Original Research Article

Computed Tomography Assessment of Nasal, Orbital Indices And Volume Among Igbo, Calabari And Ogoni Residents of Portharcourt, Rivers State, Nigeria.

ABSTRACT

Background: Understanding the morphology of the orbital and nasal cavities is essential for human identification, reconstructive surgeries and forensic medicine.

Objectives: To evaluate the orbital and nasal dimensions and their relationship with gender in the Igbo-, Calabari- and the Ogoni ethnic groups living in Port-harcourt Nigeria using computed tomography (CT).

Methods: Four hundred and sixty-six head CT images were analyzed. 43.8% were Igbos', 28.8% Calabaris' and 27.5% Ogonis' of 20-80 years of age with a mean age of 51.19±15.67. Males and females were 55.8% and 44.2% respectively. Parameters measured were orbital height (OH), orbital width (OW), orbital depth (OD), nasal height (NH) and nasal width (NW) using the ImageJ software. Data analysis was by SPSS version 20. Differences between groups were obtained using the one-way ANOVA. P-value < 0.05 was considered statistically significant.

Results: Mean orbital volume for the Igbos', Calabaris' and Ogonis' are 48.57±7.38, 48.97±5.63 and 46.27±5.59 for the right and 48.56±7.31, 48.96±5.62 and 46.32±5.56 for the left respectively $P<0.05$. Mean OD is highest in the Igbos' 4.70±0.32 while mean OH is highest in the Calabaris 2.94±0.18 ($P< 0.05$). Igbos have the highest mean NI of 89.71. Males have higher NI $P<0.05$ in all ethinic groups. Mean OI shows no sexual dimorphism or unilaterality $P>0.05$

Conclusion: Differences in the measured parameters and sexual dimorphism in the nasal indices only among the ethnic groups is demonstrated. Microseme and platyrrhine categories of orbital and nasal cavities respectively is similar to all. These findings will aid facial reconstructive surgeries and forensics.

Keywords: *nasal index, orbital index, computed tomography, dimensions, Igbo, Calabari, Ogoni, Nigeria*

1.INTRODUCTION

An objective determination of the head and face dimensions (cephalometry), is of utmost importance in clinical diagnosis, forensic medicine, plastic and reconstructive surgery, orthodontics etc [1]. Craniofacial indices are one of the essential anthropometric study important for intra- and inter-racial morphology classification [1]. Human growth and development are influenced by factors such as age, race, gender, biology, geography etc [2]. Furthermore, variations in nutrition, anatomy, physiology and genetic influence skeletal development that can manifest as differences in skeletal proportions between males and females in different geographical areas [3].

Since anthropometric methods were initiated into clinical practice to evaluate changes in the craniofacial framework, it has aided in distinguishing features between various races and ethnic groups. Normative data of facial measurements are indispensable in precisely determining the degree of deviations from the normal and also in the establishment of a standard anthropometric measurement for any particular population [4]. Determination of the origin and identity of the remains of skeleton collected from example, a crime scene, is an important task which ordinarily can be difficult. Unidentified bodies can be seen in various conditions; some may be mutilated, decomposed, badly burnt, fractioned or whole etc. This has become common especially in recent times with increasing incidents of both natural and man-made disasters-accidents, bomb explosion, terrorist attacks, wars, plane crashes, earthquakes, hurricane, tsunamis, floods etc [5]. Gender identification from skeletal remains has profound medicolegal significance and once gender is determined, estimation of stature and age is said to be more easily ascertained [6]. Different craniofacial measurements and indices are useful for this purpose.

Dimensions of Orbital and nasal cavities, gives detailed information important in clinical diagnosis, treatment, evaluation of craniofacial asymmetry, pre-operative planning, post –operative evaluation, orbital reconstruction and follow-up of orbital diseases etc [7,8,9]. They are also important anthropological tools [10].

