EVALUATION OF NASAL INDEX USING COMPUTED TOMOGRAPHY AMONG HAUSA-FULANI TRIBE IN KANO, NIGERIA

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Abstract

Background: Cephalometry continues to be a versatile technique in the investigation of the craniofacial skeleton because of its validity and practicality. The nasal index (NI) cephalometry of Hausa-Fulani tribe has been studied by so many researchers using callipers and lately radiographs. However, despite its added advantages, NI determination using Computed Tomography images is rare particularly among the Hausa-fulani tribes.

Objectives: The study aimed to determine the nasal index (NI) of the Hausa-fulani tribe, to classify their nose type and to establish if sexual differences exist in NI among Hausa-fulani tribe in Kano.

Methodology: Following ethical approval, a cross sectional prospective study was conducted at the CT-suit unit in a tertiary health facility in Kano. 153 adult head scanograms that satisfied inclusion criteria were recruited from June-September 2017. Nasal height and width were measured on a well-positioned postero-anterior CT-Scanograms. Nasal Index was determined via the variables measured. Nose type classification was based on n Martin and Sallar.

Results: Mean NI for the population was established to be 67.20 ± 2.54 and 66.36 ± 5.92 for males and females respectively. Majority of Hausa-fulani tribe have the leptorrhine nose type as distribution based on nose type was found to be 127 Leptorrhine (83%), 25 mesorrhine (16.3%), 1 platyrrhine (0.7%) in the population. Sexual difference also exists in NI among their gender ($p<0.05$).

Conclusion: The study has established Hausa-fulani tribe nose type. This will be of importance in forensic science, orthopaedic gadgets developments, rhinosurgery and anthropological studies.

Keywords: Nasal Index, Nose shape, Computed Tomography, Hausa-Fulani.

Introduction

No two individuals are exactly alike in all their measurable traits, even genetically identical twins (monozygotic) differ in some respects [1]. Skeletal development is influenced by genetic, physiological, nutritional and anatomical factors. Variations in these factors manifests as differences in skeletal proportions between males and females in different geographical areas. A desirable means of giving quantitative expression of skeletal characteristics among individuals may give an explanation to their genetic makeup and/or the influence of these factors across boundaries and ethnicity [2].

Cephalometry is an important aspect of physical anthropometry where by the dimensions of head and face is objectively determined [3,4]. It continues to be the most versatile technique in the investigation of the craniofacial skeleton because of its validity and practicality (Maina *et al*., 2013). Indices

such as cephalic, facial, orbital and nasal indices are useful anthropological tool for analysis of racial differences in a population and also to ascertain sexual differences [5,6]. In the fields of forensic medicine and anthropology, Nasal Index (NI) is relevant in distinguishing the race, ethnicity and sex of individuals whose identity is unknown [5-8]. It is also useful in the analysis and classification of fossil remains in a population [6].

Various studies have reported the varieties of nose and nasal indices of various ethnicities in Nigeria [5,8] and across the world [5,8,9]. These results were obtained manually either directly or indirectly using various types of calipers. However, with the introduction of cephalometric radiography by Holly Broadbent in 1931, the use of radiographs has been heavily explored by researchers in obtaining cephalometric results especially of orthodontics and other craniofacial indices [10]. Cephalometric radiographic analysis is performed by tracing and measuring cranial landmarks on a radiograph using linear and angular values [11, 12]. However, despite its widespread adoption, the technique is time-consuming and has several drawbacks, including a high-risk of error in tracing, landmark identification and measurement, differential magnification of bilateral structures, and superimposition of craniofacial structures [13, 14] These are errors that can be grouped into those related to the image acquisition, pattern identification and technical measurement [14]. Reproducibility of measurements by the operator is also a significant factor in determining the accuracy of any method of analysis.

With the rapid evolution of digital radiography, digital tracing has slowly replaced the manual tracing methods [11-14]. Digital radiography and conversion of radiographic films to digital images have provided several advantages, such as instant image acquisition, reduction of radiation dose, facilitated image enhancement and archiving, elimination of technique-sensitive developing processes and facilitated image sharing. Both require less storage space than conventional cephalometric film [14]. Digital archiving is also a valuable method for overcoming the problem of film deterioration, which has been a major source of information loss in craniofacial biology on radiographs over time [11]. This has been a major drawback in the past for researchers wishing to validate an already published work using cephalometric radiography.

