Morphometry of the Nasal Bones and Piriform Apertures of adult Nigerian skulls

*Jaiyeoba-Ojigho E.J[1], Edibamode E.I[2], Didia B.C[3], Sidum S.A[4]

[1] Department of Human Anatomy and Cell Biology, Delta State University, Abraka, Delta State, Nigeria,
[2, 4] Department of Human Anatomy, University of Port Harcourt, Rivers State, Nigeria
[3] Department of Human Anatomy, Rivers State University, Rivers State, Nigeria

QR CODE

Website:http://ijfmi.com/

Doi: https://doi.org/10.21816/ijfmi.v4i2

[1]corresponding author email: efemenaojigho@gmail.com
07017073851

ABSTRACT

Introduction:
Nasal bone and piriform aperture which defines the shape of the nose are anthropological indicators used in defining race.
Aim: In order to understand the morphological features of Nigerian noses, the study aimed at determining the morphometry of the nasal bone and piriform aperture of adult Nigerian skulls.

Materials and Methods:
This study was an observational study. It involved the measurement of 51 dry adult skulls of unknown age and sex. The shape of the nasal bones and piriform apertures were determined with a digital calliper.

Results:
Findings from this study showed a mean width and height of the nasal bone as 11.31±2.90mm and 20.96±3.74mm respectively. The mean height of the piriform apertures ,upper and lower width were 32.21±3.88mm, 16.41±2.31mm and 27.07±2.30mm . The mean Piriform and nasal index observed are 0.61±0.08 and 0.55±0.16while the area of nasal aperture was 699.12±97.60. Types I (long and narrow) and II (squared/slightly circular) were noticed for the nasal bones while Types A (very broad) and B (broad) were discovered for the piriform apertures. There was no significant difference ($p<0.05$) in the means of the height and width of nasal bones; height, upper and lower widths of the piriform apertures for Types I and II. However significant difference ($p<0.05$) was observed for the nasal and piriform aperture index for Types I and II.

Conclusion:
This study showed that the shape of the nasal and piriform apertures was typical of an African nose.

Key words:
Nasal bone; Piriform aperture; Nigerians; Mophometry

INTRODUCTION

The nasal bone was described by Tae-Sun et al. (2006) as an essential structure that determines the shape of the nose.[1] It lies alongside the frontal bone superiorly, the maxillary bone laterally, and forms a boundary of the piriform aperture inferiorly.[1] According to Karadag, (2011) preoperative assessment of the nasal bone and piriform aperture will estimate the pattern of the nose, soft tissues as well as skeletal changes essential for an improved surgical outcome.[2] Sexual dimorphism has been demonstrated from metric analysis of the piriform aperture and findings had shown that differences occurred among male and females.[3-4] Rogers (2005) and Williams & Rogers (2006) examined different indicators of the skull for sexual dimorphism and observed that the piriform aperture was a good index for diagnosis of sex.[5-6] Sexual dimorphic features have been observed among German and Korean populations from morphometric studies on piriform aperture .[7-9]

The size, shape of nasal bones and piriform apertures are anthropological measures used in defining race.[8]Physical and forensic anthropologist divided populations into different racesaccording to their shared morphological and skeletal traits.[10] Based on non- metric determination of race from skulls ,Norman, (1992) described the Negriods as having a plain frontonasal junction, very low (flat) nasal bridge and short and wide nasal apertures .[11]

Metric studies on the nasal and piriform apertures have been peaky carried out among Nigerian populations and with the advances in reconstructive rhinoplastry and cosmetic rhinoplatsy,[12-13] a comprehensive knowledge of the morphometry of nasal bone and piriform aperture among Nigerian skulls is paramount , hence this study classified nasal and piriform apertures of adult Nigerian skulls, anticipating that it will serve as a useful anthropological data about Nigerians in this field . An understanding of nasal anatomy will provide an insight in the field of anthropology and Otolaryngology.[8]

MATERIALS AND METHODS

This study was an observational cross sectional study. The work described the mophometry of 51 nasal bones and piriform apertures of adult Nigerian skulls. Skull bones of unknown age and sex were obtained from Anatomy museums of University of Port Harcourt,Abia State University, University of Calabar, Nnamdi Azikiwe University and Niger Delta University.Skulls with intact nasal bone showing the naso-frontal, naso-maxillary junctions, nasal ridge, rhinion and molar teeth were used for this study. Ethical consent was sourced from the Research and Ethics Committee of the Faculty of Basic Medical Sciences, University of Port Harcourt, Rivers State, Nigeria.

