Original Research Article

Comparative study of Nasofacial angular parameters of Hausa and Igbo subjects resident in Nigeria

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ABSTRACT

This study aims to compare the Nasofacial angular parameters for Hausa and Igbo ethnic groups in Nigeria. The study design was a cross-sectional design which catalogued values of the anthropometric features of adult Nigerian males using anthropometric standards for the reconstruction of a three – dimensional negroid gross anatomical modelling. The methodology used was adult males between the ages of 18 and 40 years of Igbo and Hausa Tribes residing in Imo and Kano states of Nigeria. The results are, the mean parameters of the descriptive statistics for Hausa Nasofacial parameters are as follows; NasoLabial angle (NLA) =79.44, Nasomental angle (NMA) = 139.51, NasoFacial angle (NFcA) = 20.63, MentoCervical angle (MCA) = 131.61, NasoFrontal angle (NFA) = 83.47. The mean parameters of the descriptive statistics for Igbo Nasofacial parameters are as follows; NasoLabial angle (NLA) =49.40, Nasomental angle (NMA) = 81.32, NasoFacial angle (NFcA) = 32.07, MentoCervical angle (MCA) = 7.89, NasoFrontal angle (NFA) = 103.16. In conclusion, the study's findings contribute valuable data to the understanding of ethnic variability in facial parameters, emphasizing the need for population-specific reference data in both medical and technological fields. These results are especially relevant in the context of Nigeria, a nation characterized by its ethnic diversity, where such anthropometric data can play a pivotal role in various applied sciences.

Keywords: Nasofacial; Angular Parameters; Hausa; Igbo; NasoLabial; Nigeria; Nasomental; MentoCervical.

1. INTRODUCTION

Human body dimension measurement and analysis have been indispensable in understanding variations across different populations for centuries. (Capstick et al., 2015). Such measurements, widely known as anthropometry, have applications spanning various fields including medicine, ergonomics, architecture, and forensic science, where accurate physical data are critical for identification and modeling. In forensic science, for instance, anthropometric data have proven invaluable in reconstructing appearances based on skeletal remains (Muro et al., 2015). Facial morphology, particularly the study of nasofacial angular parameters, offers crucial insights into the genetic and environmental factors that shape craniofacial development. (Darkwah et al., 2018). These angles are also of significant importance in clinical settings, particularly in maxillofacial surgery and orthodontics, where they inform surgical planning and treatment tailored to the facial structures of different ethnic groups (Arnett & Bergman, 1993).

Nasofacial angles such as the nasolabial, nasofrontal, and nasomental angles are central to defining facial aesthetics and play a critical role in clinical evaluations of facial harmony.

Variations in these angles across ethnic groups may be attributed to evolutionary adaptations, environmental influences, and genetic diversity (Cohen & Ezzat, 2015). Understanding these variations is not only important for anthropological studies but also for improving clinical practices, such as facial reconstructive surgery, by developing population-specific reference data (Thiemann et al., 2017).

Ethnic variations in nasofacial angular parameters have been well-documented in anthropometric studies (Othman et al., 2016; Virdi et al., 2017). These studies have shown that different ethnic groups often exhibit distinct facial features, which are reflected in the measurements of nasofacial angles (Othman et al., 2016). These differences can be attributed to a combination of genetic factors, environmental influences, and cultural practices (Jaruga et al., 2022). For instance, evolutionary adaptations to climate, diet, and lifestyle have contributed to the development of distinct craniofacial characteristics among various ethnic groups.

The study of nasofacial angular parameters among different ethnic groups is crucial for several reasons. First, it contributes to our understanding of human biological diversity and the factors that influence craniofacial development (Jilani et al., 2018). Second, it provides valuable reference data that can be used in clinical practice to improve the outcomes of facial surgeries and orthodontic treatments (Thiemann et al., 2017).. Finally, it enhances our ability to identify individuals based on their facial features, which is particularly important in forensic investigations (Muro et al., 2015).

