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Research Article

Morphometric Characterization of Oculonasal Features of Southern Nigerians using Multifactorial Discriminant Analysis

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Abstract

Adequate knowledge of morphologic diversities within and between populations reduces misidentification and aids in conservation of features among populations. The characterisation of diversity based on morphological properties provides to some extent a reasonable representation of the differences among populations, though not exhaustive, it could serve as the foundation upon which DNA analysis could be built. This study used multivariate discriminant analysis of oculonasal measurements of people from the southwest, southeast and south south Nigeria to determine traits or specific features that are peculiar to each of them. Interpupillary distance (IPD) Inner intercanthal distance (IID), Outer Intercanthal distance (OID), Horizontal length of palpebral fissure (HLP), Vertical length of palpebral fissure (VLP), Nasal height (NH), Nasal breadth or nasal width (NB), and Nasal tip protrusion (NTP) were measured in randomly selected individuals in Bowen University, Iwo. Results were statistically analysed using discriminant analysis. The study showed that none of the parameters measured can significantly distinguish between members of each region. Nasal height and nasal breadth however showed high discriminating powers, but do not give a high percentage of accuracy in classifying the individuals into their regions.

Keywords: Oculonasal, Anatomy, Multivariate, Analysis, Nigerians

INTRODUCTION

Oculonasal anatomy is an important region in ophthalmic, maxillofacial and rhinoplastic reconstructive surgery because of its aesthetic and functional relevance (Watlet and Van Cauwenherge, 1999; Sadacharan, 2015). The oculonasal region consists of the periorbital and nasal areas (Kokitsu-Nakata *et al*., 2009). The structures that form the periorbital areas include the bony orbit, eyelids, canthal tendons, and eyebrows. All these are usually accepted to be the major landmarks in recognition of the sense of beauty and racial decent because interracial variations is usually most prominent in these areas (Kunjur *et al*., 2006). The structures that form the nasal areas include glabella, nasion, subnasion, maxillofrontale, alare among others (Farkas, 1981, Farkas, 1986). The nose has actually been described as a person's most defining feature as it is in the centre of the face. Its shape is a signature that indicates ethnicity, race, age and sex (Ofodile and Bokhari, 1995, Milgrim1996, Mishima, 2002, Ochi and Ohashi, 2002, Ferrario, 1997, Bozkir, 2004, Leong and White, 2004, Uzun, 2006). The factors that affect the evolvement of the combined morphology of periorbital and nasal structures jointly referred to here as oculonasal features have been explored in previous studies (reviewed in Som and Naidich, 2013). The underlying complex biological mechanisms connected with the formation, development and functions of morphological traits are too complex to be analysed and interpreted through simple univariate and bivariate statistical methods (Oguntunji, 2013). This is because biological traits are complex and are under the control of the interaction of genes and environmental factors (Wu and Lin, 2006). Univariate statistical analysis, according to Dossa *et al*. (2007), analyze each variable separately and does not explain how the populations under investigations differ when all measured morphological variables are considered jointly; hence the need for multivariate analysis. Multivariate analysis refers to all statistical techniques that simultaneously analyse multiple measurements on individuals or objects under investigation (Hairs *et al*., 2010). Multifactorial discriminant analysis is a multivariate techniques that has been found to be more suitable in assessing variation within a population and can discriminate different population types when all measured morphological variables are considered jointly (Yakubu *et al*., 2010; Traore *et al*., 2008; Yakubu and Ibrahim, 2011). Discriminant analysis encompasses procedures for classifying observations into groups (i.e. predictive discriminant analysis) and describing the relative importance of variables for distinguishing among groups (Lix and Sojobi, 2010).

The application of multivariate techniques such as Principal Component Analysis and Discriminant Analyses to morphometric variables have been used extensively for assessing sexual size dimorphism and it has proved to be effective in identifying variables capable of separating sexes (Mc Cracken *et al*., 2000; Svalgelj and Quintana, 2007;

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Herring *et al*., 2011; De Marchi *et al*., 2012; Oguntunji and Ayorinde, 2014). The application of multivariate discriminant analysis to racial discrimination using morphological traits most especially among Nigerian tribes or regions is scarce. Against this background, this study was designed to identify racial discriminators among people of different regions in southern Nigeria using discriminant analysis of occulonasal traits. The aim of this study was to investigate the possibility of using multivariate discriminant analysis of oculonasal measurements of people from the southwest, southeast and south south regions of Nigeria to identify peculiar traits that could be used as a racial marker of these groups of people.