The orbital cavity is a complex anatomical structure which is shaped like an inverted cone. It houses the eyeballs, muscles, vessels, nerves, lacrimal apparatus, facial strata etc. They are located on opposite sides in the mid-sagittal plane of the skull and between the cranium and the facial bones. They can be affected by congenital, vascular, tumour/neoplastic, traumatic, endocrine disorders etc [11]. The nasal cavity is pear-shaped; broader inferiorly and narrow superiorly. It extends from the nares anteriorly, through the external nose and between the bones of the face, as far back as the posterior nasal apertures where it communicates with the nasopharynx.

Orbital index (OI) is defined as the proportion of the orbital height to its width multiplied by 100% while the nasal index (NI) is defined as the proportion of the nasal width to its height multiplied by 100% [11]. Knowledge of these indices could be applied in various fields such as interpretation of fossils record, skull classification in forensic medicine

and in exploring trends in evolutionary and ethnic differences etc [10,12-15]. Various ethnic groups has been classified under one of the predetermined categories which are Megaseme (OI = ≥ 89); Mesoseme (OI = 83 – 89); Microseme (OI = ≤ 83) [11]. For the nasal indices (NI), Leptorrhine (NI = ≤ 69.9); Mesorrhine (NI= 70 – 84); Platyrrhine: NI = ≥ 85) [16,17].

The Igbo, Calabari and Ogoni ethnic groups are indigenous groups of PortHarcourt, Rivers State of Nigeria.

Many measuring tools has been used to obtain these values in our environment but to our knowledge, none has been done using Computed tomography (CT) scan- a cross-sectional radiological imaging modality, which provides detailed, precise, reproducible information of anatomical bony landmarks of the orbit and nasal indices etc,[8,18,19] hence the purpose of this study.

2. MATERIALS AND METHODS

Ethical clearance for this study was obtained from the health research ethics committee of our institution. Four hundred and sixty-six (466) CT images of the head (showing the orbital and the nasal cavities) of the Igbos, Calabari, and Ogonis respectively from January –December 2018 were evaluated. Age range was 20-80 years of age. Females were 206 (44.2%) while the males were 260 (55.8%). Inclusion criteria were subjects who had a well- positioned, head CT scans, had CT scan for lesions unrelated to the orbit or nose, and adults 20-80 years of age. Exclusion criteria were patients with midfacial injuries, orbital or nasal tumours, evidence of previous orbital/nasal surgery, craniofacial anomaly, congenital anomalies, facial asymmetry and children. Each of the CT images were retrieved from the database of a radiology facility. The images were reconstructed to reveal the orbital and the nasal cavities using the E-files software which also measured the height, width, and the depth of the orbital and the nasal cavities respectively. Data analysis was done using statistical package for social science (SPSS) version 20. Descriptive statistics for the orbital and nasal parameters of both sexes were analyzed and compared respectively using the student t-test and was reported as mean ± standard deviation. Statistical difference in mean between groups was analyzed using the one-way ANOVA (analysis of variance). P-value less than 0.05 is considered statistically significant.

Parameters and points of measurement for orbital [8] and nasal dimensions [3]

Orbital height: the distance between frontal and maxillary bones as shown in Figure 1 below

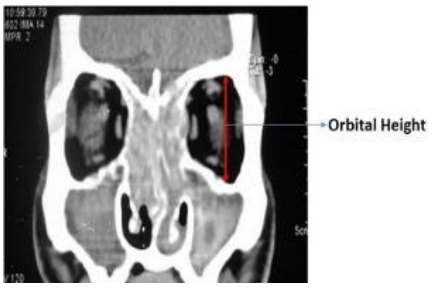

Figure 1: A CT image showing the orbital height

Orbital depth: the distance between the plane across the orbital entrance to the optic canal

Orbital width: is the distance between anterior lacrimal crest and orbital border of zygomatic bone as shown in Fig 2 below

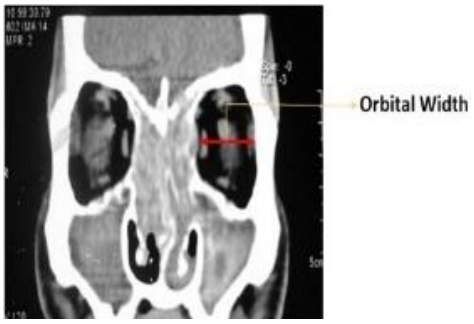

Figure 2: A CT image showing the orbital width

Nasal height: It is the distance between the superior and the inferior margins at the midpoint, perpendicular to the nasal width as shown in Figure 3 below