Nigeria's extensive ethnic diversity, with over 371 distinct ethnic groups, offers a unique opportunity for anthropometric research. Among these, the Hausa and Igbo are two of the largest ethnic groups, each exhibiting unique cultural and physical traits. (Umeh et al., 2023).

The Hausa, predominantly found in the northern region of Nigeria, are known for their tall stature, long limbs, and narrow facial features. In contrast, the Igbo, who primarily reside in the southeastern region, are characterized by their shorter stature, broader faces, and more rounded features.

Given Nigeria's significant ethnic diversity, it is essential to conduct population-specific studies on nasofacial angular parameters to establish accurate reference data for clinical and forensic applications. The Hausa and Igbo populations, with their distinct physical characteristics, provide an ideal case study for examining ethnic variations in nasofacial angles. Understanding these variations is crucial for improving clinical outcomes in facial reconstructive surgery and orthodontics, as well as enhancing the accuracy of forensic facial reconstructions.

Given the variability in anthropometric traits among different populations, it is critical to develop standardized parameters for specific Nigerian ethnic groups to ensure accuracy in applications such as 3D modeling and forensic identification (Haleem and Javaid, 201; Ononamadu et al., 2017; Castellucci et al., 2019).

Previous studies have highlighted significant differences in anthropometric characteristics between Nigerians and other populations, as well as among various Nigerian ethnic groups. These findings underscore the need for continuous evaluation of anthropometric data, particularly in light of changing diets and lifestyles that may influence physical morphology (Ononamadu et al., 2017).

By developing standardized anthropometric data that truly represent the diversity within Nigeria, we can enhance the accuracy and applicability of 3D models and other tools used in clinical and forensic settings (Ally et al., 2015).

2. MATERIAL AND METHODS

2.1 Research Design

The research design was a cross-sectional design which catalogued values of the anthropometric features of adult Nigerian males using anthropometric standards for the reconstruction of a three – dimensional negroid gross anatomical modelling.

2.2 Population for the Study

The participant of the study includes participants drawn from Imo, Enugu, Abia, Ebonyi and Anambra representing the Igbos, and participants drawn from Sokoto, Kaduna, Kano, Katsina, Zamfara, Kebbi, Gombe, Taraba, Bauchi, representing Hausa ethnic group of Nigeria.

2.3 Sample Size and Sampling Technique

The sampling technique was multistage proportionate random sampling. 1000 subjects, 500 for each ethnic group (Igbo and Hausa) were randomly selected from amongst adult males residing in Imo and Kano states of Nigeria.

Minimum sample size for the study was determined using the Taro-Yamane formula,

where;

n = minimum sample size,

N = total population and

e = margin of error = 0.05.

Only Adult males between the ages of 18 and 40 years with BMI of 18.50 to ≤30.00 were included in this research. It was ascertained that recruited subjects have both parents and four grand parents from the same ethnic group. This was determined through direct personal interviews with the participants.

2.4 Source of Data

The source was primary data through direct personal interviews.

2.5 Method of Data Collection

The data collection for this study was conducted as follows:

2.5.1 Participant Briefing: Participants were provided with a clear explanation of the study's objectives, procedures, and potential benefits. Informed consent was obtained from each participant to ensure their voluntary participation.

2.5.2 Oral Interview: Basic demographic information, including age, ethnicity, and any relevant medical history, was gathered through structured interviews. This step aimed to contextualize the anthropometric and photogrammetric data.

2.5.3 Measurements:

2.5.3.1 Photogrammetry: High-resolution digital photographs of the participants' faces were taken from frontal and lateral views. These images were analyzed using WinImager® software to measure facial parameters and angles, software was developed by Oghenemavwe et al., 2013.

2.5.3.2 Anthropometry: Whole-body measurements were obtained using calibrated tools. Key measurements included height, arm span, and circumferences of the mid-arm, chest, waist, hip, and thigh. The tools were calibrated using ISO standards and measurements were also taken twice and reliability was tested.