MATERIALS AND METHODS

Study Area, Population, Sample Size

The study area is Southern Nigeria. The group consisted of a total of 378 adult individuals between 18 and 30 years of age, from southsouth (65), southwest (247) and southeast (66) Nigerian descents with no history of trauma or congenital anomalies. The geographical origin of the subjects are presented in Figure 1. The instruments used in this research include: a digital sliding vernier caliper, plastic metre rule, scientific calculator and a data sheet. The readings were taken in millimeters, converted to centimetres and the data were recorded on the data sheet.

Ocular Measurement

The method used was the Cem *et al., 2001* method. The subject was seated comfortably in a chair with his/her head at the same level as the examiner's head. The subject's face was well illuminated. Horizontal distances and vertical distances were measured directly using a plastic metre rule. The Interpupillary distance (distance between the centers of the two globes of the eyes) was then determined by having the subject look straight at the examiner while the ruler was held tightly against the bridge of the nose of the subject. Inner intercanthal distance was measured as the distance from the medial angle of the left eye to the medial angle of the right eye. Outer Intercanthal distance was measured as the distance from the lateral angle of the left eye to lateral angle of the right eye. Horizontal length of palpebral fissure distance was measured as the distance from the medial angle of one eye to the lateral angle of the same eye. Vertical length of palpebral fissure was measured as distance between the upper and lower lid margins measured at the pupillary midline. Ocular projection was measured as the distance between the corneal apex to the lateral orbital rim. Canthal Index was then calculated as inner intercanthal distance/outer intercanthal distance x100.

Exclusion criteria were adults who had congenital and/or acquired ocular or periocular craniofacial or systemic conditions likely to affect the values of any of the anthropometric parameters of interest, and potential participants who had mixed parentage. Specifically, subjects with history of ocular/periocular surgery or trauma and those who had eyelid positional abnormality, orbitoocular or eyelid tumour, phthisis bulbi, and those who had ciliary or superciliary madarosis were excluded.

Nasal Measurement

Subjects were told to sit upright in a relaxed mood with head in an anatomical position while taking measurements. The sliding vernier caliper after been adjusted to an accurate point was used in measurement of nasal height and width and nasal tip potrusion. Nasal height was measured by placing the upper fixed divider arm of the vernier caliper on the nasion of the nose superiorly and then the lower moveable divider arm on the subnasale. The readings were read from the digital screen of the caliper and then recorded. The nasal breadth (maximum breadth of the nose) or nasal width was measured at right angle to the nasal height from ala to ala. The nasal tip protrusion is measured as the distance from the Pronasale, (the most prominent point on the nasal tip) to the Subnasale, (the midpoint of the columella base). The nasal index was calculated as the ratio of nasal width to the nasal height multiplied by 100.

The demographic data (sex and age) of the participants' were recorded. All readings were taken twice and the average was recorded to reduce the error of measurements. It was ensured that the calliper and ruler were placed properly and accurate readings were taken. It was also ensured that each subject did not smile or change facial expressions while taking measurements in order to get accurate values.

Figure 1:
Map of Nigeria, showing the study areas (Kana *et al*., 2015)

Statistical analysis

Data collected were subjected to univariate analysis of variance using the following fixed effect model:

$Y_{ij} = U + R_i + e_{ij}$

Where:

Y_{ij} = Individual observations

U = General mean

R_i = Fixed effect of region ($_i$ = 1- - - 3)

e_{ij}= experimental error assumed to be independently, identically and normally distributed, with zero mean and constant variance, i.e. nd (0, r^2).

Means between the regions were separated with Duncan's Multiple Range test at 5% probability level.

Besides, stepwise discriminant analysis was applied to identify occulonasal traits with high separating power and the relative importance of such variables in discriminating the subjects from regions were assessed through Wilk's lambda, level of significance (Pr>F), and F-statistics (F-to-remove variables). Furthermore, percentage of correct assignment of regions was assessed through a split-sample validation (cross-validation process) (Svagelj and Quintana, 2007). In addition, dendogram plot was presented and estimated Eucledian distance between the regions were determined using occulonasal traits. All statistical analyses were performed using the SPSS (2001) version 16.

RESULTS AND DISCUSSION

To the best of our knowledge, this is the first report on discriminant analysis of oculonasal traits among southern Nigerians, therefore, literature is scarce to compare and validate the results.

The descriptive statistics of the occulonasal traits of subjects from three Nigerian regions is presented in Table 1. The result of stepwise discriminant analysis is presented in Table 2. The result revealed that two (nasal breath- NB and nasal height- NH) of the nine traits investigated had higher discriminating power as reflected in their F-to remove, F-statistics and Wilk's lambda values.