Modern computed tomography (CT) allows the human body to be accurately visualized in any plane, including three-dimensional (3-D) reconstructions. Clinicians treating patients for craniofacial anomalies often use a localization scan, called a CT scanogram, to produce a survey scan of the region of interest [15]. This is a projected two-dimensional image of a three-dimensional object and is similar in appearance to a conventional projected radiographic image [15]. This solves the issue of superimposition associated with conventional radiographs as it allows focusing of anatomic structures accurately. Also, CT scanograms proffers clearer images, more precision and reliability during the visualizing of landmarks compared with conventional cephalometric radiographs [16]. Today, existing software allows us to take full advantage of CT scans in performing cephalometric measurements and developing craniofacial analyses. These measurements, made on CT images, can be more accurate and reproducible and have the potential to aid in the craniofacial diagnosis of facial asymmetries, functional shifts, and canted occlusal planes [3]. Despite these obvious advantages of this system , it is interesting to find out that most works in the country regarding nasal index and cephalometry in general were carried out

using different types of calipers and measuring tapes to obtain data from either plain radiographs or dry skulls [5-7,12,13,17,]. This has earlier been highlighted to measurement error due to overcrowding of reference anatomical landmarks as a result of superimposition of structures on other dense radiopaque structures.

The study aims to provide baseline data of nasal index and nose type of the Hausa-fulani tribe in Kano using normal CT-scanograms and to determine if sex differences exist between them. This method will obviously overcome the deficiencies inherent to cephalometric radiographic or manual caliper methods. Results from this study will guide forensic experts, rhinoplastic surgeons in reconstructive facial surgeries, anthropologists in classification of fossil remains and orthopedics in designing various orthopedic equipments.

Materials and Methods

The study was a cross sectional prospective study that was conducted between June - September 2017 in the CT suite of Muhammad Sanusi Radio-Diagnostic Centre, a unit under the Radiology department of Aminu Kano Teaching Hospital (AKTH), Kano. The hospital serves as a referral center to even neighboring states. Kano is situated in the Sahelian geographic region, south of the Sahara. It is the commercial nerve center of Northern Nigeria and is the third largest city in Nigeria after Lagos and Ibadan [18]. It is the most populous state in Nigeria, with about 9,383,682 million people according to the 2006 census [18]. These figures are expected to rise significantly presently. The city is majorly dominated by the Hausa-Fulani people. As in most parts of Northern Nigeria, the Hausa language is widely spoken in Kano [18].

Participants were those whose 2 parents were Hausa-fulani origin. They were ruled out for any history of trauma, physical deformities, surgery of face or nose and no history of cleft lip or palate. Following ethical approval, one hundred and fifty three (153) normal CT-scanograms comprising of 100 males and 53 females were recruited using simple random sampling. Their age ranged from 18-87 years. The CT-scanner was a 160-slice Toshiba Prime Aquilion with 512×512 reconstruction matrices, 203×243×107cm gantry size and 78cm gantry opening. Scanograms were acquired with participants lying supine on the couch, the head was placed in the gantry with the Frankfurt horizontal plane perpendicular to the gantry. Gantry tilt at 0°, posterior anterior (PA) scanograms were acquired using the following parameters: 120 kVp, 380 mA, 1s rotation time and 1 mm slice thickness. Confidentiality was guaranteed by the activation of partial image anonymity feature which masked subject's name, examination number and clinical diagnosis. Following image acquisition, scanograms were transferred to DICOM format.

Fig1: Nasal width measurement on CT monitor

Fig. 2: Nasal height measurement on CT monitor

Nasal width and nasal length were measured (three times on a single subject at different interval and average taken) with an on-screen linear cursor on the CT screen using the standard Martin and Saller method[19]. Nasal width was measured as the maximum distance between the most laterally placed points on the nasal opening. Nasal height was measured as the straight distance between Nasion to subnasale. Nasal Index was thus determined as:

NI = nasal width/nasal height × 100.22

Data collected was analyzed using statistical package for social sciences (SPSS), version 20.0. Mean, Standard Deviation (SD) and percentage was used to express data. Independent samples t-test was used to check for differences between sexes. A p-value of 0.05 was used as level of significance.