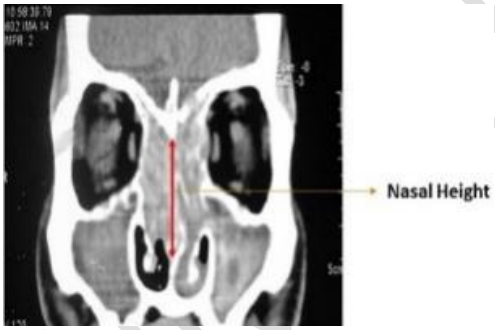

Figure 3: A CT image showing the nasal height

Nasal width: It is the distance between the widest lateral margins of the nasal opening as shown in Figure 4 below

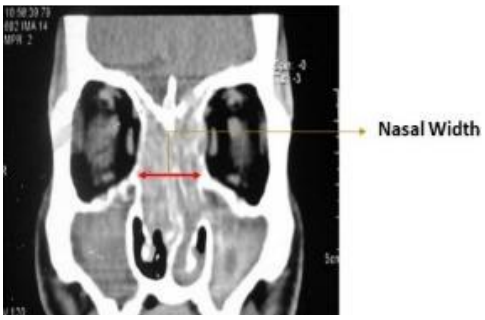

Figure 4: A CT image showing the nasal width

3. RESULTS

The ethnic groups and their percentage distribution were Igbo 204 (43.8%), Calabari 134 (28.8%), Ogoni 128 (27.5%) as presented in Table 1.

Table 1: Percentage distribution of respondent on Sex and Ethnicity

Variables	Frequency	Percentage
Ethnicity		
Igbo	204	43.8
Calabari	134	28.8
Ogoni	128	27.5
Total	**466**	**100.0**
Sex		
Male	260	55.8
Female	206	44.2
Total	**466**	**100.0**
	Mean	**S.D**
Age	51.19	15.67

Table 2 below summarizes the orbital parameter values, mean and standard deviation of the two orbits which was calculated by using OH and OW and volume. Comparison of

all the parameters at p-value < 0.05 showed that there were significant statistical differences except in the values of the right and left orbital indices amongst the three ethnic groups.

Table 2: mean distribution of orbital parameters based on ethnic groups

Orbital Parameters	**Mean ± SD**				**P-values**
	Igbos	**Calabari**	**Ogoni**	**Total**	
Right Orbital Height	2.91 ± 0.21[a.b]	2.94 + 0.17[b]	2.86 ± 0.18[a]	2.90 ± 0.19	0.006*
Left Orbital Height	2.91 ± 0.21[a.b]	2.94 ± 0.18[b]	2.86 ± 0.18[a]	2.90 ± 0.19	0.006*
Right Orbital Width	3.54 ± 0.23[b]	3.54 ± 0.12[b]	3.46 ± 0.16[a]	3.52 ± 0.19	0.001*
Left Orbital Width	3.54 ± 0.23[b]	3.54 ± 0.12[b]	3.47 ± 0.16[a]	3.52 ± 0.19	0.001*
Right Orbital Depth	4.70 ± 0.32[b]	4.60 ± 0.25[a]	4.65 ± 0.27[a.b]	4.66 ± 0.29	0.012*
Left Orbital Depth	4.70 ± 0.32[b]	4.60 ± 0.26[a]	4.66 ± 0.27[a.b]	4.66 ± 0.29	0.013*
Right Orbital Index	82.23 ± 4.38	82.86 ± 3.10	82.58 ± 4.02	82.51 ± 3.95	0.352
Left Orbital Index	82.24 ± 4.38	82.86 ± 3.10	82.49 ± 4.07	82.49 ± 3.97	0.364
Right Orbital Volume	48.57 ± 7.38[b]	48.97 ± 5.63[a.b]	46.27 ± 5.59[a]	47.77 ± 6.51	0.006*
Left Orbital Volume	48.56 ± 7.31[b]	48.96 ± 5.62[a.b]	46.32 ± 5.56[a]	47.78 ± 6.46	0.008*

*Significant P < 0.05, Superscripts from a post-Hoc test (Bonferroni test) was used, whereby mean values with the same alphabet do not differ significantly from each other along each dimensions/indices.