2.6 Method of Data Analysis:

Statistical analysis was done using statistical package for the social science (SPSS version 25.0) and Microsoft Excel 2019. Continuous variables were presented as meanSD; minimum and maximum. Analysis of variance (ANOVA) was done to establish significant differences in the measured anthropometric parameters according to ethnic group while Tukey's Post Hoc test of multiple comparison was carried out to determine the specific ethnic groups that differ in specific anthropometric parameters. The confidence interval was set at 95%, therefore $p< 0.05$ was considered significant.

2.7 Precautions

To ensure measurement accuracy, the study verified that all participants had both parents and four grandparents from the same ethnic group. Measurements adhered to international anthropometric standards, recorded to the nearest 0.01 cm (0.1 mm), with subjects positioned anatomically. Each measurement was repeated three times by a single observer to minimize errors and avoid parallax issues. Data analysis employed suitable statistical methods.

3. RESULTS AND DISCUSSION

3.1 The Results of the Comparative Study of Nasofacial angular parameters of Hausa and Igbo subjects resident in Nigeria

Table 1 presents the descriptive parameters for Hausa tribe in Nigeria for the Design of three-dimensional (3D) model, including the NasoFrontal angle, NasoLabial angle, NasoFacial angle, NasoMental angle, MentoCervical angle.

Table 2 presents the descriptive parameters for Igbo tribe in Nigeria for the Design of three-dimensional (3D) model, including the NasoFrontal angle, NasoLabial angle, NasoFacial angle, NasoMental angle, MentoCervical angle.

Table 3 presents the Cranofacial parameters for males of Hausa and Igbo tribe in Nigeria, including the NasoFrontal angle, NasoLabial angle, NasoFacial angle, NasoMental angle, MentoCervical angle.

Table 1. Descriptive Statistics for Hausa Nasofacial Parameters or the Design of 3D Model.

Parameters	N	min	max	Mean	SEM	SD
NLA	500	42.07	89.98	79.44	0.38	8.52
NFA	500	110.81	171.48	139.51	0.52	11.77
NMA	500	105.12	150.82	131.61	0.31	6.93
MCA	500	58.50	89.99	83.47	0.23	5.16
NFcA	500	18.73	54.87	32.07	0.24	5.53

*N= Total population, NFA = NasoFrontal Angle, NLA = NasoLabial Angle, NMA = Nasomental Angle, MCA = MentoCervical Angle NfcA = NasoFacial Angle.

Table 2: Descriptive Statistics for Igbo Nasofacial Parameters for the Design of 3D model

Parameters	N	min	max	Mean	SEM	SD
NFA	500	103.16	227.10	134.74	0.44	10.04
NLA	500	49.40	90.00	77.45	0.41	9.24
NFCA	500	20.63	51.88	35.10	0.23	5.35
NMA	500	81.32	164.68	129.92	0.31	7.15
MCA	500	7.89	89.97	82.66	0.28	6.43

*N= Total population, NFA = NasoFrontal Angle, NLA = NasoLabial Angle, NMA = Nasomental Angle, MCA = MentoCervical Angle NfcA = NasoFacial Angle.

Table 3. Craniofacial Parameters between Hausa and Igbo males of Nigeria

Parameters	Hausa	Igbo	F	P value	Inference
NFA	139.51±11.77**	134.74±10.04**	28.47	0.00	S
NLA	79.44±8.53*i	77.45±9.24**	8.90	0.00	S
NFCA	32.07±5.53**	35.10±5.35**	40.15	0.00	S
NMA	131.61±6.93*i	129.92±7.16**	16.24	0.00	S
MCA	83.47±5.17*y	82.66±6.43	3.87	0.02	S

*NFA = NasoFrontal Angle, NLA = NasoLabial Angle, NfcA = NasoFacial Angle, NMA = Nasomental Angle, MCA = MentoCervical Angle. **S**= significant ($P<0.05$)

3.2 DISCUSSION OF FINDINGS

The study compares nasofacial angular parameters between Hausa and Igbo subjects residing in Nigeria, providing insights into the anthropometric differences that could be significant for applications in fields such as forensic science, plastic surgery, and facial recognition technologies.