Results

The overall mean and standard deviation (SD) by sex of nasal height and nasal width was determined to 54.39 ± 2.53 and 36.48 ± 2.78 for males and 54.28 ± 2.54 and 35.00 ± 2.64 for females respectively as can be seen in table 1.

Table 1: Mean and SD of Nasal height and width according to sex.

Anthropometric Parameter	**Males Mean (mm) ± SD**	**Females, Mean (mm) ± SD**
Nasal height	54.39 ± 2.53	54.28 ± 2.54
Nasal width	36.48 ± 2.78	35.00 ± 2.64

Nasal Index was also determined among the participants and was categorized based on gender as can be seen in table.2.

Table 2: Descriptive statistics of nasal index of males and females

Variable	**Gender**	**Mean ± SD**	**Minimum**	**Maximum**
Nasal Index	**Males**	67.199 ± 2.5420	59.30	88.20
	Females	66.364 ± 5.9243	58.60	81.30

The frequency (percentage) distribution of nose shapes from nasal index among Hausa-Fulani (males and females) were shown to be leptorrhine: 81(81%) for males and 46 (86.6%) for females, mesorrhine: 18 (18%) for males and 7(13.2%) for females, plattyrrhine: 1(1%) for males and 0(0%) for females as can be seen in table 3

Table 3: Frequency distribution of the Nose types amongst the Hausa-Fulani males and females

Nose shapes	Males Frequency (%)	Females Frequency (%)	Total Frequency (%)
Leptorrhine	81(81.0%)	46(86.8%)	127(83%)
Mesorrhine	18(18.0%)	7(13.2%)	25(16.3%)
Platyrrhine	1(1.0%)	0(0%)	1(0.7%)
Total	100(100%)	53(100%)	153(100%)

The study also established that sexual dimorphism exist in nasal index between males and females ($p<0.05$) as can be seen in table 4

Table 4: Independent t test of nasal index between sex.

Variable	**N**	**t-value**	**Df**	**p-value**
Nasal Index (male +female)	153	118.45	99	0.007

Discussion

Surgical interventions to the nasal region are uncommon in our locality when compared to the western world. This may perhaps be due less preference given to cosmetic surgery by the populace and the subsequent shortage of rhinoplastic surgeons. Currently, the tide is changing and the few surgeons around still require an objective normogram using the latest methodology that will serve as reference data regarding nose of the Hausa-fulani tribe.

Many studies have shown the racial and ethnic differences in Nasal Index (NI) between different populations and with different climatic variations [5-7,9]. Majority of black Africans (Indo-African and Afro-American) were reported to be Platyrhine probably because of the nature of the African climate [5,6]. In fact, strong correlation was reported between climate and nose shape, expressed as the nasal index [17]. Flat and narrow nose (Leptorhine) which is attributable to most caucacians is reported to be favored in cold/dry climates, whereas broader nose (Platyrhine) is seen in individuals living in warmer/moist climates [5]. In the current study, overall mean ±SD of nasal height and width was estimated to be 54.30mm±2.74 and 36.30mm±5.75 respectively. These findings are lower than what was reported by Umar *et al*. in 2006 and Adebisi in 2003 who worked on Hausa-fulani in Jos (Middle-Belt) and Zaria (northern), Nigeria respectively [20,21]. Slight difference was noticed to exist between the present study and the works of Mohammed *et al*. in 2018, where they reported the nasal height and width to be 5.45 0.47cm and 3.91 0.42cm respectively for the same Hausa population in Northwest Nigeria [6]. While these variations are subtle, the differences could be attributable to methodology differences. All these cited studies used external calipers as against the present study that utilized CT scanograms thus measuring

directly from osseous tissue while eliminating the potential variability from subcutaneous tissues especially in obese individuals.