Comparison of all the parameters at P-value < 0.05 showed that there were statistically significant differences in the dimensions amongst the ethnic groups except in the nasal index as shown in Table 3 below.

Table 3: mean distribution of the nasal parameters based on ethnic groups

Orbital Parameters	**Mean ± SD**				**P-values**
	Igbos	**Calabari**	**Ogoni**	**Total**	
Nasal Height	2.98 + 0.4[b]	2.84 + 0.40[a]	3.00 + 0.31[b]	2.94 ± 0.39	0.001*
Nasal Width	2.67 ± 0.46[b]	2.52 ± 0.39[a]	2.66 ± 0.28[b]	2.62 ± 0.40	0.002*
Nasal Index	89.73 ± 11.34	88.84 ± 12.12	89.09 ± 7.12	89.29 ± 10.59	0.727

*Significant P < 0.05, Superscripts from a post-Hoc test (Bonferroni test) was used, whereby mean values with the same alphabet do not differ significantly from each other along each dimensions/indices.

There is sexual dimorphism: the mean values of all orbital and nasal parameters were greater in males and in all linear measurements except in the Calabari ethnic group as presented in Table 4 below.

Table 4: mean distribution of the Nasal and Orbital Dimensions by sex and by ethnicity

Orbital Parameters	**Igbo**			**Calabari**			**Ogoni**			**Total**		
	Mean		**P - value**	**Mean**		**P - value**	**Mean**		**P - value**	**Mean**		**P - value**
	Male	Female		Male	Female		Male	Female		Male	Female	
Orbital Dimensions												
Right Orbital Height	2.9	2.83	0.000*	2.93	2.94	0.630	2.87	2.84	0.322	2.93	2.87	0.001*
Left Orbital Height	2.9	2.83	0.000*	2.93	2.94	0.630	2.87	2.84	0.322	2.93	2.87	0.001*
Right Orbital Width	3.60	3.46	0.000*	3.53	3.55	0.409	3.47	3.45	0.503	3.54	3.49	0.001*
Left Orbital Width	3.60	3.46	0.000*	3.53	3.55	0.409	3.47	3.46	0.731	3.54	3.49	0.002*
Right Orbital Depth	4.77	4.62	0.002*	4.62	4.59	0.432	4.68	4.63	0.392	4.70	4.61	0.002*
Left Orbital Depth	4.76	4.62	0.003*	4.62	4.59	0.518	4.68	4.63	0.414	4.70	4.61	0.004*
Right Orbital Volume	51.12	45.78	0.000*	47.98	47.96	0.982	46.80	45.46	0.188	48.98	46.23	0.000*
Left Orbital Volume	51.07	45.51	0.000*	47.94	47.99	0.959	46.80	45.46	0.238	48.94	46.29	0.000*
Nasal Dimensions												
Nasal Height	3.00	2.96	0.562	2.85	2.81	0.635	2.96	3.06	0.068	2.95	2.94	0.950
Nasal Width	2.68	2.65	0.556	2.58	2.46	0.084	2.65	2.68	0.550	2.65	2.60	0.206

*Significant P < 0.05

Table 5 below summarizes the calculated indices of the two orbits and the nasal cavities. Comparison of the all indices at P-value < 0.05 showed that there were significant differences in the nasal indexes value amongst the three ethnic groups while there was no significant difference in the orbital indices.

