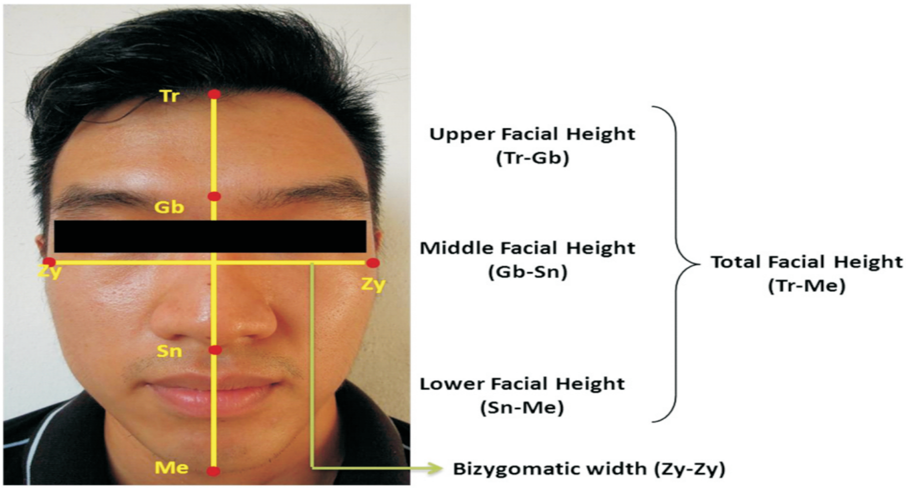

Figure 1: Diagram showing soft tissue point's measurements[10]

prediction outcome is about 13.7% [Table 3].

The predictions of the variables (F1) were very low as they displayed maximum prediction capability of 33.3% (LFH) and lowest prediction of 14.0% for F1 (Table 4). All the variables seem to have predictions lower than 50%. The unstandardized coefficient (F3) creates the discriminant function (equation), which operates like a regression equation. In this case we have: DF = (0.538×LFH) + 1.291 ×TFH) + (-2.904×BZW) + (-2.904×UFH) + (-1.686×MFH) + (63.201×F.I) + (-36.218).

The discriminant function coefficients or standardized form beta both indicate the partial contribution of each variable to the discriminate function controlling for all other variables in the equation [Table 4].

Note: An added way of interpreting discriminant analysis results is to describe each group in terms of its profile, using the group means of the predictor variables. These group means are called centroids. These are displayed in the Group Centroids table [Table 5]. In this study, males have a mean of -0.393 while females produce a mean of 0.401.

The Coefficients of Linear Discriminant Function table interprets the Fisher's theory, so it is only available when linear mode is selected for Discriminant Function. The linear discriminant functions, also called "**classification functions**", for each observation, have following form

$$\mathbf{C_k = C_{k0} + C_{k1} X_1 + C_{k2} X_2 + \ldots + C_{km} X_m}$$

Where;

C_k is the classification score for group k

C's are the coefficients in Table 6

For one observation, we can compute its score for each group by the coefficients according to equation (above). The observation should be assign to the group with highest score.

In addition, the coefficients are helpful in deciding which variable affects more in classification. Comparing the values between groups, the higher coefficient means the variable attributes more for that group.

Note: The classification results [Table 7] reveal that 71.4% of the population were classified correctly into 'male' or 'female' groups using the various measured parameters and after cross-validation (expunging of close outliners), the model produce a classification accuracy of 70.8%. This overall predictive accuracy of the discriminant function is called the '*hit ratio'*.

Discussion

The craniofacial anthropometric studies are valuable for anthropometrics, medicine, dentistry and forensic facial reconstruction experts.[10]Numerous metrical traits have been investigated on craniofacial region of different population, in an effort to make the sex determination easier, reliable and consistent[16-18].The face and cranium are vital physiognomic features in humans. The craniofacial dimensions are amongst the most significant cephalometric factors that define anthropoid morphology. The disparities in the form of the face are greater than those found in the cranium and much greater than the body variation as a whole [17]. Sex is considered as one of the easiest determinations from the skeletal remains and one of the most reliable if essential parts of the skeleton are available in good condition[11].

The Statistical analysis indicated how the mean deviation in both sex changes with the facial parameters, a good example is the bizygomatic width indicating sex discrimination. In forensic anthropometry, the use of DFA is to evaluate the accurateness and predictability of the model using the observed significant measured variables[17]. The strength of such model is the ability to classify above 80% of the measured parameters into groups (sex) although a 95% accuracy bench mark have been placed[12.13.14].

In this study, males and females were classified with an accuracy of 70.8% which seems quite low. However, Abledu *et al*. reports for the Ghanaian population which stated that DFA model accuracy varied from 69.8% to 80.3% for Africans which indicates that the ability to classify above 80% may not be reached by Africans[15,18].

Conclusion and Recommendation

Evidence from this study clearly shows sex-associated difference in facial parameters. DFA successfully predicted 70.8% of the data into groups (sex) and the prediction statistically significant; thus suggestive forensic attributes.

However, such predictive value seems quite low but not low according to Abledu *et al*.[15] hence, the use of facial dimensions may or may not be effective for sex differentiation. The findings argue that a single set of facial parameters may not be applicable in sex grouping. Therefore, facial parameters can serve as adjunct in sex differentiation. Extensive study using larger population should be carried out on the establishment of sex discriminatory characteristics from facial parameters.

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