Digital calliper with an accuracy of 0.1mm was used to obtain linear measurements of nasal bones and piriform apertures. The height of Nasal bones (HNB) were evaluated from the nasion to the rhino while the width of the nasal bones were measured between the upper points of the lateral borders of the nasal bone . For the piriform apertures, linear measurements of the lower and upper width of piriform apertures, and height were obtained. Lower width of the piriform apertures (LWPA), was between the right and left margin of the anterior surface of the maxilla while upper width was between the right and left naso-maxillary junction. Height of piriform apertures (HPA), was from the nasal spine to the rhino of the skulls. Nasal index was calculated as the ratio of the width to height of the nasal bones while piriform aperture index was obtained as the ratio of the lower width to upper width of the piriform apertures. Mean, standard deviation ,tables and graph were used to illustrate variables .

The approximate area of the piriform aperture (APA) was adopted from the knowledge of the area of the irregular trapezium. For statistical analysis , analysis of variance (ANOVA) which is a parametric test for more than two independent variables was used to define the types and shapes of the nasal bones and piriform apertures. Person's Correlation Coefficient was used to find an association between nasal and piriform aperture index. All analyses were conducted using SPSS programme (version 20). Significance was accepted at $p< 0.05$

Fig 1: Photoplate of the height of the nasal bone (HNB).

Fig 2: Photoplate of the width of the nasal bones (WNB).

Fig 3: Photoplate of lower width of piriform aperture

Fig 4:Photoplate of upper width of piriform aperture

Fig 5:Photoplate of height of piriform apertures

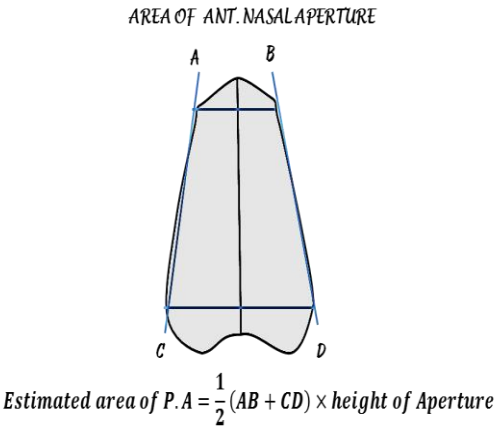


Fig 6: Area of piriform aperture

RESULTS

Figure 7: Proposed classification of the nasal bone based on nasal height and width. Type I|AB|<|CD|, long and narrow; Type II- |AB|=|CD|, squared/slightly circular; Type III |AB>|CD|, short and narrow.