Table 5: Orbital indices and Nasal indices

Orbital Parameters	**Igbo**			**Calabari**			**Ogoni**			**Total**		
	Mean		**P-value**	**Mean**		**P-value**	**Mean**		**P-value**	**Mean**		**P - value**
	Male	Female		Male	Female		Male	Female		Male	Female	
Right Orbital Index	82.59	81.81	0.209	82.85	82.89	0.954	82.74	82.36	0.604	82.71	82.28	0.245
Left Orbital Index	82.59	81.81	0.208	82.85	82.88	0.955	82.73	82.12	0.406	82.70	82.21	0.187
Nasal Index	89.93	89.49	0.783	90.69	86.75	0.060	90.02	87.69	0.070	90.16	88.20	0.047*

*Significant P < 0.05

4. DISCUSSIONS

The importance of craniofacial morphometry with the use of a precise imaging tool like CT scan cannot be overemphasized. This study shows that in the orbital cavities in all the ethnic groups considered, depth has the highest of the values followed by the width. Height has the least value. This is similar to a study in Iran which also demonstrated depth to have the highest of the values [9]. The report from Ghana (although depth was not considered in their study), shows width to have higher values [10]. Their mean OW of 4.0cm is much higher than the mean OW of 3.5 cm obtained from the 3 ethnic groups considered [10].

We demonstrated that the Ogonis generally have the least orbital dimensions of the 3 groups. Comparison of the mean OI of the genders showed a significantly higher OI in males amongst the Igbos and Ogonis. This is in agreement with other reports [9,11,12,20-23] However, the female values were higher than males in the Calabari ethnic group and this is similar to studies in Ghana, Kenya, Turkey and Malawi [8,10,24,25]. Yet a research in India showed no sex difference [26].

This study revealed that there is no statistical difference between the right and left OI. This is in line with other findings [10,12,20,24,26] but contrary to a report in Iran that showed a statistical difference with the right larger than the left [9]. Yet another study demonstrated the left to be higher than the right [27].

The OI in the three groups of this study falls within the microseme category (mean OI=82.52). This is similar to earlier report done on Igbos [12]. Their figure of mean OI=73.09, is however much lower than ours. The disparity in figures, even though they fall within the microseme category, may be due to the different methods utilized: theirs was with plain skull radiographs while ours was with Computerized Tomography scan. This microseme category is also reported in Ghana, Egypt, India [10,11,20,27]. Mesoseme category has been noted in studies in Kenya, Iran and a part of India [9,24,26]. Megaseme category has been described in reports from Turkey, Malaysia, Chinese, Polynesians and also another section of India [8,25,28].

The nasal index in this study also demonstrated sexual dimorphism with males having higher values, similar to most works done within Nigeria and also beyond [14,29-33]. However, within the study by Eliakin- Ikechukwu et al 2013, females of Yakurr ethnic groups of South Southern part of Nigeria, were shown to have higher values [33].

This study shows that the mean NI in the Igbos', Calabaris' and Ogonis' were 89.71, 88.72, 88.86 respectively -all have significant differences with that of the Igbos highest. These values are close to those in Urbobors and Itsekiris' which has mean NI of 89.63 and 90.74 respectively [34]. Higher figures of 91, 92.3, 95.7, 96.37, 97.32 has been demonstrated in the Isoko ethnic group of Delta state, Idoma, Tiv, Ijaw, and Bini tribes all in Nigeria respectively [17,29,35,36]. Additionally, the Yorubas, the ethnic group in the Western part of Nigeria, has been reported to have mean NI values as high as 103.5 [37]. Lower values of 72 and 66.78 has however been reported in the northern Nigeria [3,14]. These lower range of values are closer to values of 50.7 reported in Iran; 59.2 reported in the Baluchi ethnic group and 69.7 reported in the Sistani group [2,38] as well as those reported in Afro American 79.7, North America 62.1 and Korea

America 68.5 [38] , 79.56 was demonstrated in the Chinese and 81 in Malaysia [39]. The later however was done in a much younger age- group.

It has been reported that the shape of the nose is influenced by the environmental, climatic conditions, race, tribe etc [40,41]. The colder and drier the climate, the narrower the nose and the warmer and moister the climate, the broader the nose [42]. The studied ethnic groups fall within the platyrrhine type of nose which had been described as generally prevalent in the African continent [40]. Our report is similar to the demonstrated NI of other Nigerian ethnic groups which includes for example Ejagham in Cross river state [43], the Urhobos' Itsekiris' [34], Tiv, Idomas' [35], Isokos' in Delta state [17], the Yorubas', Ijaws, the Okirikas in Rivers state [15,44], the Bini ethnic group [36] etc This however, is contrary to a study by Oladipo et al. 2009 who reported the mesorrhine nose type in the Adoni ethnic group of Rivers State [15].