Nasal Index in the present study was determined to be 66.90 ± 5.755. The NI based on gender was also established to be 67.20±2.54 and 66.36±5.92 for the males and females respectively. The classification of nose type is done using the NI. Thus, from the present study's established values, the Hausa-fulani tribe belongs to the leptorrhine nose type even among gender. This is in agreement with the works of Taura (2002) and Umar *et al*. (2006), where the former worked on Hausa-Fulani tribe from Kano (Northwestern) while the latter worked on a heterogenous ethnic settlement in Jos (North-central), Nigeria. Both studies reported a mean nasal index of 68.8 and 67.1 respectively [20,22]. Both studies established values falling under the leptorrhine nose shapes. It also agrees with other studies carried among other tribes which reported leptorrhine nose type in Serbians: (NI: 67.56 in males and 66.01 in females), North American Whites (NI: 65.5 in males and 64.2 in females), Armenians (NI: 63.8) and Turkish citizens (NI: 61.45) [23,24]. Also, independent studies conducted by Anas and Saleh in 2014 [5] and Mohammed *et al* in 2018 [6] in the same population reported that the Hausa's have predominantly Mesorrhine type of nose. The simple explanation to the discrepancy in studies relating to NI among the Hausa-fulani may be as a result of interaction of environmental/ climatic conditions and inter-tribal marriages. Anas and Saleh in 2014 and Oladipo et al., in 2008 explained that certain variables are known to determine the shape of the nose [5,7]. These variables includes: race, tribes and environmental /climatic conditions; with narrower nose being favoured in cold weather and dry climate and broader nose in warmer climate. Migration, warmer climate in the north and the vast inter-tribal marriages between Hausa and Fulani ethnic tribes whom share a lot of histories after the Fulani war may have accounted for these inconsistencies.

Mean NI values for males were higher than those of females and the difference is statistically significant ($p<0.05$). This is in agreement with the works of Anas and Saleh 2014 [5], Mohammed et al 2018 [6] that worked in the same population. It also agrees with the work of Oladipo et al. in2010 [7], who reported higher values of nasal index in males than females for adult Ijaws of Bayelsa state, Nigeria. Adebisi (2003) who worked on Hausa-fulani in northern Nigeria reported a similar finding and he further explained that his finding could be due to endocrine influence on postnatal growth of bones [21]. At preadolescent age, bone growth in both sexes is almost at the same rate and of equal dimension, but with the onset of puberty in females, the inhibitory effects of oestrogen on osteoblast activities at the growing ends of the bone appear to retard the bone growth. Hence, the lower dimension recorded. However, this is not in agreement with the works of Oladipo et al. 2009 who reported that the Andoni and Okrika tribes of Rivers State, Nigeria, had significantly higher mean nasal index values for females than males[25].

Conclusion

Nasal Index has been studied in most ethnic communities using the external callipers. The use CT-scanograms to evaluate NI in the present study presents a novel data particularly for the Hausa-fulani population who were separate ethnic groups but share a lot of physical, cultural and religious qualities that presently are regarded as same ethnic groups. Majority of Hausa-fulani has been found to have a leptorrhine shape of nose and sexual differences exist between their sexes.

Recommendations

Similar study should be carried out to compare the NI of Hausa and Fulani ethinc groups whom 2 parents are Hausa and Fulani respectively using this method. This may provide independent anthropometric data for research and increase the pool of data especially for forensic scientists.