The high separating power of these traits implies that using occulonasal traits for racial discrimination among subjects of the three Nigerian regions, consistent measurements of the two parameters could be of assistance in classifying southern Nigerians to their appropriate regions. In addition, it can be inferred that only nasal traits were identified for racial discrimination. Their importance in this regarded was buttressed from their significant differences in Table 1.

Table 1

Descriptive Statistics of the Oculonasal Traits in Southern Nigerians

Traits	South west	South south	South east
Interpupillary distance	7.14 ±4.05a	6.82 ±0.49a	6.93 ±0.51a
Outer Intercanthal distance (OID)	13.26 ±6.90a	12.61 ±0.79a	12.90 ±1.90a
Inner intercanthal distance (IID)	4.74 ±3.94a	4.23 ±0.91a	4.24 ±0.70a
Horizontal length of palpebral fissure (HLP)	4.63 ±0.66a	4.59 ±0.57a	4.70 ±0.77a
Vertical length of palpebral fissure (VLP)	1.11 ±0.65a	1.12 ±0.26a	1.12 ±0.20a
Ocular projection (OP)	2.60 ±0.40a	2.60 ±0.38a	2.62 ±0.40a
Nasal height (NH)	45.62 ±4.05a	47.12 ±3.83b	46.50 ±4.00ab
Nasal breadth (NB)	40.29 ±4.19a	39.91 ±4.53a	42.13 ±4.65b
Nasal tip protrusion (NTP)	1.19 ±0.96a	1.09 ±0.14a	1.13 ±0.13a

The result of the cross validation in Table 3 revealed overall low classification success rate (41.8%). The highest success rate was observed in South east (53 %), intermediate in South South (46.2) but lowest (37.7%) in South west subjects. The factors responsible for low classification success rate are multifaceted.

One of the possible underlying factors responsible for low correct classification rate could be attributed to the method used in classifying subjects into regions. In consonance with African culture, Nigerians are patrilinear i.e an individual is classified and recognised according to the family and tribe of the father. Therefore, since morphological parameters were considered in this study, there is a likelihood that most of the mis-classified subjects resembled their mother; thus, saliently contributing to the reported misclassification of a large number of subjects.

Table 2:

Summary of Stepwise Selection of Traits

Step	Variables entered	F. value	Wilk's lamda	P>F
1	Nasal breadth	0.971	0.978	0.004
2	Nasal height	0.948	0.971	0.000

Table 3:

Classification of Results of the Discriminant Analysis. Predicted Sub-Regional Membership

Cross-validated count	South west N=247	South south N=65	South east N=66	Total
South west	93	83	71	247
South south	16	30	19	65
South east	12	19	35	66
Percentage (%)				
South west	37.7	33.6	28.7	100.0
South south	24.6	46.2	29.2	100.0
South east	18.2	28.8	53.0	100.0

Table 4:

Euclidean Distance between Southern Nigerians

Sub region	South west	South south	South east
South west	0.000	4.60	2.143
South south	4.60	0.00	5.83
South east	2.14	5.83	0.00

The low success rate in classifying the subjects into their expected region is also an indication of unrestricted gene flow among the subjects in the three regions. One possible reason could be attributed to the inter-ethnic and inter-tribal marriages. Southern Nigerians are the most educated and more urbane than the northern counterparts. The advent of Christianity and Western education in the three regions culminating in civilization were of great assistance in breaking age-long discriminations and taboos associated with inter-tribal and inter-ethnic marriages. The abolition of the said taboos paved way for emergence of new generation but subtly contributed to the 'genetic erosion' of racial identity; hence, poor classification rate.

It is worthy of note that South easterners were better classified and had low classification error compared to others. One possible reason could be adduced to Nigerian Civil war in late 60's (1967-1970). The only ethnic group in the south east region (Igbos) fought against Nigeria, as a result of this, majority of Igbos outside their root (South east region) migrated enmass to their villages in the east. This indirectly contributed to intra-tribal marriages among themselves, thereby contributing to conservation of racial identity; hence, higher classification success rate than other regions. Furthermore, though most Igbos are traders and professionals and could be found scattered in different parts of Nigeria and outside Nigeria. Nevertheless, it is a common practice that most males of marriageable age go back to their villages to marry. This also helps a lot in conserving their identity.