It is of note that varying values may be obtained in same tribe depending on the measuring tools utilized. For example, past studies done on nasal dimensions and indices in the Igbo ethnic group, shows varying figures. In the study done on Igbo ethnic group by Akpa et al and Eliakin-Ikechukwu et al, tape rule was used [31,33] . Olotu J et al and Oladipo GS et al in their study used sliding caliper for obtaining their measurements [45,46]. Our study, carried out with computerized tomography scan, a cross-sectional, reproducible, imaging tool, has a superior advantage of precision, compared to the other methods. Additionally a dedicated maxillofacial CT using Sn100-kVp with ultra-low-dose protocol has been demonstrated to maintain image quality for diagnosis with much significant reduction in radiation dose especially in cases of craniofacial trauma [47]. However from our knowledge this is the first study of Nasal, Orbital Indices and dimensions in the south east and south southern Nigeria using CT scan.

5. CONCLUSIONS: There is sexual dimorphism in the nasal, orbital indices and volume amongst the Igbo-, Calabari- and Ogoni- ethnic groups of Port-harcourt, Rivers state, Nigeria. Although their mean nasal indices were significantly different, there is no significant difference in their orbital indices. The ethnic groups has the microseme and platyrrhine categories with the Igbos having the highest nasal index. Normative values has been established. Findings from this study will be very relevant for reference in reconstructive facial surgeries, rhinology and rhinoplasty, forensic medicine, oncology, clinical diagnosis, and anthropology in classification of fossil remains, in years to come.

Ethical issues: None.

REFERENCES

1. Obaje GS, Uzomba GC. The cephalofacial characterization in humans: the study using Igbo tribe in Nigeria. The Egyptain journal of Medical Human Genetics 2018; 19:399-402

2. Heidari Z, Mahmoudzadeh-Sagheb H, Khammar T, Khammar M. Anthropometric measurements of external nose in 18-25-year-old Sistani and Baluch aborigine women in the southeast of Iran. Folia Morphol 2009;68 (2):88-92
3. Abba M, Kadir FI, Adamu YM, Garba I, Baba IA, Dambele MY et al. Evaluation Of Nasal Index Using Computed Tomography Among Hausa-Fulani Tribe In Kano, Nigeria. Nigerian Journal of Medical Imaging and Radiation Therapy 2018;7(1):75-82
4. Farkas LG, Katic M J, Forrest CR, Alt KW, Bagic I, Baltadijiev G et al. International Anthropometric Study of Facial Morphology in Various Ethnic group/ Races. J Craniofac Surg 2005;16 (4):615 – 46.
5. Cattaneo C, Ritz-Timme S, Gabriel P, Gibelli D, Giudici E, Poppa P . Personal Identification of “Cadavers and Human Remains” In Forensic Anthropology and Medicine: Complementary Sciences from Recovery to Cause of Death (Ed. A. Scmitt, E. Cunha, and J. Pinhiero)2009. Humana press Inc., Totowa, NJ.359
6. Gopal K S, Nagammai N, Harsha Vardhan B G. Assessment of human orbital index and mandible in gender determination: An institutional-based retrospective cone-beam computed tomographic study. Int J Forensic Odontol 2021;6:8-12
7. Ji Y, Qian Z, Dong Y, Zhou H, Fan X. Quantitative morphometry of the orbit in Chinese adults based on a three-dimensional reconstruction method. J Anat 2010;217:501-6
8. Ozdikici M, Bulut E, Agca S. Assessment of the orbital structures using computed tomography in healthy adults. Niger J Clin Pract 2021;24:561-8
9. Khademi Z, Bayat P. Computed tomographic measurements of orbital entrance. dimensions in relation to age and gender in a sample of healthy Iranian population. Journal of Current Ophthalmology 2016; 28: 81-84
10. Botwe BO, Sule DS, Ismael AM. Radiologic evaluation of orbital index among Ghanaians using CT scan. Journal of Physiological Anthropology 2017 ;36:29
11. Swetha TV, Mohanraj KG. Estimation of orbital index as a measure of craniofacial complex – A morphometric study. Drug Invention Today 2019;11(10):2557-2560
12. Ezeuko V, Om'Iniabohs F. Radiologic evaluation of orbital index among the Igbo Ethnic Group. Eur J Anatomy. 2015;19(1):9–14.
13. Anas IY and Saleh MS. Anthropometric Comparison of Nasal Indices between Hausa and Yoruba Ethnic Groups in Nigeria. Journal of Scientific Research & Reports 2014;3(3):437-444
14. Mohammed I, Mokhtari T, Ijaz S Omotosho DA, Ngaski AA, Milanifard M, et al. Anthropometric study of nasal index in Hausa ethnic population of northwestern Nigeria. J.Contemp Med Sci 2018;4(1)26-29
15. Oladipo GS, Eroje MA, Fawehinmi HB. Anthropometric comparison of the nasal indices between the Adoni and Okrika ethnis groups of Rivers State, Nigeria. Int. J. Med. Sci 2009; 1 (4): 135-137