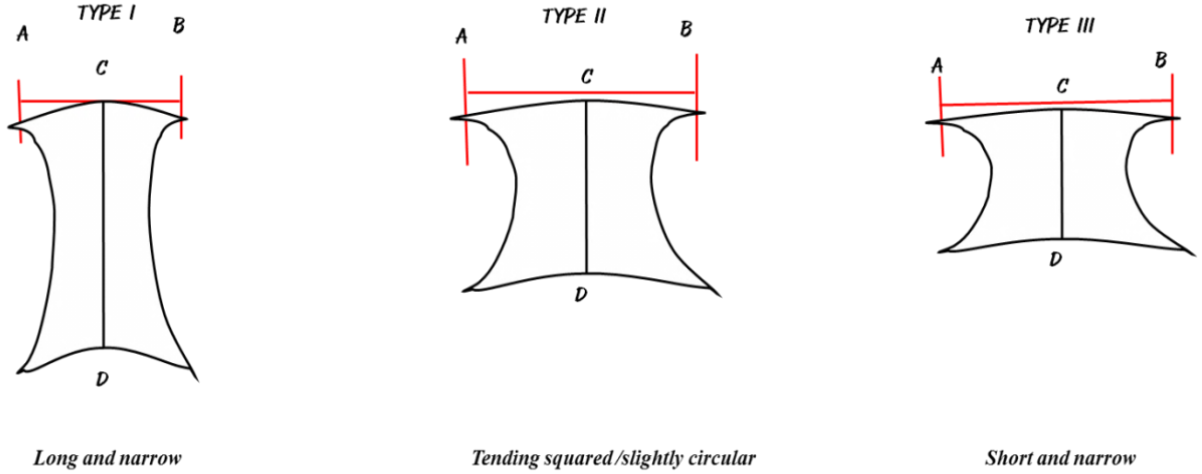
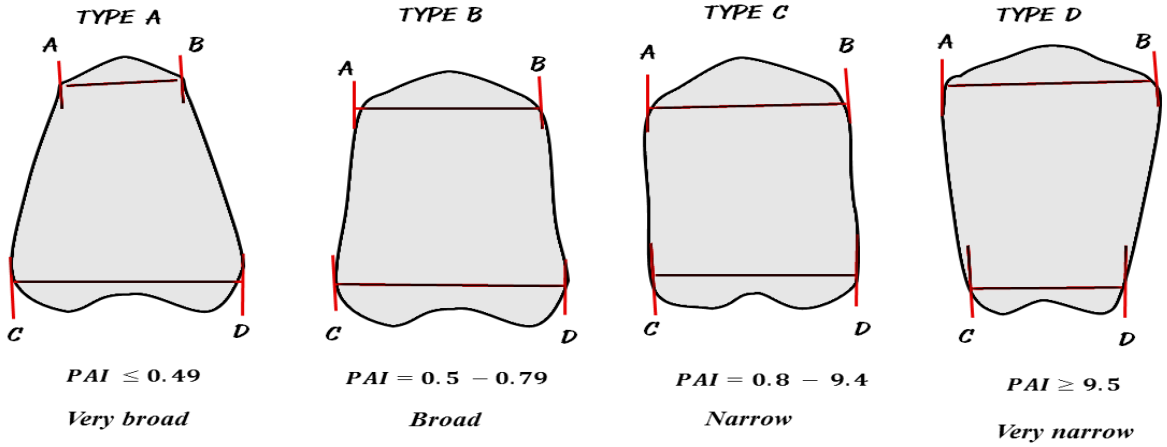


Figure 8: Proposed classification of the piriform aperture according to upper and lower width.



The study reclassified nasal shape based on their mophometry and modification of indices (Fig VII,VIII). Three types(Type I,II,III) were proposed from this study .Type I where the height was longer than the width with an index of ≤0.80 .Type II being squared/slightly circular in which the height was almost equal to the width with an index between 0.8-9.4 . Type III described as short and narrow where the height was shorter than the width with an index ≥9.5. Piriform aperture was reclassified into Type A (Very broad) with an index (PAI) ≤ 0.49 , Type B (Broad) with PAI 0.5-0.79 , Type C classified as narrow with PAI 0.8-9.4, Type D (Very narrow) with PAI ≥ 9.5

Table 1: Descriptive statistics of nasal bones and piriform apertures

Variables	Mean±S.D (mm)	Std. Error	Range(mm) min –max
WNB	11.31±2.9	0.41	3.35 – 18.77
HNB	20.96±3.74	0.54	11.27 - 27.16
HPA	32.21±3.882	0.54	23.34 - 47.01
UWPA	16.41±2.31	0.32	10.[illegible]
LWPA	27.07±2.3	0.32	20.17 - 33.3
P.A INDEX (LWPA/HPA)	0.61±0.08	0.01	0.36 – 0.75
NASAL INDEX (WNB/HNB)	0.55±0.16	0.02	0.17-0.87
AREA OF NASAL APERTURE	699.12 ± 97.60	0.01	552.09- 938.05

WNB- Weight of Nasal Bone; HNB- Height of Nasal Bone; HPA- Height of Piriform Aperture; UWPA- Upper Width of Piriform Aperture LWPA- Lower Width of Piriform Aperture.

Table 1 showed thatthe mean height(HNB) and width of the nasal bone (WNB) were obtained as 20.96±3.74 and 11.31±2.9mm respectively. The mean height of piriform aperture (HPA), upper width of piriform aperture (UWPA) , lower width of the piriform aperture (LWPA) ,piriform aperture index (PAI) ,nasal index (NI) and area of nasal aperture were 32.21±3.88mm, 16.41±2.31mm, 27.07±2.3mm, 0.61±0.08mm, 0.55±0.16mm and 699.12±97.60mm^2(Table 1) . The range observed for the width of the nasal bone (WNB), height of nasal bone (HNB), height of piriform aperture (HPA), upper width of piriform aperture (UWPA), lower width of the piriform aperture (LWPA), piriform aperture index, nasal index and area of nasal apertures were presented in table i respectively.