Conflict of Interest

We declare there was any conflict of interest in the entirety of the manuscript

References

1. Obaje SG, Hamman WO, Ibegbu AO. Anthropometric study of cephalometric indices among Idoma and Igede ethnic groups of Benue State Nigeria. *International Journal of Medicine and Biomedical Research*. 2015; *4*(1).
2. Guyton A. and Hall J. Textbook of Medical Physiology. 11th ed. Philadelphia: Saunders publishers;2005.
3. Chidiac JJ, Shofer FS, Al-Kutoub A, Laster LL, Ghafari J. Comparison of CT scanograms and cephalometric radiographs in craniofacial imaging. *Orthodontic Craniofacial Resources* 2002;*5*(2):104–113.
4. Obaje SG, Hamman WO, and Ibegbu AO. Anthropometric study of cephalometric indices among Idoma and Igede ethnic groups of Benue State, Nigeria. *International Journal of Medicine and Biomedical Research* 2015;*4*(1).
5. 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.
6. 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.
7. Oladipo G., Fawehinmi H, Suleiman Y. The Study Of Nasal Parameters (Nasal Height , Nasal Width , Nasal Index) amonst The Yorubas of Nigeria. *The Internet Journal of Biological Anthropology* 2008;*3*(2):2–6.
8. Porter JP and Olson KL. Analysis of the African American female nose. *Plast Reconstr Surg. 2003*;111: 627–628.
9. Farkas LG, Katic MJ, Forrest CR. International anthropometric study of facial morphology in various ethnic groups/races. *J Craniofac Surg. 2005*;16:615-46.
10. Broadbent HB. A new x-ray technique and its application to orthodontia. *The Angle Orthodontist 1981* 51(2):93-114
11. Polat O, Erkan CO, Ufuk TTM. Comparison of cephalometric measurements with digital versus conventional cephalometric analysis. *Europian Journal of Orthodontics 2009*;*31*(3):241–246.
12. Mohammed UF, Khan MA, Imran S, Sameera A, Qureshi A, Ahmed SA, Kumar S. Assessing the Reliability of Digitalized Cephalometric Analysis in Comparison with Manual Cephalometric Analysis. *Journal of Clinical and Diagnostic Research* 2016;*10*(10):20-23.
13. Thomos VA, Mathew S, Sivarajan S. A Novel Approach to Digitizing a Conventional Cephalometric Film. *J Ind Orthod Soc* 2014; *48*(4):500–503.
14. Tanwani HB, Potnis SS, Baralay SS, Patil SS. Comparison of Conventional and Digital

Cephalometric Analysis : A Pilot Study. *Journal of Dental and Allied Sciences* 2014; *3*(2):3–7.

15. Lee FCC, Harold JN, David RE. Evaluation of the CT scanogram for assessment of craniofacial morphology. *Angle Orthodontist* 2011;*81*(1):17–18.
16. Giulia R, Cavallini C, Michele C, 3D cephalometric analysis obtained from computed tomography. *Journal of Odontostomatologic Science 2012*; *2*(3–4):31–39.
17. Kpela T, Danborno B, Adebisi SS, Ojo SA. Anthropometric Study of Cephalic Index of adult Tiv and Idoma ethnic groups of North Central Nigeria. *Global Adv. Res. J. Med. Medical Science 2012*;*5*(4):109–115. ISSN: 2315-5159.
18. Asabe D, Abdulkarim U. Yandaba: the "terrorists" of Kano Metropolitan? *Youth and Health in Kano Today, special issue of Kano Studies,* pp. 85-112.
19. Martin R, Saller K, Lehrbuch der Anthropologie, 3rd ed. Gustav Fischer Verlag: Stuttgart, 1957; p. 11.
20. Umar MBT, Singh R, Shugaba AI. Cephalometric indices among Nigerians. *Journal of Applied Science 2006*; *6*(4): 9939–942. (https://doi.org/10.3923/jas.2006.939.942)
21. Adebisi SS. Sex determination from skulls of Hausa-Fulani in Northern Nigeria. *Annuals of American Medicine* 2003;*2*(1):22–26.
22. Taura MG. Cephalometry of Hausa tribe of Kano State of Nigeria-a Preliminary study. M.A. Thesis, Submitted to *Postgraduate, ABU Zaria 2002*.
23. Farkas LG, Katic MJ, Forrest CR. International Anthropometric Study of Facial Morphology in Various Ethnic Groups/Races. *Journal of craniofacial surgery 2005;* 16(4):615-646.
24. Jovanović J, Jeremić D, Jovanović B, Maja V, Sazdanović P, Maja S. Nasal morphological characteristics of the Serbian population. *Arch Biol. Sc. Belgrade 2014*;66(1):227–234.
25. Oladipo GS, Eroje MA, Fahwehinmi HB. Anthropometric comparison of nasal indices between Andoni and Okrika tribes of Rivers State, Nigeria. *International Journal of Medicine and Medical Sciences 2009;1(4):*135-137.