16. Willams P, Dyson M, Dussak JE, Bannister LH, Berry MM. Collins P. Skeletal System. Gray's Anatomy, 3rd ed.; Churchill Livingstone 1995: Edinburgh. 609–612.
17. Anibor E, Etetafia MO, Eboh DE, Akpobasaha O. Anthropometric study of the nasal parameters of the Isokos in Delta State of Nigeria. Annals of Biological Research 2011; 2 (6):408-413
18. Shaw RB Jr., Kahn DM. Aging of the midface bony elements: A three-dimensional computed tomographic study. Plast Reconstr Surg 2007;119:675-81
19. Rubin KM, DeLeon VB. Ancestral variation in orbital rim shape: A three-dimensional pilot study. J Forensic Sci 2017;62:1575-81
20. Fetouh FA, Mandour D. Morphometric analysis of the orbit in adult Egyptian skulls and its surgical relevance. Eur. J. Anat.2014; 18 (4): 303-315
21. Ebeye OA, Otukpo O. Orbital Index in Urhobos of Nigeria. Journals of Dental and Medical Sciences 2013. 8 (2). 51 – 53
22. Forbes G, Gehring DG, Gorman CA, Brennan MD, Jackson IT (1985). Volume measurements of normal orbital structures by computed tomographic analysis. AJR Am J Roentgenol 1985: 145: 149–54.
23. Furuta M. Measurement of orbital volume by computer tomography: especially on the growth of the orbit. Jpn J Ophthalmol. 2001;45(6):600-6.
24. Munguti J, Mandela P, Butt F. Sex difference in the cranial and orbital indices for a black Kenyan population. Int J. Med.Med.Sci.2013;5(2):81-84
25. Igbigbi P, Ebite L. Orbital index of adult Malawian. J Forensic Med Toxicol. 2010;11(1). http://www.anilaggrawal.com/ij/vol_011_no_001/papers/paper001.html.
26. Mekala, D., Shubha, R. and Rohini, D. M. Orbital Dimensions and Orbital Index: A Measurement Study on South Indian Dry Skulls. International Journal of Anatomy 2015. Vol (3): p1387 – 91.
27. Gopalakrishna, K., and Kashinatha, M. (2015). The Craniometrical Study of Orbital Base of Indian Population and its Applied Importance. Scholars Academic Journal of Bioscience 2015;3 (2):618-23
28. Khan Z , Nadeem G , Khan H , Khair AB. An anatomical study of orbital dimensions and its utility in orbital reconstructive surgery. Oncology and Radiotherapy 2021;15 (3): 1-9
29. Oladipo, G. S., Olabiyi, A. O., Oremosu, A. A., and Noronha, C. C. Nasal Indices among Major Ethnic groups in Southern Nigeria. Scientific research and Essay 2007; Vol. 2 (1): 020-022
30. Ray, S. K., Saha, K., Kumar, A. and Banjare, S. Anthropometric Study of Nasal Index among the Population of Western Uttar Pradesh Region. International journal of Scientific Study 2016; 4 (2):65 – 70.
31. Akpa AOC, Ugwu C, Maliki SO. Morphometric study of the nasal parameters in Nigerian Igbos. J. Exp. Clin. Anat 2003; 2 (2): 24-25.
32. Dhulqarnain AO, Mokhtari T, Rastegar T, Mohammed I, Ijaz S, Hassanzadeh G. Comparison of Nasal Index Between Northwestern Nigeria and Northern Iranian Populations: An Anthropometric Study. J Maxillofac Oral Surg. 2020 Dec;19(4):596-602. doi: 10.1007/s12663-019-01314-w. Epub 2019 Dec 6. PMID: 33071509; PMCID: PMC7524939.