Table 2: Descriptive statistics of predominant nasal types

VARIABLES	Mean Height ± S.D	Mean Weight ±S.D (mm)	Mean HPA± S.D(mm)	Mean LWPA± S.D(mm)	Mean UWPA ± S.D(mm)	Mean Nasal Index(mm)	Mean Aperture Index(mm)	Area of nasal apertures (mm^2)
TYPE I	21.14± 3.70	11.20± 2.91	32.19± 3.96	26.99±2.30	16.52±2 .33	0.54±0.15	0.61±0.0 7	699.32± 99.56
TYPE II	16.45±0.78	13.83± 1.45	32.52± 1.25	29.07± 1.98	13.64 ±2.33	0.84±0.04	0.47 ±0.01	694.19 ± 20.65

Table II reported descriptive values for the most predominant nasal types. Findings showed that Type I (long and narrow) showed a mean width (WNB) and height of nasal bone (HNB) as 11.20±2.91 and 21.14±3.7mm while that of Type II(tending squared/cicular) were 13.83±1.45 and 16.45±0.78mm .

Table 3: Descriptive statistics of predominant aperture types

VARIABLES	Mean Nasal Height ± S.D (mm)	Mean Nasal Weight ±S.D (mm)	Mean HPA± S.D(mm)	Mean LWPA± S.D(mm)	Mean UWPA± S.D (mm)	Mean Nasal Index(mm)	Mean Aperture Index (mm)	Area of nasal apertures(mm^2)
TYPE A	18 .64 ± 4.61	13.92 ± 1.99	33.92± 3.09	29.90± 1.10	11. 44 ± 0.50	0. 76 ±0.12	0. 38± 0.02	700.28 ± 49.27
TYPE B	21.10 ± 3.69	11. 14± 2.88	32.10± 3.93	26. 89± 2.25	16.72 ±2.00	0.54 ± 0.16	0.62 ±0.06	699.05 ± 100.15

Table III reported Type A (Very broad) and B (Broad) as the most predominant piriform aperture types. Findings showed that Type A presented a mean value of 13.92±1.99, 18.64±4.61mm, while Type B displayed a mean value of 11.14±2.88, 21.1±3.69mm, for the width of nasal bone (WNB) and height of nasal bone (HNB) respectively .

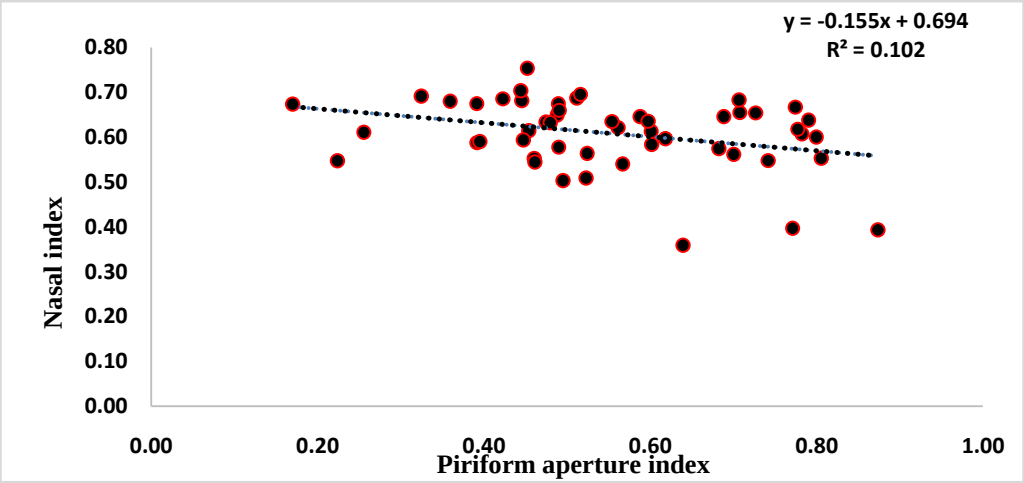


FIG 9: Scatter plot of Nasal Index (NI) against Piriform Aperture Index (PAI)

A coefficient of -0.320was obtained between nasal index and piriform index (Fig 9). Analysis of variance was used to depict any significant differences within groupsfor Type I and Type II nasal bone types. Findings showed that there was no significant difference within the groups. However significant differences was observed for nasal index (NI) (F=7.341, P= 0.009,=0.171) and piriform aperture index (PAI) (F=6.836, P= 0.012,=0.038) within the groups .