The canonical representation of the subjects from the three regions is presented in Figure 2. It could be inferred from the graphical representation that the subjects from the three regions clustered together and not well separated. The absence of distinct separation of the regions or intermingling of the clusters corroborated further the poor classification success rate (41%) (Table 3) and is indicative that oculonasal traits are poor racial indicator among southern Nigerians. The poor cluster of the regions indicates further that the oculonasal traits are not reliable and could not be employed exclusively for racial discrimination among southern Nigerians.

The poor clustering of the regions as exemplified in graphical representation could also probably be linked to possible common origin of the ancestors of the subjects which could have contributed to expression of similar morphological attributes; hence, poor clustering of the subjects.

The estimated Euclidean distance between the regions using oculonasal traits are presented in Table 4. The estimated distances were low and not significant (P>0.05). Nevertheless, the shortest distance (2.14) was between SW and SE, intermediate (4.60) between SW and SS while highest (5.83) between SS and SE subjects. The remote and immediate reasons responsible for the longest Euclidean distance between SS and SE subjects in spite of their geographical proximity as shown in Figure 1 are not clearly understood.

Putting into consideration the geographical separation between SW and SE subjects (Figure 1), one would be tempted to expect higher Euclidean distance. Wide geographical separation tends to limit and discourage interaction and reduce to the barest minimum the possibility of inter-regional marriages. Nevertheless, it is worth emphasizing that the least Eucledean distance between the two regions could be partially be adduced to the high rate of inter-tribal marriages between the two regions. This is so because subjects used for the two regions were sampled among Bowen University students and preponderance of these students reside in Lagos state. Lagos state is located in SW region and is predominantly a Yoruba-speaking state; however, Igbos from SE region is the second most populous ethnic group, hence low distance between the two regions.

In conclusion, the study showed that only nasal traits among other oculonasal traits considered could be possibly used to differentiate subjects originating from different regions in southern Nigeria. The low success rate in classifying subjects into their expected origin implies that oculonasal traits are poor racial markers of southern Nigerians.

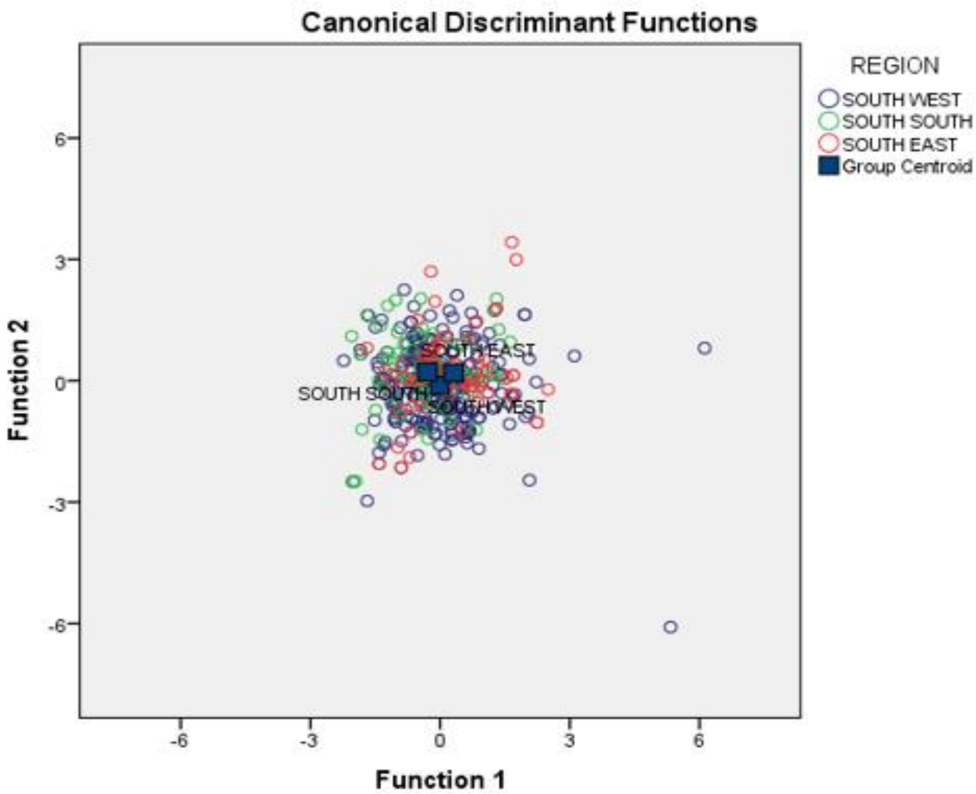

Figure 2:
Canonical representation of subjects from southern Nigeria

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