3.2.1 Descriptive Statistics of Hausa Nasofacial Parameters

The analysis of nasofacial parameters among the Hausa subjects indicates the following:

3.2.1.1 Nasofrontal Angle (NFA): The mean NFA was 139.51 ± 11.77, with values ranging from 110.81 to 171.48. This angle reflects the slope of the forehead relative to the nasal bridge, and the variation in this parameter among Hausa subjects is moderate.

3.2.1.2 Nasolabial Angle (NLA): The mean NLA was 79.44 ± 8.52, with a minimum of 42.07 and a maximum of 89.98. The NLA is important for assessing the aesthetic relationship between the nose and upper lip. The relatively narrow range suggests a degree of homogeneity in this population's nasolabial profile.

3.2.1.3 Nasomental Angle (NMA): The NMA averaged 131.61 ± 6.93, ranging from 105.12 to 150.82. This angle, which combines the nasal bridge and chin, showed some variability, indicative of differences in facial convexity among individuals.

3.2.1.4 Mentocervical Angle (MCA): The mean MCA was 83.47 ± 5.16, with a range of 58.50 to 89.99. The MCA, which is significant in evaluating the neck and chin relationship, showed lower variability, suggesting a more consistent profile in the Hausa group.

3.2.2 Descriptive Statistics of Igbo Nasofacial Parameters

For the Igbo subjects, the following descriptive statistics were observed:

3.2.2.1 Nasofrontal Angle (NFA): The mean NFA was 134.74 ± 10.04, with a range from 103.16 to 227.10. The wider range and slightly lower mean compared to the Hausa group suggest a greater variation in the forehead slope among the Igbo.

3.2.2.2 Nasolabial Angle (NLA): The Igbo population had a mean NLA of 77.45 ± 9.24, which is slightly lower than the Hausa group. The NLA ranged from 49.40 to 90.00, indicating a broader diversity in the nasal-lip configuration in this group.

3.2.2.3 Nasomental Angle (NMA): The mean NMA for the Igbo was 129.92 ± 7.16, slightly lower than that of the Hausa subjects, with a range of 81.34to 164.68, This suggests that the Igbo might have a slightly more pronounced facial convexity.

3.2.2.4 Mentocervical Angle (MCA): The Igbo subjects showed a mean MCA of 82.66 ± 6.43, ranging from 7.89 to 89.97. The MCA variability is similar to that of the Hausa group, reflecting similar neck-chin relationships.

3.2.3 Comparative Analysis Between Hausa and Igbo Subjects

The comparative analysis between Hausa and Igbo males reveals statistically significant differences in all measured nasofacial angles ($P < 0.05$):

3.2.3.1 Nasofrontal Angle (NFA): The Hausa group exhibited a significantly higher NFA (139.51 ± 11.77) compared to the Igbo (134.74 ± 10.04). The greater NFA in the Hausa group suggests a more acute slope of the forehead relative to the nasal bridge. The NasoFrontal Angle measures the angle between the nasion and the frontal plane, reflecting the prominence of the forehead. Hausa males show a significantly larger NFA compared to Igbo males,

indicating a more prominent or protruding forehead in the Hausa group. This finding is consistent with studies that report ethnic variability in craniofacial dimensions (Ogunleye et al., 2023).

The slight difference in Nasofrontal Angle (NFA) between the Hausa and Igbo groups could be attributed to various factors, including genetic diversity, evolutionary adaptations, and environmental influences. Genetic factors may contribute to distinct craniofacial features among different ethnic groups due to variations in ancestry and evolutionary history (Richmond et al., 2018). Additionally, environmental influences, such as climate and habitual behaviors, might also play a role in shaping these anatomical features over time (Sperber et al., 2010)

3.2.3.2 Nasolabial Angle (NLA): There was a small but significant difference between the Hausa (79.44 ± 8.52) and Igbo (77.45 ± 9.24) groups, with the Hausa group showing a slightly more open nasolabial angle. This could be indicative of a more pronounced or elevated nasal tip in the Hausa population. The NasoLabial Angle, which measures the angle between the nasion and the labial plane, indicates the degree of the labial projection relative to the nose. The difference suggests that Hausa males have a slightly more prominent labial region compared to Igbo males. This can affect facial aesthetics and has implications for both medical and cosmetic applications (Olawole et al., 2020).