33. Eliakim-Ikechukwu CF, Iro CM, Jonadab Ihentuge CJ, Bassey TE. Nasal Parameters of Ibibio and Yakurr Ethnic Groups of South South Nigeria. IOSR Journal of Pharmacy and Biological Sciences 2013; 5(6): 23-26
34. Oladipo, G, Udoaka A, Afolabi E, Bob-Manuel I. "Nasal Parameters Of Itsekiris And Urhobos Of Nigeria." The Internet Journal of Biological Anthropology2008;3(1).DOI:10.5580/91a, corpus ID:56367608
35. Kpela, T. Danborno, B. and Adebisi, S. (2019) Nasal Anthropometry of Adult Tiv and Idoma Tribes of Nigeria. Advances in Anthropology 2019; 9:103-110. doi: 10.4236/aa.2019.92008.
36. Omotoso DR, Oludiran OO, and Sakpa CL, "Nasofacial anthropometry of adult Bini tribe in Nigeria," African Journal of Biomedical Research 2011;14 (3): 219–22
37. Eliakim-Ikechukwu C,Bassey T, Ihentuge C "Study of the Nasal Indices and Bialar Angle of the Ibo and Yoruba Ethnic groups of Nigeria." Journal of Biology, Agriculture and Healthcare 2. 2012: 149-152.
38. Jimoh RO, Alabi SB, Kayode AS, Salihu AM, Ogidi OD. Rhinimetry: Spectrum of nasal profile among Nigeria Africans. Bra J Otorhinolaryngol 2011;77(5):589-93
39. Wai MM, Thwin SS, Yesmin T, Ahmad A, Adnan AS, Hassan AA et al. Nasofacial Anthropometric Study among University Students of Three Races in Malaysia. Advances in Anatomy 2015, Article ID 780756. http://dx.doi.org/10.1155/2015/780756
40. Risely HH. The People of India. 2nd Edn., Crooke W. (Ed.),1915; 1969: 395-399.
41. Last RJ. Anatomy Applied and Regional, 6th ed. Churchill Livingstone 1981: 398–403.
42. Hall RL, Hall DA. Geographic variation of native people along the Pacific Coast. Hum. Biol 1995; 67 (3):407-426.
43. Ugochukwu EG, Ijomone OM, Ude RA, Nandi EM. Anthropometric analysis of the nose of the Ejagham ethnic group in Cross River State, Nigeria. Annals of Bioanthropol 2014;2(1):13-16
44. Oladipo, G. S., Olabiyi, A. O., Oremosu, A. A., and Noronha, C. C. Nasal Indices among Major Ethnic groups in Southern Nigeria. Scientific research and Essay 2007; 2 (1): 020-022.
45. Olotu, J. E., Eroje, A., Oladipo, G. S., Ezon-Ebidor, E. Anthropometric study of the facial and nasal length of adult Igbo ethnic group in Nigeria. Int J Biol Anthropol 2009; 2.10–15.
46. Oladikpo GS, Gwunireama IU, Asawo OD. Anthropometric comparison of nasal indices between the Igbos and Yorubas in Nigeria. Global Journal of Medical Sciences, 2006; 5(1);37-40 DOI: 10.4314/gjms.v5i1.10147
47. Ha JY, Baek HJ, Ryu KH, Cho E. Feasibility study of ultra-low-dose dedicated maxillofacial computed tomography using filter-based spectral shaping in patients with craniofacial trauma: assessment of image quality and radiation dose. Quant Imaging Med Surg. 2021;11(4):1292-1302.