DISCUSSION

The shape of the nasal bone and that of the piriform aperture which is dependent on the area of the piriform aperture gives the overall shape of the nose. The shape of the piriform aperture observed in this study was the broad (Type A) which was more frequent and very broad (Type B). Findings were different from metric studies on various population. Adil et al.(2016) observed a triangular to oval shaped piriform apertures among Indian skulls .[14] In a study carried out among skulls from the Ashanti tribe in West Africa, black Americans, Austrians in Northern Europe, and American Indians , findings showed that the piriform apertures in the Ashanti was oval, Austriansand American Indian was triangular , Black Americans varied from triangular to oval, showing dissimilarity in different populationgroups.[15]Wolpoff ,(1968) stipulated that climatic effect could affect the parameters of the piriform apertures.[16]The Nigerian population being among the Negroid race is known to have the flat and broad type of nose.[11,17] Other studies carried out among various ethnic groups in Nigerians observed a short and broad nose .[18-20]

Several Authors are of the opinion that the piriform apertures directly affects the heating and humidity of the inspired air , speculating that the shapeof the piriform aperture is adapted to the environment in a way that reflects geographical variations .[9,15,21] Hall and Hall, (1995) stipulated that broader noses are favoured in warmer and moister climate which is as a result of natural selection in human evolution .[22] It was observed from this study that the mean upper width of the piriform apertures reported from this investigation was lower than values obtained among Brazilian, Korean , Ashanti and German skulls, [3,8,15,23] while the mean lower width of the piriform apertures was higher than those found among Cantín et al.2009; Hwang et al.2005Ofodile ,1994;Hoffman et al.1991; Erdem et al. 2004.[3,8,15,24-25] The height of the piriform apertures was lower than those of Cantin et al.(2009) and Boyan et al. (2007).[3,26]

Nasal bones are paired bones that project like a tent on the frontal process of the maxilla.[27]In the midline they articulate with one another.[27]The nasal septum lies beneath this midline articulation,superiorly the nasal bones are thicker where it articulates with the nasal process of frontal bone .[27]

Type I (long and narrow) and Type II (tending squared/slightly circular) were types of nasal bones discovered in this study. Type I was similar to Type 1-3 of Lang and Baumeister (1982) classification.[23] It was also in concordance with Hwang et al., (2015) Type A and B nasal classification.[8] According to Porter and Olison, (2003) the nose is considered broad when the upper nasal width is less than the lower nasal width and classified narrow when the stated dimensions are equal or the upper dimension is greater than the lower.[28]Findings from this investigation depicts that the mean height and width of the nasal bones were lower than those of Hwang et al.(2005) for the Korean population but was higher than that of Boyan et al.(2007) who carried out a study among the Anatolian population .[8,26]

Findings on the piriform aperture and nasal bone morphology among Nigerian skulls will be beneficial to

forensic anthropology in identification of humans, creating a biological profile for missing individuals and provide information for surgical procedures and nasal reconstruction in Otolaryngology.