3.2.3.3 Nasofacial Angle (NFCA): The Hausa group had a mean NFCA of 35.10 ± 5.53, compared to 35.10 ± 5.35 in the Igbo group. This minimal difference suggests similar overall facial width relative to the nose. The significant differences in nasofacial angles between Hausa and Igbo subjects align with the broader understanding that facial morphology varies with ethnicity, and these variations are critical for applications in clinical and forensic settings (Darkwah, 2018). The NasoFacial Angle reflects the overall facial profile and the relationship between the nose and the face. Igbo males exhibit a significantly larger NFCA, indicating a more prominent nose or a different facial profile compared to Hausa males. This parameter can be crucial for designing facial implants or understanding ethnic variations in facial features (Chukwuma et al., 2021).

3.2.3.4 Nasomental Angle (NMA): The NMA was significantly greater in the Hausa (131.61 ± 6.93) compared to the Igbo (129.92 ± 7.16), implying a relatively less pronounced chin in the Hausa group.

This finding aligns with Neeraja (2017), which also reported significant differences in this measurement across various ethnic groups. The Nasomental Angle measures the angle between the nasion and the menton, reflecting the prominence of the chin relative to the nose. Hausa males have a slightly larger NMA, suggesting a more pronounced chin. This difference could influence facial aesthetics and has implications for reconstructive surgery and orthodontics (Idris et al., 2024).

3.2.3.5 Mentocervical Angle (MCA): The MCA was higher in the Hausa subjects (83.47 ± 5.16) compared to the Igbo (82.66 ± 6.43), suggesting subtle differences in the contour and profile of the chin-neck relationship. The MentoCervical Angle measures the angle between the menton and the cervical plane, which can reflect the posture of the head and neck. The difference is minor but statistically significant, indicating subtle ethnic variations in head and neck posture (Akinmoladun et al., 2022).

Studies have shown that craniofacial dimensions vary significantly across different ethnic groups (Ogundipe et al., 2019; Olawole et al., 2020). This variability is crucial for designing personalized medical devices, ergonomic solutions, and for anthropological studies. Understanding these craniofacial differences can help in creating more accurate 3D models for surgical planning, prosthetic design, and ergonomic products tailored to the specific needs of Hausa and Igbo populations. Expanding studies to include more ethnic groups and exploring additional craniofacial parameters could provide a more comprehensive understanding of facial diversity in Nigeria and contribute to more effective healthcare solutions (Chukwuma et al., 2021).

In summary, the data reveals significant craniofacial differences between Hausa and Igbo males, highlighting the importance of considering ethnic variations in anatomical studies and applications.

4. CONCLUSION

The significant differences in nasofacial angles between the Hausa and Igbo populations emphasizes the importance of considering ethnic diversity in facial analysis, especially in the context of designing 3D facial models, forensic reconstructions, or surgical planning. These variations are crucial for ensuring accurate and culturally appropriate representations, which are vital in clinical and technological applications.

Moreover, the observed variations between the two ethnic groups highlight the potential influence of genetic and environmental factors on facial morphology. Future studies could delve deeper into the underlying causes of these differences, including the role of genetic drift, intermarriage, and environmental adaptation.

In conclusion, the study's findings contribute valuable data to the understanding of ethnic variability in facial parameters, emphasizing the need for population-specific reference data in both medical and technological fields. These results are especially relevant in the context of Nigeria, a nation characterized by its ethnic diversity, where such anthropometric data can play a pivotal role in various applied sciences.

ETHICAL APPROVAL AND CONSENT

For this study involving human subjects, ethical clearance was sought and obtained from the Post Graduate Research Ethics Committee of the School of Graduate Studies, University of Port Harcourt. Informed consent was gotten from all subjects.

Disclaimer (Artificial intelligence)

We hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of manuscripts.

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