REFERENCES

1. Tae-Sun H, Jihwan S, Ho Y, Bryun-Phil C,Ho-Suck K. Mophometry of the nasal bones and piriform apertures in Koreans. Ann Anat.,2005;187:411-14.
2. Karadag D, Ozdoll NC, Beriat KK, Akinci T. CT evaluation of the bony nasal pyramid dimensions in Anatolian people. Dentomaxillofacial Radiology. 2011;40:160–64.
3. Cantín, LM , Suazo GIC, Zavando MDA , Smith RL. Sexual dimorphism determination by piriform aperture morphometric analysis in Brazilian human skulls. Int. J. Morphol., 2009; 27:327-31.
4. Prado FB, Caldas RA, Rossi AC, Freire AR, Groppo FC, Caria PHF, et al. Piriform aperture morfometry and nasal bones morphology in Brazilian population by postero-anterior Caldwell radiographys. Int J Morphol. 2011;29(2):393–98.
5. Rogers TL. Determining the sex of human remains through cranial morphology. J. Forensic. Sci.,2005; 50:493-500.
6. Williams BA, Rogers T. Evaluating the accuracy and precision of cranial morphological traits for sex determination. J. Forensic Sci., 2006; 51:729-35.
7. Hommerich CP, Riegel A. Measuring of the piriform aperture in humans with 3D-SSD-CT-Reconstructions Ann. Anat., 2002; 184:455-9.
8. Hwang TS , Song J, Yoon H, Cho BP, Kang HS. Morphometry of the nasal bones and piriform apertures in Koreans. Ann. Anat.,2005; 187:411-4.
9. Lee SE ,Yang TY, Han GS , Kim YH, Jang TY. Analysis of the nasal bone and nasal pyramid by three dimensional computed tomography. Eur. Arch.Otorhinolaryngol., 2008; 265:421-4.
10. Molnar S. Human Variation: Races, Types and Ethnic Groups. Pearson Prentice Hall.2006; Pp. 4.
11. Norman JS. Forensic Anthropology and the Concept of Race: If Races don't exist, why are Forensic Anthropologists so good at identifying them? Social Science and Medicine.1992; 34(2): 107-111.
12. Oludiran OO. Reconstructive rhinoplasty in Benin City, Midwestern Nigeria: Indications,techniques and outcome. Annals of Biomedical Sciences; 2012; 11(2).
13. Akinbami BO. Assessment of the Need for Cosmetic Rhinoplasty in a Nigerian Population. Annual Research & Review in Biology; 2005; 5(6): 529-534.
14. Adil A, Aparna D,Manta R.Mophometric study of nasal bone and piriform aperture in human dry skull of Indian origin.J Clin.Diagn.Res.2016;10(1):05-07.
15. Ofodile FA. Nasal bones and pyriform apertures in blacks. Ann Plast Surg. 1994;32:21–26
16. Wolpoff, M. H. Climatic influence on the skeletal nasal aperture. Am. J. Phys. Anthropol. 1968; 29:405-23.
17. Carey JW, Steegmann AT.Human nasal protrusion, latitude, and climate. Am. J. Phys. Anthropol.1981;56(3):313- 319.
18. Oladipo GS, Olabiyi AO, Oremosu AA , Noronha CC.Nasal indices among major ethnic groups in Southern Nigeria.Sci. Res. Essay. 2007; 2(1):20-2
19. Eboh DEO. Nasal indices among Bini Adolescents in Edo State,Nigeria.Int.J.Mophology.2011;29(4):1231-4.
20. Fawehinmil HB, Ligha AE. Subnasale to Gnathion Distance and Nasal Index of Children with Homozygous Sickle Cell Disease in Port-Harcourt. Eur. J. Gen. Med. 2010;7(2):197-202.
21. Hwang TS , Kang HS. Morphometry of nasal bases and nostrils in Koreans. Ann. Anat.2003; 185:189-93.
22. Hall RL, Hall D. Geographic variation of native people along the Pacific Coast. Hum. Biol.1995; 67(3): 407-426.
23. Lang J, Baumeister R. Über das postnatale Wachstum der Nasenhöhle. Gegenbaurs Morphol.1982; 128:354-93.
24. Hoffman BE, McConathy DA, Coward M, Saddler L, Relationship between the piriform aperture and interalar nasal widths in adult males. J. Forensic Sci.1991; 36: 1152–1161
25. Erdem T, Ozturan O, Erdem G, Akarcay M, Miman MC. Nasal pyriform aperture stenosis in adults. Am. J.Rhinol.2004; 18:57-62.
26. Boyan N, Kizilkanat E, Tekdemir I, Soames R, Oguz O. Usefulness of Nasal Morphology in Surgical Approaches for Skull Base Tumours. Neurosurg Q. 2007;17(4):283–86.
27. Lee SE, Yang TY, Han GS, Kim YH, Jang TY. Analysis of the nasal bone and nasal pyramid by three dimensional computed tomography. Eur. Arch.Otorhinolaryngol.2008; 265:421-4.
28. Porter JP, Olson KL.Analysis of the African American female nose. Plastic Reconstruct. Surg.2003; 111(2):627-628.